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PARAMETRIC STUDY OF MACHINE FOUNDATION SUPPORTING RECIPROCATING MACHINE USING ELASTIC HALF SPACE MODEL BY FEM AND CLASSICAL METHOD

V.R. Dhut, K.Y. Desai, K.N. Sheth

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Dharamsinh Desai University, Nadiad, India
dhutvivek@gmail.com

Abstract

Machine foundation is a requisite part of any industry; costs less as compared to the cost of machine and losses caused due to its failure can cause a big loss to any industry. A machine foundation needs to be designed carefully as static as well as dynamic loads are acting on it due to working of machine. The machine weighs several tons and is required to design the foundations having dimensions of several meters but amplitudes restricted to only a few microns. In addition, natural frequency of the machine foundation is depends on the soil lying below the foundation. This necessitated a deeper scientific investigation of dynamic loading and analysis. Elastic Half Space Method (Recommended by ACI 351.3R-04 - "Foundation for Dynamic Equipment") proposed by Whitman and Richart gives thus necessary importance to damping and embedment depth effect. Finite Element (FE) is the most commonly accepted analysis tool for solution of engineering problems. Effective Pre & Post-processing capabilities make modeling and interpretation of results simple. It is relatively easy to incorporate changes if any and re-do the analysis without much loss of time. STAAD Pro V8i is chosen for this Literature for analysis of Machine Foundation by Finite Element Method. In this literature three different machines of 150 rpm, 250 rpm, and 450 rpm are taken into account and six different soil types: Medium Clay, Stiff Clay, Hard Clay, Loose Sand, Medium Sand and Dense Sand are considered. Foundation sizes are optimized according to soil cases and each case is analyzed using classical method and FEM for 0.8, 1 and 1.2 times the soil parameters to cover the confidence range. Codal Criteria are taken as per IS:2974-1982.

Keywords: Machine Foundation, Elastic Half Space Model, Structural Dynamics

I. Introduction

Machine foundation require the special attention of a structural engineer. In addition to static loads due to weight, loads acting on foundation are dynamic in nature. In a machine foundation, a dynamic force is applied repetitively over a large period of time but its magnitude is small, and it is therefore necessary that the soil behavior be elastic, or else deformation will increase with each cycle of loading until soil becomes practically unacceptable. The amplitude of motion of a machine at its operating frequency is the most important parameter to be determined in designing a machine foundation, in addition to determining the natural frequency of a machine foundation soil system. Choice of type of machine foundation basically depends upon machine and its characteristics. Functional characteristics of the machine play a significant role while selecting the type of foundation.

There are three most important categories of machines that generate different periodic forces.

I. Reciprocating machines: Machines that produce periodic unbalanced force (such as compressor) belong in this category. The operating speed of such machines is usually less than 600 rpm. For analysis of their foundation, the unbalanced forces can be considered to vary sinusoidally. For such type of machines Block Type Foundation having relatively low Natural frequency is to be provided.

II. Impact machines: Machines that produce impact loads (such as forging hammers) are included in this category. Their speeds of operation are usually 60 to 150 blows per minute. Their dynamic loads attain a peak in a very short interval and then practically die out. Block foundation may also be provided for impact type machine foundation but their detail would be different from reciprocating machines.

III. Rotary machines: High speed machines like turbo generators or rotary compressors may have speed of more than 3000 rpm and up to 10,000 rpm. For such type of machine Frame type foundation is preferred.

Dynamic analysis of Machine Foundation is a trial and error method until it gives acceptable response hence it's a very time consuming and tedious task. Finite Element (FE) is the most commonly accepted analysis tool for dynamic analysis. It is relatively easy to incorporate changes if any and re-do the analysis without much loss of time, but validation of results is the main issue. This gave motivation to make a comparison of results by Excel worksheet with FEM by STAAD ProV8i.

In this paper a reciprocating machine mounted on block type foundation is discussed. Typical diagram of block-type machine foundation is shown in Figure 1.

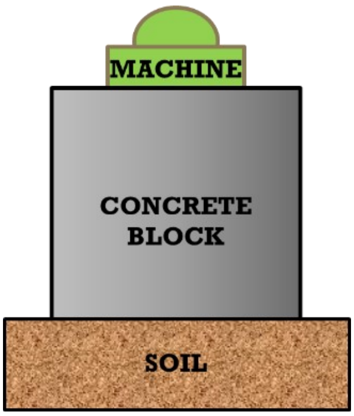


Figure 1: *Block Type Machine Foundation*

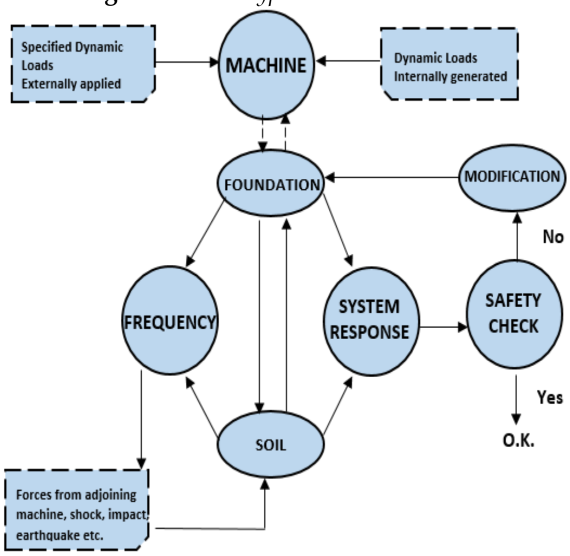


Figure 2: *Schematic Flow of Machine Foundation System*

Machine foundation system broadly comprises of machine, supported by foundation and foundation resting over soil as shown in schematic shown in Figure 2.

Dynamic Analysis of Block-Type Machine Foundation

A foundation concrete block is much rigid as compared to the soil on which it is resting. Hence, it can be assumed that when unbalanced forces acts, the foundation block undergoes translations and rotations with six degrees of freedom as shown in Figure 3.

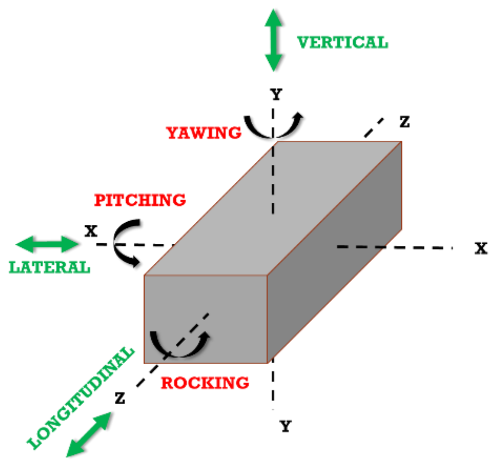


Figure 3: *Degrees of freedom of Machine Foundation*

II. Parameters used in this study

The details of parameters used in this study are listed below:

Modes of Computations for Dynamic Analysis

Machine foundations are analysed by elastic half space method using Classical solution and Finite Element Method. Classical solution of each case was carried by preparing excel worksheets and Finite Element Solution was done by modelling machine foundation in STAAD Pro. Software.

Machine Parameters

Machine parameters used in this study is table below.

Table 1: *Machine Parameters*

Parameters	Unit	Machine 1	Machine 2	Machine 3
Operating Speed	rpm	150	250	450
Weight	kN	36	10	25
Vertical Dynamic Force	kN	-	2.5	-
Horizontal Dynamic Force	kN	12	2	-
Horizontal Dynamic Moment	kN.m	-	4	4.9
Height of Machine C.G. above base of foundation	m	0.6	0.2	0.15

Soil Parameters

Soil properties of all the six soils used in this study are shown in summarized form in the table.

Table 2: *Soil Parameters*

SOIL TYPE		Unconfined Compressive Strength (qu)	N - Value
		kN/m2	
1	Medium Clay	75	-
2	Stiff Clay	200	-
3	Hard Clay	450	-
4	Loose Sand	-	8
5	Medium Sand	-	25
6	Dense Sand	-	40

III. Design Criteria as per IS: 2974 (Part I) – 1982

- Mass of Foundation >> Mass of Machine. (General rule of thumb to keep this ratio greater than 3 for Reciprocating Machines)
- The eccentricity <5% of the base dimension of block.
- 1.5 < Frequency Ratio < 0.4
- Limiting Amplitude of foundation is 200 Micron

IV. Finite Element Method for Machine-Foundation-Soil System

Finite element method enables the modeling of machine, foundation and soil in one go, which brings behavior of the machine foundation system closer to that of the prototype, resulting in improved reliability.

Rigid beam elements are used for modeling the machine whereas solid elements are used for modeling the foundation.

Soil is represented by a set of equivalent springs. A set of three translational springs and three rotational springs are either attached at the CG of the base or attached at each node at the base of the foundation in contact with the soil.

Modeling the foundation block with 8-noded brick elements or 10-noded tetrahedral elements works reasonably well and is considered good enough. A higher order solid element would increase the size of the model, requiring more computational time and power.

V. Formulations for Classical Solution

Correlations of dynamic properties of soil:

Correlation of N-value with Modulus of Rigidity (G):

$$G = 35 \times 161.5 \times N^{0.34} \times \sigma_0^{0.4} \tag{1}$$

Where, N = Uncorrected SPT Value
σ_0 = Effective Confining Pressure

Correlation of Unconfined Compressive Strength (qu) with Undrained Shear Strength (Su)

$$S_u = q_u / 2 \tag{2}$$

Correlation of Undrained Shear Strength (Su) with Modulus of Rigidity (G)

$$G = 487 \times S_u^{0.928} \tag{3}$$

Formulations for dynamic analysis of machine foundation by classical model:

Table 3: *Mass Moment of Inertia*

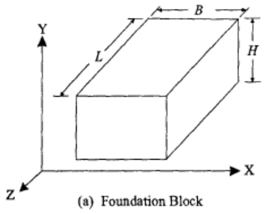
Rectangular Prism	 (a) Foundation Block	$I_x = \frac{1}{12}m\,(L^2+H^2)$ $I_z = \frac{1}{12}m\,(H^2+B^2)$ $I_y = \frac{1}{12}m\,(B^2+L^2)$ $I_y = I_y + \frac{mL^2}{4}$

Table 4: *Equivalent Radius*

Sr No	Mode	Equivalent Radius
1	Vertical	$r_y = \sqrt{\frac{LB}{\pi}}$
2	Horizontal	$r_x = \sqrt{\frac{LB}{\pi}}$
3	Rocking	$r_{\Phi x} = \sqrt[4]{\frac{LB^3}{3\pi}}$
4	Rocking	$r_{\Phi z} = \sqrt[4]{\frac{BL^3}{3\pi}}$

Table 5: *Embedment coefficients for equivalent radius*

Sr No	Mode	Coefficient
1	Vertical	$n_y = 1+0.6\,(1-\nu)\frac{h}{r_z}$
2	Horizontal	$n_x = 1+0.55\,(2-\nu)\frac{h}{r_x}$
3	Rocking	$n_{\Phi x} = 1 + 1.2 * (1-\nu) * (h/r_{\Phi x}) + 0.2*(2-\nu) * (h/r_{\Phi x})^3$
4	Rocking	$n_{\Phi z} = 1 + 1.2 * (1-\nu) * (h/r_{\Phi z}) + 0.2*(2-\nu) * (h/r_{\Phi z})^3$

Table 6: *Equivalent spring coefficients*

Sl No	Mode	Spring Stiffness
1	Vertical	$k_y = [G/((1-\nu))] * \beta_y * \sqrt{(B*L)} * \eta_z$
2	Horizontal	$k_x = 2*(1+\nu) * G * \beta_x * \sqrt{(B*L)} * \eta_x$
3	Rocking	$k_{\Phi x} = [G/((1-\nu))] * \beta_\Phi * B * L^2 * \eta_{\Phi x}$
4	Rocking	$k_{\Phi z} = [G/((1-\nu))] * \beta_\theta * B * L^2 * \eta_{\Phi z}$
5	Twisting	$k_\Psi = [G/((1-\nu))] * \beta_\Psi * B * L^2 * 8$

Table 7: *Mass ratio*

Sl No	Mode	Mass ratio(B)
1	Vertical	$B_y = [\frac{(1-\nu)}{4}] * [\frac{W}{\varrho * r_{y}{}^3}]$
2	Horizontal	$B_x = [\frac{(7-8*\nu)}{32*(1-\nu)}] * [\frac{W}{\varrho * r_{x}{}^3}]$
3	Rocking	$B_{\Phi x} = [\frac{3*(1-\nu)}{8}] * [\frac{I_{\Phi x}}{\varrho * r_{\Phi x}{}^5}]$
4	Rocking	$B_{\Phi z} = [\frac{3*(1-\nu)}{8}] * [\frac{I_{\Phi y}}{\varrho * r_{\Phi z}{}^5}]$

Table 8: *Geometrical Damping Ratio*

Sl No	Mode	Geometrical Damping Ratio
1	Vertical	$D_{gy} = [\frac{0.425}{\sqrt{B_y}}] * \alpha_y$
2	Horizontal	$D_{gx} = [\frac{0.288}{\sqrt{B_x}}] * \alpha_x$
3	Rocking	$D_{g\Phi x} = [\frac{0.15 * \alpha_{\Phi x}}{(1+n\varphi * B_{\Phi x}) * \sqrt{n\varphi * B_{\Phi x}}}]$
4	Rocking	$D_{g\Phi z} = [\frac{0.15 * \alpha_{\Phi z}}{(1+n\varphi * B_{\Phi z}) * \sqrt{n\varphi * B_{\Phi z}}}]$

Table 9: *Embedment coefficients for soil damping ratio*

Sl No	Mode	Coefficient
1	Vertical	$\alpha_y = \dfrac{1+1.9*(1-\nu)*(\frac{h}{r_{zy}})}{\sqrt{\eta_y}}$
2	Horizontal	$\alpha_x = \dfrac{1+1.9*(2-\nu)*(\frac{h}{r_x})}{\sqrt{\eta_x}}$
3	Rocking	$\alpha_{\Phi x} = \dfrac{1+0.7*(1-\nu)*(h/r_{\Phi x})+0.6*(2-\nu)*(h/r_{\Phi x})^3}{\sqrt{\eta_{\Phi x}}}$
4	Rocking	$\alpha_{\Phi z} = \dfrac{1+0.7*(1-\nu)*(h/r_{\Phi z})+0.6*(2-\nu)*(h/r_{\Phi z})^3}{\sqrt{\eta_{\Phi z}}}$

- **Frequency and Amplitude formulations**

1. Vertical Vibration

$$\omega_{nz} = \sqrt{\frac{K_z}{m}}$$

$$A_z = \frac{F_Z}{K_z\left[\left\{1-\left(\frac{\omega}{\omega_{nz}}\right)^2\right\}^2 + \left(2\xi_z\frac{\omega}{\omega_{nz}}\right)^2\right]^{1/2}}$$

2. Torsion Vibration

$$\omega_{nz} = \sqrt{\frac{K_\psi}{M_{m\psi}}}$$

$$A_z = \frac{F_Z}{K_\psi\left[\left\{1-\left(\frac{\omega}{\omega_{n\psi}}\right)^2\right\}^2 + \left(2\xi_\psi\frac{\omega}{\omega_{n\psi}}\right)^2\right]^{1/2}}$$

3. Coupled sliding and rocking Vibration

$$\omega_{nx} = \sqrt{\frac{K_x}{m}}$$

$$\omega_{n\phi} = \sqrt{\frac{K_\phi}{M_{m\phi}}}$$

- Damped natural frequencies obtained as the roots of the following equation:

$$\left[\omega_{nd}^4-\omega_{nd}^2\left\{\frac{\left(\omega_{n\phi}^2+\omega_{nx}^2\right)}{r}-\frac{4\xi_x\xi_\phi\omega_{nx}\omega_{n\phi}}{r}\right\}+\frac{\omega_{nx}^4\omega_{n\phi}^2}{r}\right]^2 + 4\left[\frac{\xi_x\omega_{nx}\omega_{n\phi}}{r}\left(\omega_{n\phi}^2-\omega_{nd}^2\right)+\frac{\xi_\phi\omega_{nd}\omega_{n\phi}}{r}\left(\omega_{nx}^2-\omega_{nd}^2\right)\right]^2=0$$

- Undamped natural frequencies can be obtained by the applied moment, can be obtained as below:

$$\omega_{nL\,2}^2=\frac{1}{2r}\left[\left(\omega_{nx}^2+\omega_{n\phi}^2\right)\pm\sqrt{\left(\omega_{n\phi}^2+\omega_{nx}^2\right)^2-4r\omega_{nx}^2\omega_{n\phi}^2}\right]$$

- Damped amplitudes for motion occasioned by the applied moment, can be obtained as below:

$$A_X=\frac{M_y}{M_m}\frac{\left[\left(\omega_{n\phi}^2\right)^2+\left(2\xi_x\omega_{nx}\right)^2\right]^{\frac{1}{2}}}{\Delta(\omega^2)}$$

$$A_\phi=\frac{M_y}{M_m}\frac{\left[\left(\omega_{n\phi}^2-\omega^2\right)^2+\left(2\xi_x\omega_{nx}\right)^2\right]^{\frac{1}{2}}}{\Delta(\omega^2)}$$

Where $\Delta(\omega^2)$ is given by Eq.

$$\Delta(\omega^2)=\left[\left\{\omega^4-\omega^2\left\{\frac{\left(\omega_{x\phi}^2+\omega_{nx}^2\right)}{r}-\frac{4\xi_x\xi_\phi\omega_{nx}\omega_{n\phi}}{r}\right\}-\frac{\omega_{nx}^4\omega_{n\phi}^2}{r}\right\}^2 + 4\left\{\frac{\xi_x\omega_{nx}\omega}{r}\left(\omega_{n\phi}^2-\omega^2\right)+\frac{\xi_\phi\omega_{n\phi}\omega}{r}\left(\omega_{nx}^2-\omega^2\right)\right\}^2\right]^{\frac{1}{2}}$$

- Damped amplitudes for motion occasioned by an applied force F_X acting at the center of gravity of the foundation may be obtained as below:

$$A_X=\frac{F_x}{m\,M_m}\frac{\left[\left(-M_m\omega^2+K_x+L^2K_x\right)^2+4\omega^2\left(\xi_\phi\sqrt{K_\phi M_{mo}}+L^2\xi_x\sqrt{K_x m}\right)^2\right]^{\frac{1}{2}}}{\Delta(\omega^2)}$$

$$A_X=\frac{F_xL}{m\,M_m}\frac{\omega_{nx}\left(\omega_{nx}^2+4\xi_x\omega^2\right)^{\frac{1}{2}}}{\Delta(\omega^2)}$$

VI. Results

The dynamic analysis of machine foundation is done by classical method as well as Finite Element Method using STAAD Pro. V8i by Elastic half space method. Change in Natural Frequency of machine foundation and amplitude of foundation is shown with respect to unconfined compressive strength (qu) for clay and SPT N-Value for sand.

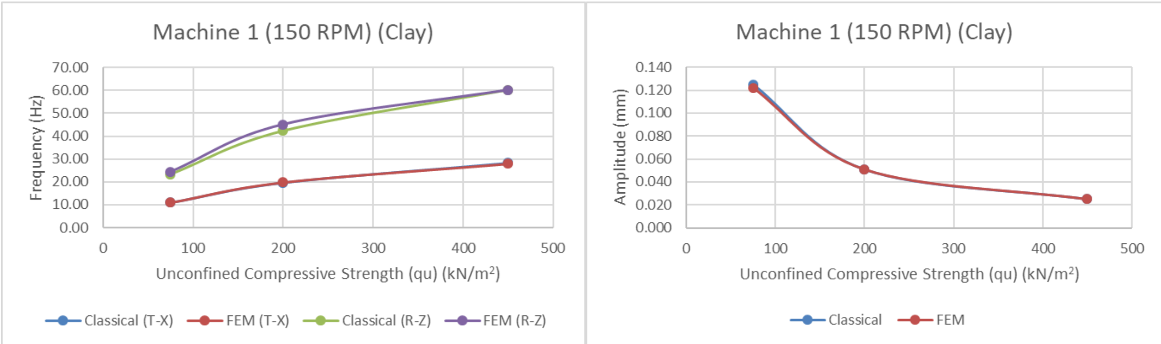


Figure 4: *Frequency and Amplitude of Machine 1 resting on Clay*

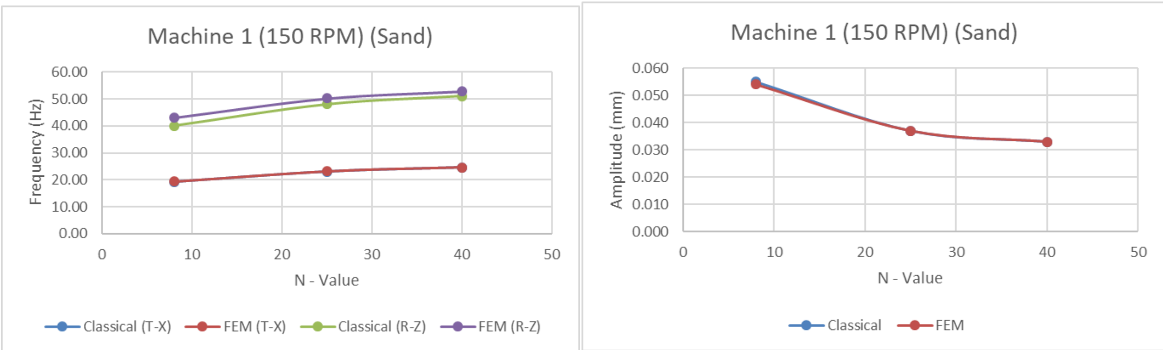


Figure 5: *Frequency and Amplitude of Machine 1 resting on Sand*

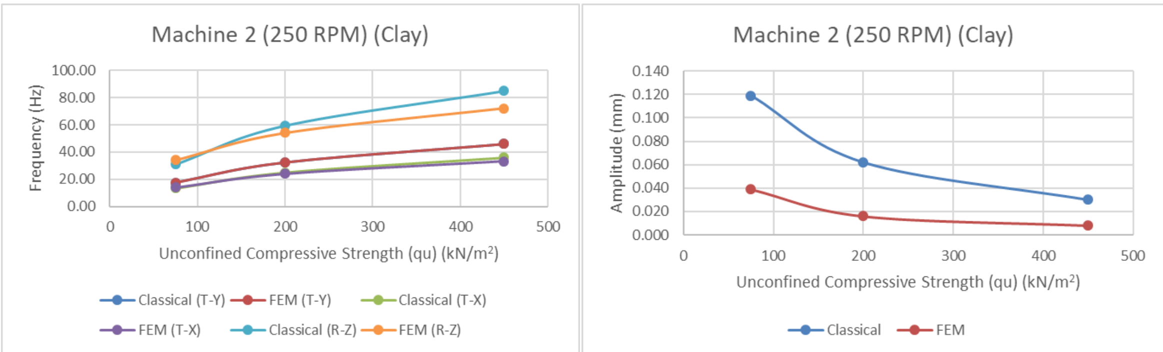


Figure 6: *Frequency and Amplitude of Machine 2 resting on Clay*

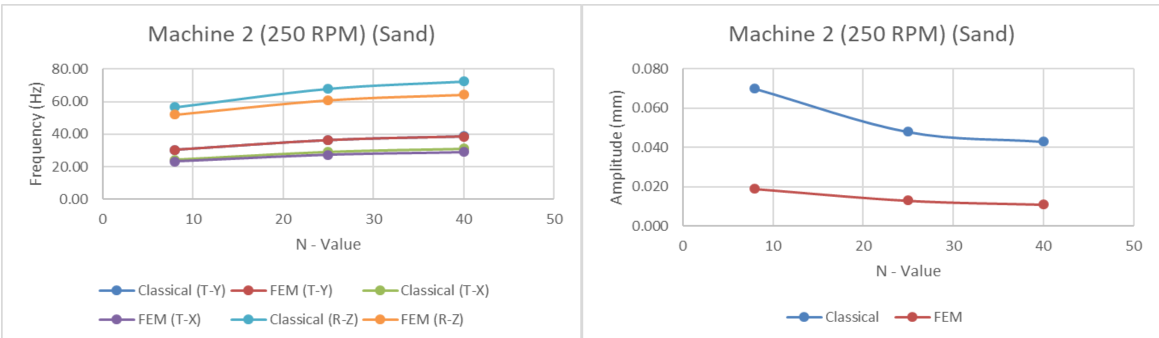


Figure 7: *Frequency and Amplitude of Machine 2 resting on Sand*

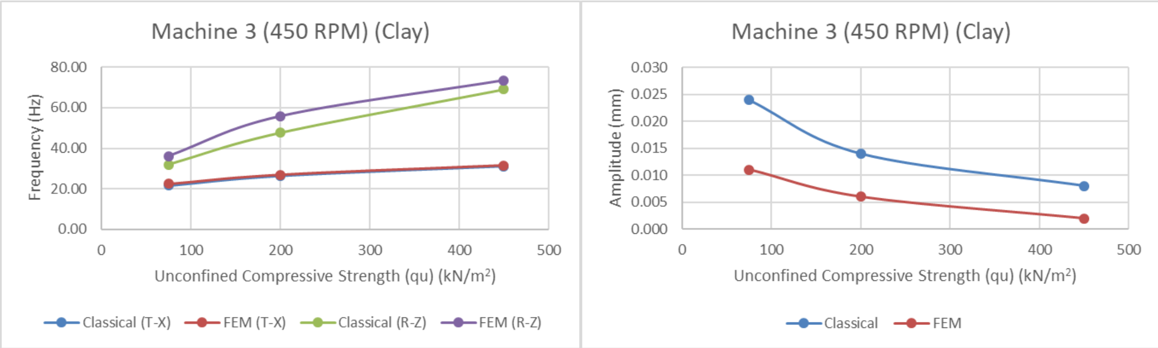


Figure 8: *Frequency and Amplitude of Machine 3 resting on Clay*

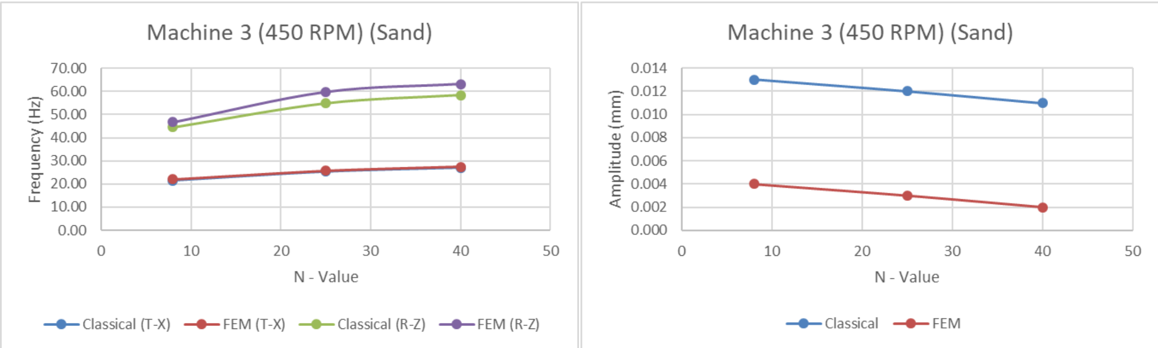


Figure 9: *Frequency and Amplitude of Machine 3 resting on Sand*

Sizes of foundation are optimized for all the cases. Also, each foundations is checked to fulfil all codal criteria even in 20% variation in soil parameters to cover the confidence range. The concrete quantity consumed in each case is also compared. The dimensions of foundation and computed volume is as shown in Table 10 to Table 15.

Table 10: *Volume of foundations for machine-1 resting on clayey soil*

Soil Type	Dimensions (m)			Volume (m3)
	Length	Width	Height	
Medium Clay	3	3	0.6	5.40
Stiff Clay	2.8	2.8	0.6	4.70
Hard Clay	2.8	2.8	0.6	4.70

Table 11: *Volume of foundations for machine-1 resting on sandy soil*

Soil Type	Dimensions (m)			Volume (m3)
	Length	Width	Height	
Loose Sand	3	3	0.6	5.40
Medium Sand	2.8	2.8	0.6	4.70
Dense Sand	2.8	2.8	0.6	4.70

Table 12: *Volume of foundations for machine-2 resting on clayey soil*

Soil Type	Dimensions (m)			Volume (m3)
	Length	Width	Height	
Medium Clay	1.8	1.8	0.6	1.94
Stiff Clay	1.5	1.5	0.6	1.35
Hard Clay	1.5	1.5	0.6	1.35

Table 13: *Volume of foundations for machine-2 resting on sandy soil*

Soil Type	Dimensions (m)			Volume (m3)
	Length	Width	Height	
Loose Sand	1.9	1.9	0.6	2.17
Medium Sand	1.5	1.5	0.6	1.35
Dense Sand	1.5	1.5	0.6	1.35

Table 14: *Volume of foundations for machine-3 resting on clayey soil*

Soil Type	Dimensions (m)			Volume (m3)
	Length	Width	Height	
Medium Clay	2.8	2.8	0.5	3.92
Stiff Clay	2.5	2.5	0.6	3.60
Hard Clay	2.4	2.4	0.6	3.46

Table 15: *Volume of foundations for machine-3 resting on sandy soil*

Soil Type	Dimensions (m)			Volume (m3)
	Length	Width	Height	
Loose Sand	2.8	2.8	0.5	3.92
Medium Sand	2.5	2.5	0.6	3.75
Dense Sand	2.4	2.4	0.6	3.46

VII. Discussion

This study was undertaken to evaluate dynamic response of reciprocating machine mounted on block type foundation by classical method and FEM, as per Elastic Half Space Model. Three different type of machines and six different type of soil were considered for the study. Based on the study presented here in, the following conclusions can be drawn:

- Size of machine foundation is governed by mass ratio in the case where soil stiffness is high.
- It is advisable to keep height of the foundation less as compared to its length and width to design over-tuned foundation. As with the increase in height of the Foundation, Natural Frequency decreases significantly and amplitude of the foundation increases.
- From the Elastic Half Space Model, it is observed that the difference in translational mode frequency, computed both manually and by FEM is negligible. Frequency variation in rotational mode is around 10% to 20%.
- It has been observed that, with the increase in base contact area of foundation,

natural frequency of the Machine Foundation soil system increases and amplitude decreases.

- Natural frequency of machine foundation system increases and amplitude of foundation decreases, with the increase in stiffness of soil.
- Classical Method is more conservative as compared to FEM, as the amplitudes obtained using classical method are higher than those computed using FEM.
- The results grossly show that as the clay changes from medium to hard, and sand from loose to dense the volume of the foundation decreases.

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BRIDGE INFORMATION MODELING AND AR USING TERRESTRIAL LASER SCANNER

Neha Patel, Komal Parikh, Bhagyesh Patel
•
Faculty of Technology, CEPT University Ahmedabad, India
Khodiyar CAD center Ahmedabad, India
neha2319patel@gmail.com

Abstract

There are many incidents where bridges collapse before its life span is over or just after it is built or even during construction, so all this calls for its routine inspection and methods to do it as efficiently as possible. One of the methods to do an inspection is using a terrestrial laser scanner. This paper mainly focuses on studying the methodology for inspecting the bridges using a terrestrial laser scanner and Augmented Reality technology. In this paper, Laser scanning data was used to prepare Bridge Information Model and that model was further processed in Unity to create an Augmented Reality model. All this requires various data processing and post-processing. With the help of this model, one can do bridge inspection at the comfort of the office and reaching those inaccessible areas which are not possible to reach with traditional methods. This paper focuses on finding a different method or approach to do Bridge Information Modeling and get data of bridges for maintenance purposes. Visual inspection was carried out from the model without going to the site.

Keywords: Terrestrial laser scanner, AR Technology, Bridge Information Modeling, Visual Inspection, Unity, Point Cloud, Trimble Business Center

I. Introduction

1. Background

In India, there are a lot of bridges getting constructed and there are a lot of bridges that are already constructed but no one has data about those bridges for maintenance purposes. A bridge's performance life is subjected to deterioration due to excessive usage, overloading, material, aging, and environmental impacts. There are various incidents of bridge failures and all this is due to lack of maintenance of bridges. So, inspection is required which requires knowing the details like plan, elevation, and design of the bridge. Visual inspection may also require rather significant logistics and bridge closure. Thus, the method is complex and time-consuming when obtaining the relevant information for bridge assessment, so all this calls for its routine inspection and methods to do it as efficiently as possible. One of the methods to do an inspection is using Terrestrial Laser Scanner. Bridge Inspection is required to ensure public safety. In this study, a Terrestrial laser scanner was used to scan the bridge site, and then the 3-D model was prepared from the point cloud. Then the 3-D model was further processed in Unity and AR model was prepared and all this output was further used to create as-built drawings and do a visual inspection of the bridge.

1.1 Terrestrial Laser Scanning:

TLS technique requires 3-D position information of object surfaces by contactless measurement and produces three-dimensional coordinate information in terms of points that define the whole building and object. We can do rapid and easy surveying with the help of TLS. Also, TLS is used for building information modeling (BIM) as well as for the measurement of shape deformation by 3D data. [12]

1.2 AR technology:

The motivation for this study is to know whether Augmented Reality could be used to eliminate the limitations and problems faced by engineers during visual inspection. TLS data in the form of point cloud and images were used as a base for AR. This is processed for display in a custom application written by authors. This is written using the computer games authoring platform Unity and is displayed on any android smartphone.

Augmented Reality gives a better technical understanding of projects and it provides solution creation while working on remote places But hardware unavailability makes it difficult to create XR content. We can use the phone, HMD Devices & Hololens Remote working is going to be new normal in upcoming years and for this XR is life-changing. [13]

2. Need for Study

Various incidents are happening of bridge failure due to structural weakness. Many bridges need to be assessed and monitored and to monitor them there should be a reliable method. Also, old bridges that are to be maintained do not have any details or drawings to be studied so, with the TLS technique, Bridge Information Model was created that gave details about the bridge and then the model was used to extract information for various purposes like an inspection. Visual inspection has been the primary technique for assessing the serviceability and performance of structures. As the traditional method is time-consuming and requires certain tools to access certain areas of the bridge which might require obstructing or stopping traffic and going to certain areas might be a risk to the person inspecting. Therefore to reduce the risk and save time we need to establish some non-contact technique that will be efficient and accurate. So to ease-out inspection and bring the whole bridge virtually at the office to inspect is the aim of the research.

II. Methods

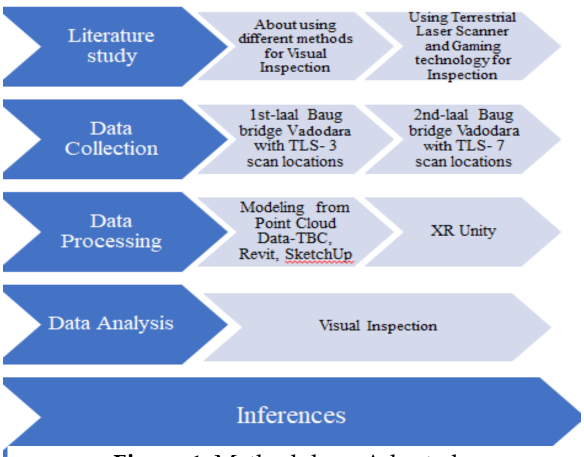

Figure 1: Methodology Adopted

The methodology followed during the study for this paper was

In this study first, a site of Vadodara was selected that is laal baug bridge and then it was scanned with TLS with proper care and minimizing errors and disturbances. TLS helped to capture data in the form of point cloud and that data can be used in many software for post-processing to create a 3-D model. This model helped to get information about the bridge and its condition. After 3-D modeling, the next step was to make an AR model and use it to do an inspection. We can use it for many purposes but in this study, we used a model to extract information, know the condition of the bridge, and do a visual inspection. Also, it aims to determine a detailed methodology for doing modeling and inspection.

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3. Field Data Collection and Processing

Data Collection

With the help of TLS laal baug bridge was inspected and (***fig 2)*** shows scan locations and *table 1* shows the coordinates of the scan location.: After the instrument is fixed and all the adjustments and settings are done, we can start scanning process. The scanner scans within the fixed frame. It continuously rotates up and down on Y-axis scanning from top to bottom and also rotates clockwise on the X-axis. For scanning the full dome it took around 11 minutes. The scanner scans the objects first as image data through its camera

Data Processing

In Trimble Business Center data was imported and Processed. Removing the noise by removing unwanted regions was done in TBC. Model was not completed in TBC due to technical issues.so we then exported the file to various other formats to model further in Revit and other similar softwares After TBC, revit can help us create BrIM so edited point cloud was exported to Revit.. In revit piers were modeled.

Certain dimensions need to be assumed A heavy sketch-Up model of bridge was prepared and also surroundings were added to the model as it was to be used in Unity for AR model. Also we used this model to identify the defects and prepare plan, elevation and sections of bridge and also of the elements *(refer fig 6).* It helped us to know the dimensions also. Assumed dimension are the one which was hidden behind the noise

Model and Video with audio was prepared in Unity. A unity application was created and that includes a model, about inspection, table of remedies for defects. All this required two target images.

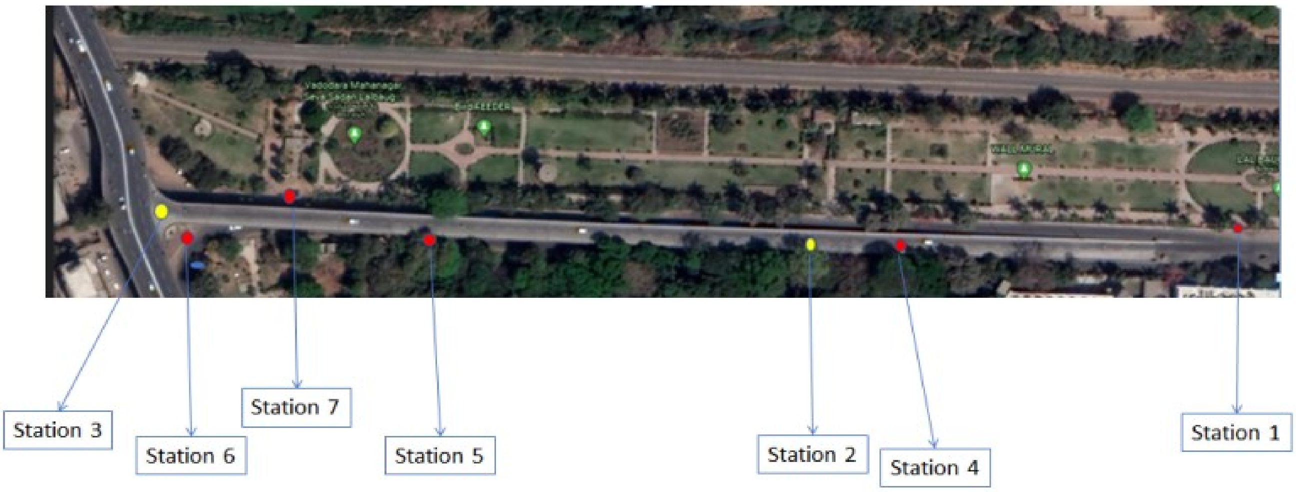


Figure 2 Location of station points

Figure 3: Final 3-D Model

Table 1: Coordinates of Scan Location

STN	X	Y	Z	CODE
1	1000	1000	100	stn1
2	1032.953	1000	100.549	bs
100	1234.069	1078.176	107.158	stn2
101	1383.856	1137.359	110.873	stn3
102	1049.498	1001.592	101.78	stn4
103	1298.252	1102.227	101.189	stn5
104	1376.654	1135.819	101.786	stn6
105	1370.584	1130.801	101.522	res stn 6
106	1356.484	1138.863	101.559	stn 7

4. AR model development

For the processing in Unity, the first unity hub was downloaded and then in that unity version, 2019.3.11f1 version of unity was downloaded.

After that other packages were downloaded like an android studio and Vuforia developer was synced with Unity

First, the target images were decided *(refer fig 12)* in Vuforia which was an image of a model that was prepared. Then the ratings of images were checked. Rating should be above 3-star to process in unity and it was more than 3-star. After that 3-D model was imported in Unity and then align it on the image as per scale and orientation.

After this project was saved and build the project command was given in Unity and it converted and saved as .apk file. After doing the process in Unity target images were downloaded.

So to view model and another video output unity application was downloaded in the phone and then the camera was brought in front of target images. Target images showed the model and played the video as it was made in unity.

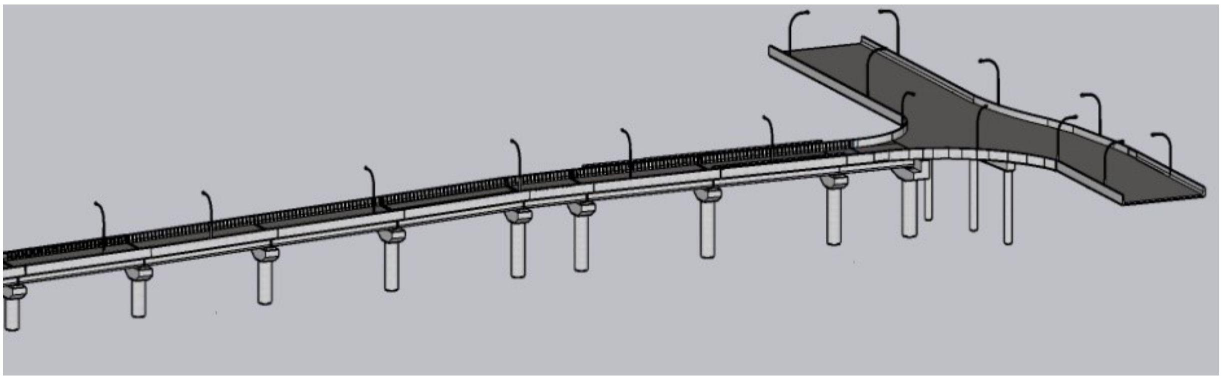
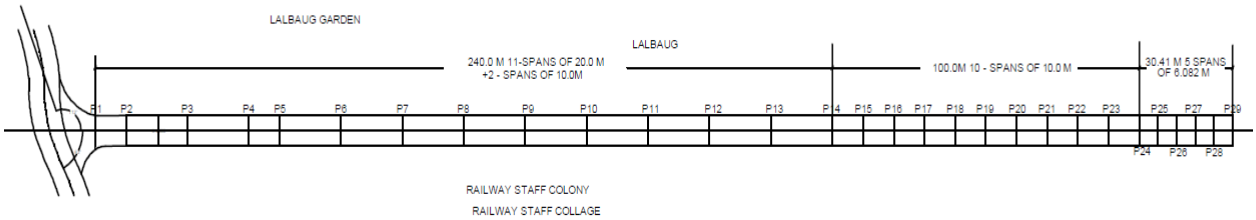


Figure 4: Final bridge model from point cloud

III. Results

5. Extracting Output from the 3-D model

After doing all the process of making a 3-D model and an AR model, data was used to create a plan, section of the bridge with all the dimensions as shown in *fig8,9,10* from the model. So bridge information modeling was done and then we used that 3D model to create an AR model which helped us to do visual inspection simply with the smartphone. Defects were visible in the 3-D bridge model but not in the AR model. To view AR model base images also known as target images are required. In smartphone, Unity application .apk need to be installed which will read the target images on any screen or paper to show us the model or video or audio that is worked out while preparing the application in Unity. The representation of cracks was also done in plans as seen in the model *fig 12.*



*(fig12)*Left side images show target images and right side images show their output. The first image is a part of the video. The other image shows the model. The second image will bring a model and it was analyzed and then from that cracks were examined and remedies were found out. These remedies were put up in the presentation form to be shown. The first image shows the location of cracks and how they can be repaired. All this was the output of the target images.

IV. Discussion

This research here took up the case study of Laal Baug bridge Vadodara as per availability of the machine and point cloud was worked upon in various software and post-processing brought the following:

1. The data collected in the form of point cloud helped in making the 3-D model. This model helped us to create as-built drawings (*refer fig 5,6,8,9*) which were not available. So this model and as-built drawings helped us to know about the bridge and its condition and its whole structure can be identified which can further help us to do maintenance. For this research visual inspection was done and all the data was used to carry it out. This method for inspection is consistent and repeatable as compared to traditional method The 3-D model was used to process in Unity and produce AR model as seen in *fig 7.* This model can be viewed conveniently and details can be seen by adjusting the phone camera. We can zoom and see model with different angle by changing camera position This model is secure in terms of that it cannot be changed or edited so we can be assured that no changes are possible from outside as output is in terms of an application.

2. Bridge Information modeling was helpful for reaching this stage but it can further be used to present it infront of authority people to get permissions or approvals for maintenance or further restoration by actually showing them the unity model and the key problem areas just from an application of Unity in our smartphone and no need to carry heavy data or systems to show the details. Also with 3-D model data there is risk of data getting edited

and used but model in Unity application is safe. Also we can prepare presentation in Unity itself which can be used to present data and this file can also not be edited.

3. Frequency of inspection depends on damage detected. This bridge is not much damaged and can be inspected after 1 year as there is no damage to structural element of the bridge.

6. Process Setup for bridge inspection

1. Collecting data with tls-It should be noted that the data collection and images both taken by TLS
2. Processing data (part 1) – there are many software for this data to process. Here we used TBC and Revit
3. We exported the point cloud to sketchup and tried to make the model in SketchUp as Revit was crashing (only scan locations got exported) so we used hard copy from VMC and Revit model to extract the data. 3-D Model was prepared
4. We can now view the model in our phone through Unity app with the help of Target Images
5. By looking at this we can fill the Visual Inspection Sheet *(refer table 9*). But we could identify it only from the model.

Acknowledgement

I felt immense pleasure while working on the said topic "Bridge Information Modelling and AR using Terrestrial Laser Scanner for Inspection". I would like to pay my sincere gratitude to Aadesh Dharr Sir, Sachin Pardesi Sir and Varun Dave Sir from Alterra for helping me made this research possible and providing guidance and support throughout.

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HAND GESTURE RECOGNITION USING MORPHOLOGICAL OPERATION

Manisha H. Devnani, Dr. Udesang K Jaliya
•
Birla Vishvakarma Mahavidyalaya, Gujarat.
udesang.jaliya@bvmengineering.ac.in

Abstract

A nonverbal communication involves movements of different body parts to communicate a particular message. Hand, face and lips movements or other movement of body parts are regarded as gestures. In this paper I have proposed a method based on hand gesture recognition to recognize the different gestures used by deaf people to communicate using morphological operation. This will help to communicate between deaf and dumb people and normal public. In earlier systems the use of colour markers and gloves for gesture recognition has been used but it resulted in delay in processing time and sometimes inconvenient for the user.

Keywords:image recognition; image processing; image acquiring; morphological operations; Human computer interface

I. Introduction

The People who cannot speak or hear use sign language to express the thoughts and communicate with the common people or among them. Sign language (Cowie, 2017) includes movement of different parts like the hand, lips, mouth and many others which are referred to as gestures. But the challenge of the people who are deaf and dumb is the sign they use to speak are often not understandable by common people who does not have proper knowledge of different sign they use to communicate. It becomes a problem for this disabled people to communicate with others. To resolve this problem often a translator is used who has better knowledge of the sign language but that becomes very costly and often getting a person who has knowledge of that specific sign language is not an easy job which is another problem. In this paper I have tried to resolve this issue by proposing a method which will be cost effective, easily accessible and won't be time consuming. The work flow of hand gesture recognition is described as follows. First the hand area is detected from the gesture of the hand that will be captured. Then some features are extracted to describe the hand gestures. Lastly the gesture of hand is recognized by the dataset. The camera detects the hand area but if the area of skin and hand is the same the camera cannot detect the gesture properly. The hand gesture recognition system involves use of color marker gloves (Chaudhary, Raheja, Das, & Raheja, 2014), but this often results in inconvenience for the user. I have focused on developing a system without using color markers or gloves which will be more convenient. I used mathematical operations (Alvarez, Baumela, Márquez-Neila, & Henríquez, 2012) and each step has been defined accurately so that some error occurred during the program or in the process of the recognition which will be a more convenient system for the user. This system reduces the processing time and enhances the accuracy. The development of human computer interface (HCI) (Bevan, 1995) (Karray, Alemzadeh, Saleh, & Arab, 2008) has also been done for virtual recognition of gestures. Gestures are non-vocal ways of communication like posing a victory sign from fingers in front of a smartphone camera for clicking photos.

II. Methods

Overview of the Hand Recognition Method:

The overview of the hand recognition is described in Figure 1. First the webcam captures the gesture of the hand using background subtraction. Then the captured image is converted into a binary image. The morphological operations are applied and then the image is flipped so that the fingers can be detected.

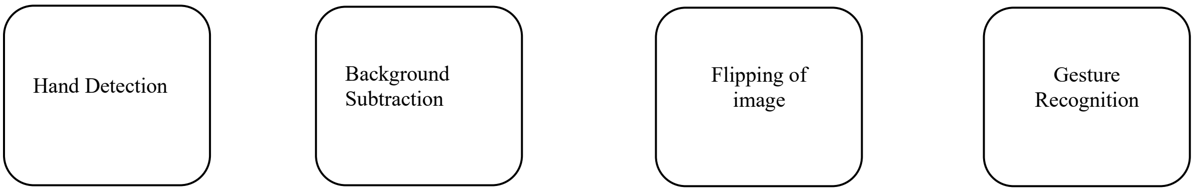

Figure 1: Flowchart of the Hand Gesture Recognition

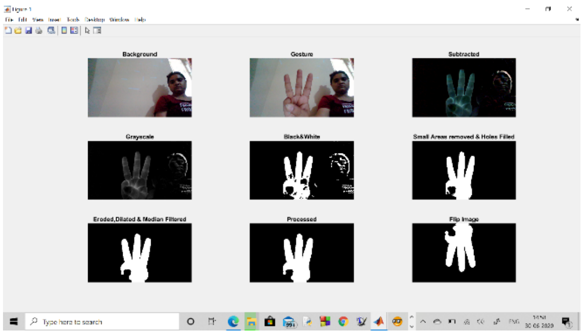

Figure:2 The process of Hand Gesture Recognition.

Hand Detection:

The process of hand detection has two parts. First the background image is captured and in the second process the gesture image is captured using the webcam. The two different images are then processed with the help of background subtraction (Vasavi & Sanku, 2013) and thus the processed image is formed. The subtraction of an image is important because the background of the image is identical. However, in some cases, there are other moving objects included in the result of background subtraction. The skin colour can be used to discriminate the hand region from the other moving objects. The Figure 3 of the background image subtraction is shown below:

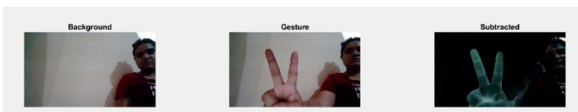

Figure:3 Background Image Subtraction

Pre-Processing of the image:

The pre-processing of the image takes place after the image background subtraction. There are four steps containing the pre-processing of the image. The explanation of each steps are as follows:

Formation of GreyScale image:

After the formation of the subtracted image this is converted into the Gray scale image. That is the image is processed through the grey scale and is converted to black and white image. This is helpful for the computer to recognize the finger and palm region correctly. There are two ways in which we can convert an image into the Gray scale form. They are:

a. Average Method
b. Weighted Method or luminosity method

The equation of converting the image into Gray scale is shown below:

New grayscale image = ((0.3 * R) + (0.59 * G) + (0.11 * B))

The Figure 4 of the binary image is shown below.

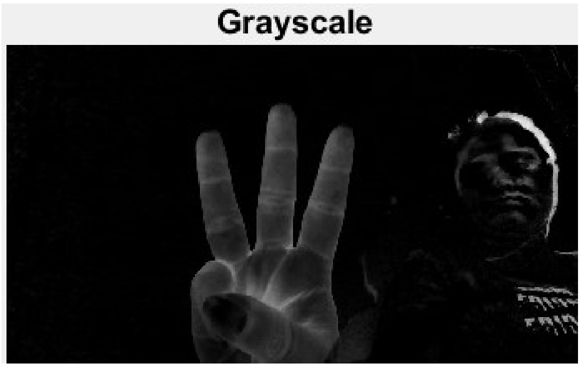

Figure: 4 Conversion of Image into GreyScale.

Black and White image:

Now the image is converted into the binary image or also we can say that the image is converted into black and white image. The morphological operation is applied in this process and thus the processed image is formed. The equation of the conversion of the image into binary or black and white image is as follow:

BW=imbinarize(X,cmap,level)

Figure: 5 Black and White image.

Erosion, Dilation and Median Filter:

In this method of hand gesture recognition, the process of erosion is used to shrink the image pixels so that the pixels which are located in the boundary can be removed.

The process of dilation in the hand gesture recognition is used to convert images in an expanded form. The image is dilated and eroded because the result of the image produced is better for the result. The median filter is also known as nonlinear filtering. It is used to eliminate salt and pepper noise. Here the pixel value is replaced by the median value of the neighboring pixel. The Figure 6 below shows the formation of the processed image.

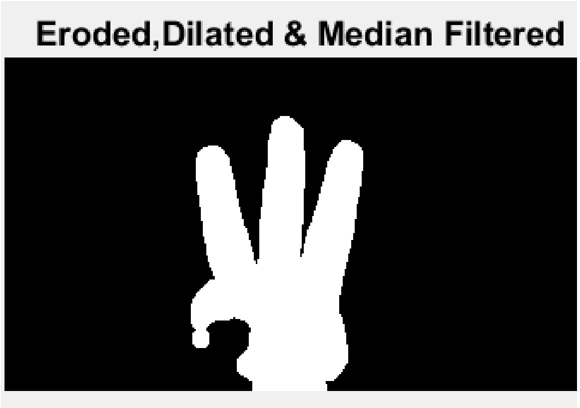

Figure: 6 Erosion, Dilation and Median applied to an image.

Flipping of the image:

In the process of hand gesture recognition, the last step is the flipping of the image. The image is flipped to get the better result in the process. The Figure 7 below shows the output result of the flipping of an image.

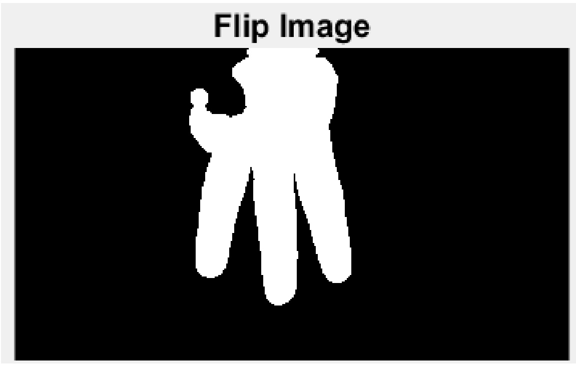

Figure:7 Flipping of the Image.

III. EXPERIMENTAL RESULTS

In the experiment, to obtain the accurate result I obtained the result using different hand gestures at different angles. This will help us to obtain the more accurate result and will be helpful for the user to use it properly. I have shown the four different gestures of an image that have been used by me as a database. The result obtained is of four different structures. The Figure 8 below shows us the experiment result of hand gesture recognition.

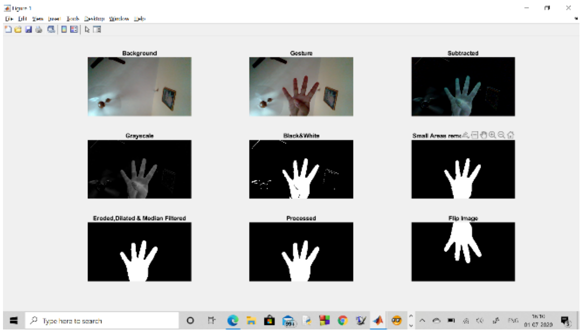

Figure: 8 The input of the Hand Gesture.

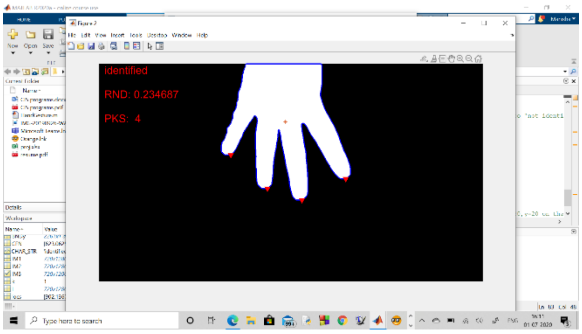

Figure: 9 The corresponding output of the Hand Gesture.

IV. APPLICATION, ADVANTAGES AND LIMITATIONS

A. *Applications*

1. It can be used by deaf and dumb people for communication with the normal people.
2. It can be used in smart classes for real time translation of language where deaf and dumb students can be taught.
3. It can be used in computer games as a robust system to help its translation for the people who are mute.
4. It can also be used to classify the number. Which means that when the hand gesture creates a number the output will be produced respectively.

B. *ADVANTAGES*

1. The result of hand gesture recognition gives the result in an appropriate time.
2. The time taken is less than the other processes that have been made.
3. Takes low power consumption.
4. Automated results are obtained.
5. An effective way of communication for physically challenged people.
6. Takes less time as compared to others.

C. *LIMITATIONS*

1. The intensity of the light plays an important role in this project. If the colour of skin and background is the same there would be a problem.
2. The input image should be properly taken.

V. CONCLUSIONS

The hand gesture recognition proposed in this paper uses a background subtraction method. This method reduces the delay of time and is more helpful and understandable for the user to use this project. The hand gesture recognition forms the bridge between the physically disabled person and the normal person.

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EFFECT OF TRAFFIC COMPOSITION ON STREAM EQUIVALENCY FACTOR

[1]Milan P. Kacha, [2]Ankit H. Patel, [3]Pinakin Patel, [4]Dr. L.B. Zala

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[1,2] M. Tech Student (Transportation Engineering),
[3]Assistant Professor Department of Civil Engineering,
[4]Professor and Head Department of Civil Engineering,
Birla Vishvakarma Mahavidyalaya Engineering College, Gujarat, India.
kachamilanbvm@gmail.com

Abstract

India having different categories of highways with various categories of vehicles. The geometric plan of highways and the number of lanes in highways are affected by the various vehicle operations on 2-lane, 4-lane, 6-lane highways. Different characteristics of vehicles moving on the various categories of roads are the characteristic of vehicles, the size of vehicles, weight of vehicles, maximum turning radius of vehicles, speed of various categories of vehicles on the road, acceleration of vehicles, braking, and horsepower of the engine of vehicles are different from vehicles to vehicles on the road. The aim of this study is the estimation of stream equivalency factor (K) for 2-lane, 4-lane, 6-lane roads. The Passenger Car Unit (PCU) values determine with the help of the equation of INDO-HCM 2017 and IRC 106. In this study, 6 different sites of the Gujarat region of India are selected for the study of stream equivalency factor (K). Traffic volume and speed of various categories of vehicles at 5 min interval data are used for calculation of (K) values. In this study, dynamic PCU values are calculated from data, and estimation of stream equivalency factor values. Stream equivalency factor values vary from various categories of roads according to several lanes under mixed traffic conditions. Stream equivalency factor equation have R^2 for 2-lane, 4-lane, 6-lane roads are 0.9966, 0.8111 & 0.8023 respectively.

Keywords: Mixed traffic, PCU values, Stream equivalency factor, Indian roads.

I. Introduction

The Passenger Car unit values (PCU) values for different categories of vehicles are found to be sensitive with the geometric design of road, and nature of traffic. The nature of traffic on India roads is different from other country roads in the world. The roads in India consider several categories of vehicles with different characteristics of vehicles. The rode user characteristics like diver behavior, condition of the road, frog on road, and mist on the road and various vehicular characteristics are different from vehicles to vehicles on the road. So, various types of vehicles on 2-lane road, 4-lane road, 6-lane road convert into one standard unit into a small car. Small car considers engine power less than 1400 CC according to INDO-HCM 2017 and various types of IRC codas. Small car standard dimension with a length of 3.72 m and width of vehicle 1.44 m. The projected rectangular area of a small car is 5.36 m^2. Various types of vehicle convent into standard unit SC by Passenger Car Equivalent (PCU) of various categories of vehicle. Passenger Car Equivalent (PCU) values are different for different categories of highways because of PCU values depend on the characteristics of the vehicle and characteristics of road condition. So, a new factor Stream Equivalency factor (K) is introduced to convert total traffic flow (Vehicle/h) to total traffic flow (PCU/h). Passenger Car Equivalent (PCU) values of different categories of vehicles depend on the proportion of two-wheeler, proportion of three-wheeler, proportion of light commercial vehicles, and proportion of heavy commercial vehicle, the proportion of big car, proportion of small car and traffic volume of vehicles on the highways. The various categories of roads in India like 2-lane road, 4-lane road, 6-lane road, the geometric design is different from various categories of roads and different vehicle composition on the road. Because of different characteristics of highways Stream Equivalency factor (K) values are different for 2-lane, 4-lane, 6-lane road. Various studies were conducted on Stream Equivalency factor values and Passenger Car Equivalent (PCU) for different categories of highways.

II. Literature Review

[1] study conducted for estimation of (K) value based on four different sites like NH – 47, NH – 04, NH – 08, SH – 15. Speed models are developed based on 4 sites for various categories of vehicles. Stream equivalency factor equation developed with R-square value 0.98 and t-statistical test conducted for the validation of the model. Various categories of vehicles PCU values relationships with the traffic volume graph plotted and show the variation in PCU values in a particular stretch. [2] has been conducted a study for a comparison of PCU values in various categories of terrain in India. Comparison of various methods like headway method, density method, and IRC 106 method for plain and hilly terrain. A study was conducted at south India Vishakhapatnam city for two locations. Data collected for PCU estimation for only 2 hours. In the headway method, PCU values for HCV are 10.82 is very high compare to all method. With the comparison of all methods, IRC 106 method is best for all categories of vehicles on the highway because of this method all types of data of various categories of vehicles include in the equation of IRC 106. [3] conducted a study for new methods like the kriging method. Speed of different categories of vehicle estimate by kriging mathematical model and PCU values determine by IRC 106 procedure. Here 6 six different location data included for estimation of speed values like a crossroad in Dehradun with width 5.5 m, Paschim road in Chandigarh with width 6.2m, Subhash road in Dehradun with width 7.0m, Ring road in Kolkata with width 7.0m and Vigyan path in Chandigarh with width 9.0m, Palam road with width 9.5m in new Delhi. Projected rectangular are for different categories of vehicles are for two-wheeler 1.20 m^2, three-wheeler 4.48 m^2, for HCV 24.54 $m^{2,}$ BC 8.11 $m^{2,}$ SC 5.36 m^2 based on length and width. For traffic volume PCU/h and traffic volume Vehicle/h graph are plotted by Y=1.298X with R- square value 0.18. .[6] have been conducted a study to convert the whole type of vehicle into a small car. Data collected at four sites including Hingna road with width 7.2m and shoulder-width 1.6m, Bhandara Road 7.8m with carriageway width 7.8m and Shoulder width 1.8m, Umred Road with width 7.0 m and Shoulder width 1.6m, and Wardha road width 7.8m and Shoulder width 1.8m. Mean speed of various categories of vehicle estimate for Car 54.40 Km/h, Truck/bus 41 Km/h, Two-wheeler 39.84 Km/h, L.C.V 39.69 Km/h, Rickshaw 39.18 Km/h, Cycle 11.32 Km/h, Trailer 38.53 Km/h. Capacity value estimate for various categories of roads for SH-09 with 1897PCU/h, NH-07 with 2675 PCU/h, NH-06 with 4652 PCU/h, SH-255 with 3738 PCU/h. In this study Motor cycle percentage 78% and 22% of all categories of vehicle. [5] researched PCU estimation and the effect of roadway width on PCU values. PCU estimate by the length of the vehicle, the width of the vehicle, and the speed of various categories of vehicles. Data collected at ten different sites for a study like NH-22 with a width of carriageway 8.8m and shoulder brick on edge 0.3m and 2m earthen, NH-58 of 110km length with a width of carriageway 7.4m shoulder brick on edge 0.3m and earthen 1.5m and NH-31, SH-5, SH-6, SH-14, NH-73, SH-12, NH-38, NH-58. This study calculation of PCU values based on the width of the carriageway. [4] conducted a study PCU value prediction using an artificial neural network. Here traffic volume data Q1, Q2……. Qn considers as input and hidden layer estimate with the help of various functions used in a hidden layer of the model and out-put value is the speed of vehicles.

III. Study Area Profile

For estimation of PCU and K values for various categories of vehicles require data for traffic volume and speed of each category of vehicles. Data collected at six different sites inroads of India. Data collected by video grapy techniques by the high resolution of the camera. Mark line with plaster of peris (POP) or White cement (WC) on the road for data collection. Line marking throw-out roadway between 50m to 80m in 2-lane, 4-lane, 6lane road under various types of vehicles on the road. Detailed site location information including carriageway width, shoulder width shown in Table-1

TABLE 2 Details of Study Area Profile

No	Site Name	Number of Lanes	Width of Carriageway	Width of Shoulder	
				Paved	Un Paved
1	Rajkot to Kalawad	2-lane	7.0m	1m	1.5m
2	Bakrol to Vadtal	2-lane	7.0m	1m	1.5m
3	Makkam to Bhaktinagar Circle (Rajkot)	4-lane	15m	1m	1.5m
4	Sorathiyavadi to Nanda Hall (Rajkot)	4-lane	15m	1m	1.5m
5	Gondal Chokdi to Kothariya (Rajkot)	6-lane	23m	1.5m	1.5m
6	KKV Hall to Mavdi Chokdi (Rajkot)	6-lane	23m	1.5m	1.5m

TABLE 3 Traffic Composition

Traffic Composition (%)						
Section	2W	3W	SC	BC	LCV	HCV
2-lane	21.69	18.05	21.31	8.13	12.71	18.08
4-lane	54	14	16	13	2	1
6-lane	67.76	9.76	14.32	6.76	1	0.37

IV. Estimation of PCU & Stream Equivalency Factor (K)

PCU values for different categories of a vehicle for different categories of road estimation by a procedure of IRC-106 and INDO-HCM 2017.

$$\text{PCU} = \frac{Vc/Vi}{Ac/Ai} \tag{1}$$

Where, V_c = Clearing speed of car (km/hr), V_i = Clearing speed of vehicle i (km/hr), A_c= Projected rectangular plan area of car (m^2), A_i= Projected rectangular plan area of vehicle i (m^2).

Table 4 Projected Area of Different Categories of Vehicles

Vehicle Type	Length(m)	Width(m)	Projected Area(m^2)

Motorized Traffic			
Standard car (SC)	3.72	1.44	5.36
Big car (BC)	4.58	1.77	8.11
Motorized Two-Wheeler (TW)	1.87	0.64	1.2
Auto rickshaw (3W)	3.2	1.4	4.48
Bus (B)	10.1	2.42	24.54
Light commercial vehicle (LCV)	6.1	2.1	12.81
Two/ Three axle truck (TAT)	7.5	2.35	17.63
Multi Axel Truck (MAT)	12.1	2.44	29.52
Tractor / Tractor Trailer (TT)	7.4	2.2	16.28

Table 5 Range of PCUs Values for Different Categories of Vehicles

Vehicle Type	**Range /Median Values of PCUs**	
	Range	**Median**
Motorized Traffic		
Big car (BC)	1.13 - 2.50	1.6
Small car (SC)	1	1
Motorized Two-Wheeler (TW)	0.20 - 0.50	0.3
Auto rickshaw (3W)	1.10 -2.00	1.2
Bus (B)	2.80 - 4.80	4.5
Two/ Three axle truck (TAT)	3.0 - 5.50	5
Multi Axel Truck (MAT)	4.6 - 11.60	6
Tractor / Tractor Trailer (TT)	5.0 - 8.00	7

Stream Equivalency Factor (K) is the ratio of flow in PCU/hour to Flow in Vehicle/hour.

$$K = \frac{\text{Flow in PCU/hour}}{\text{Flow in vehicle/hour}} \tag{2}$$

Stream Equivalency Factor (K) for various categories of a road depends on the characteristic of various categories of vehicles and the proportion of various categories of vehicles. A minor change in behavior of various categories of vehicle and percentage of vehicle travel on highways various categories of vehicles. For the large size of vehicles like a heavy commercial vehicle, bus, truck dimension is very important for the estimation of PCU and K values. For equivalency factor for various categories of a road depends on the geometric design of various categories of road. The geometric design includes carriageway width, shoulder width, super elevation, condition of a pavement of various categories of highways. For the equation of various categories of a vehicle are shown below.

SEF (K) for 2-lane road

$$SEF_{2\text{-lane}} = 1 + 0.174271*P_{2w} + 0.9818 * P_{AR} + 1.3242*P_{LCV} + 0.7414* P_{SC} + 1.3711* P_{HCV} + 1.088* P_{BC} - 133.314 *(1/N) \quad (R^2 = 0.9066)$$

SEF (K) for 4-lane road

$$SEF_{4\text{-lane}} = 1 + 0.001842*P_{2w} + 0.007366* P_{AR} + 0.016402*P_{LCV} + 0.006793* P_{SC} + 0.04096* P_{HCV} + 0.007336* P_{BC} + 321.329*(1/N) \quad (R^2 = 0.8111)$$

SEF (K) for 6-lane road

$$SEF_{6\text{-lane}} = 1 + 0.00198*P_{2w} + 0.01058 * P_{AR} + 0.032029*P_{LCV} + 0.007806* P_{SC} + 0.020254* P_{HCV} + 0.013065* P_{BC} + 149.0247*(1/N) \quad (R^2 = 0.8023)$$

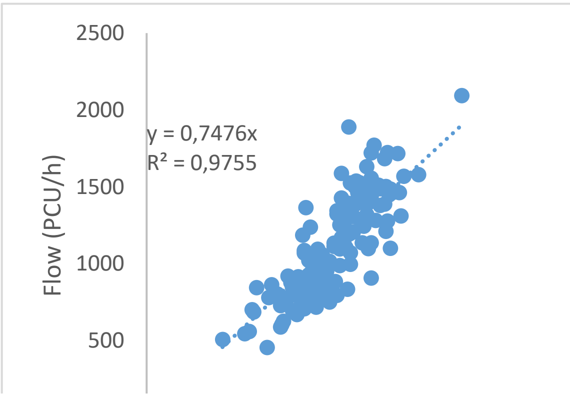
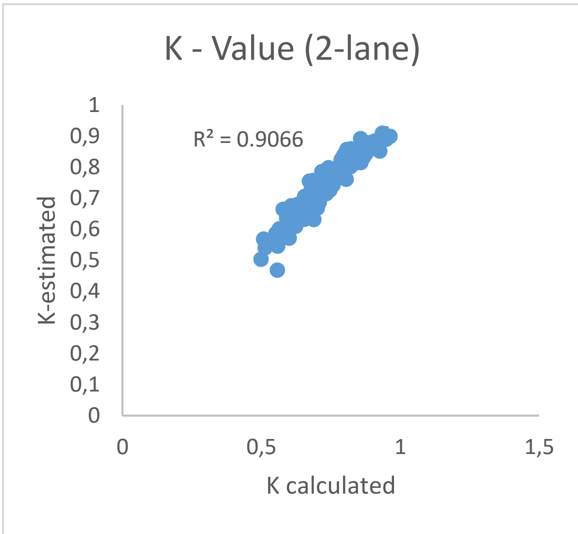


Figure 1 Flow (Veh/h) Vs Flow (PCU/h) 2-lane roads



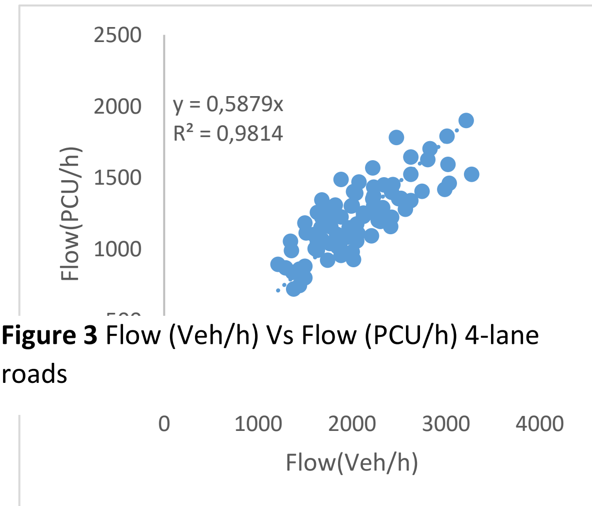


Figure 3 Flow (Veh/h) Vs Flow (PCU/h) 4-lane roads

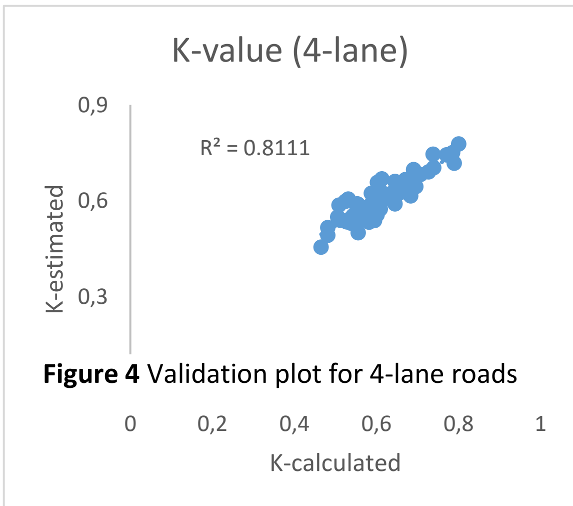


Figure 4 Validation plot for 4-lane roads

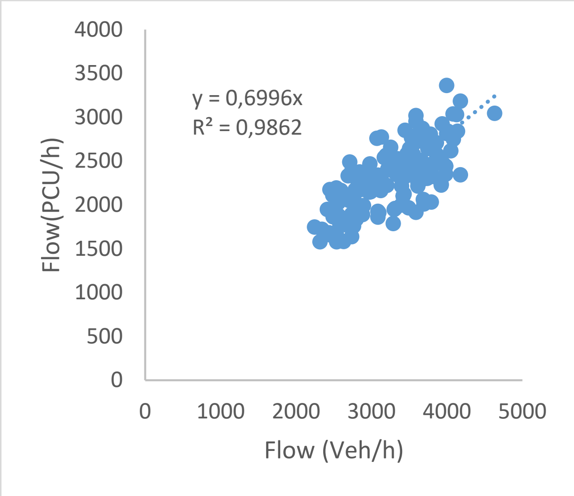


Figure 5 Flow (Veh/h) Vs Flow (PCU/h) 6-lane roads

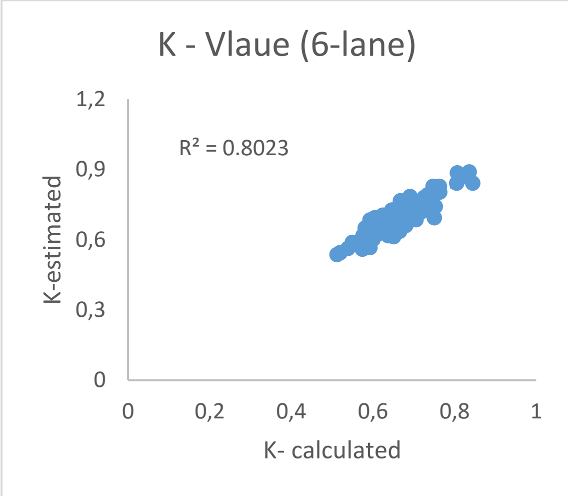


Figure 6 Validation plot for 6-lane roads

TABLE 6 SEF Equation Coefficients, T- Stat, P-Values

2-Lane Road								
	2W	**3W**	**SC**	**BC**	**LCV**	**HCV**	**BUS**	**1/N**
Coefficients	0.17	0.98	0.74	1.08	1.32	1.37	NA	-133.31
t Stat	2.01	9.64	8.85	8.15	15.95	21.8	NA	-5.69
P-value	0.04	4.92E-17	8.93E-33	4.37E-15	6.03E-46	2.26E-13	NA	7.57E-08
4-Lane Road								
	2W	**3W**	**SC**	**BC**	**LCV**	**HCV**	**BUS**	**1/N**
Coefficients	0.001	0.007	0.006	0.007	0.016	0.040	0.03	321.3
t Stat	2.90	2.61	3.58	2.37	2.63	2.73	5.78	4.58
P-value	0.004	0.01	0.0005	0.02	0.01	0.007	1.48E-07	1.72E-05
6-Lane Road								
	2W	**3W**	**SC**	**BC**	**LCV**	**HCV**	**BUS**	**1/N**
Coefficients	0.001	0.01	0.007	0.01	0.03	0.02	0.06	149.02
t Stat	4.2	7.5	4.87	8.20	9.08	3.99	12.1	1.55
P-value	4.40E-05	6.45E-12	2.92E-06	1.36E-13	9.40E-16	0.0001	1.70E-23	0.12

V. Conclusion

SEF is for various categories of road developed based on various types of data of road like traffic data and geometric data. SFF was found for two-lane road according to INDO-HCM 2017 between 0.44 to 3.06 but here Y=0.73X for 2-lane road based on calculated and estimated value of K. In this paper developed an equation of SEF for 2,4,6- lane roads and coefficient and P-value and T-stat value for various types of variable shown in Table-5. The R^2 value for 2-lane road for SEF is 0.9966 and R^2 value for 4-lane road for SEF is 0.8111 and R^2 value for 6-lane road for SEF is 0.8023.

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SPEED ESTIMATION MODEL OF VEHICLE AT HORIZONTAL CURVES ON TWO-LANE HIGHWAY

Ankit H. Patel, Milan P. Kacha, Pinakin Patel, Dr. L.B. Zala

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Birla Vishvakarma Mahavidyalaya Engineering College, Gujarat, Indiaankit.patel.ap802@gmail.com

Abstract

In this study, 85th and 98th percentile speed estimation models of vehicle on two-lane rural highways were developed using a statistical technique of multiple regression. Models were developed using spot speed data obtained from five sites out of total eight and data of three remaining sites were taken into account for validation. Speed of vehicle at 50m initial to point of curvature, point of curvature, middle of the curve along with Geometric aspects of Horizontal curve and section adjacent to tangent were considered as independent variables. Car and SUVs speed for the 85th and 98th percentile was found to be parallel, so united for further analysis. Vehicle speed at middle of the curvature was found to be dependent on its speed at previous segment and geometric features predicted previously. Speed estimation of car and two-wheeler at middle of the curve was found to be strongly corelated with curve length and deflection angle. Gradient at particular locations was resulted to be a most affecting parameter for 85th percentile speed of HCV and LCV. The 98th percentile speed at middle of the curve were found in strong correlation with speed at 85th percentile speed. Root mean square errors were calculated to be within range of 2 to 8 km/h. study concluded that length of curve could be a very significant factor in the practice of highway geometric design.

Keywords: Speed estimation model, Horizontal curve geometry, Highway geometric design consistency, Two-lane highway

I. Introduction

Road accidents are mainly caused by factors associated to one or a mixture of the three elements of the traffic system: the road, the driver and the vehicle. Among these, Driver error is quoted as main contributor to road accidents (04). Driver accident and errors are further expected to occur due to inequality between what drivers may have conviction in to be a safe speed and real time speed with which a feature can be passed securely (08). Abrupt changes in roadway characteristics surprise drivers, resulting in speed errors or critical driving maneuvers that lead to collisions.

At most the promising strategies to improve traffic safety on rural highways is the implementation of the concept of design consistency. Design consistency is known as the conformance of highway geometric design with driver anticipation (07). highway geometric design consistency defined as the mark to which highway systems are designed and developed to sidestep collision risk with critical driving manoeuvres. A consistent design harmonizes driver performance by reducing speed variations (01). It also reduces speed differences between different classes of vehicles.

Most widely used approach in the area of design consistency Among the different approaches to design consistency evaluation is an operating speed-based approach (04). The first step in this approach is the development of models for predicting operating speed.

Numerous models have been developed to predict operating speed on horizontal curves in different parts of the world. However, there is large variation in model form, explanatory variables, and regression coefficients. This might be due to the changes in driver behaviour and road geometrics (07). This highlights the fact that no single model is universally acceptable. So far, no study has been reported on the design consistency of two-lane rural highways in India.

The commonly seen vehicles on rural highways in India are cars, motorized two-wheelers, buses, and trucks. The static characteristics, such as length, width, and height, dynamic characteristics, such as acceleration rate, engine power, and load carried, vary widely among these vehicles. These variations, coupled with driver behaviour, result in considerable differences in the speed of different classes of vehicles.

Literature considered passenger car and rarely heavy commercial vehicle in the majority of speed estimation model development. Only a few studies measured an effect of two-wheeler, SUVs and bus which plays significant role to Indian mix traffic condition.

A reliable operating speed model could be a useful tool in the evaluation of alternate designs and in the selection of the right design choice for the improvement of roads. Operating speed models will be useful for establishing speed limits for highway sections of unfavourable design.

A. Vehicle Classification Consideration

The Indian Automobile Manufacturers classified passenger cars in eight segments based on engine capacity and vehicle length. However, the most widely used passenger cars in India have engine capacity less than 1,500 mL and length less than 4 m. Therefore, passenger cars meeting these two criteria were considered in this study. Other than passenger cars, sports utility vehicles, light commercial vehicles, and heavy vehicles were considered in this study. The technical details of these vehicle categories are:

- Passenger cars: Passenger vehicles with total length less than 4m, engine capacity less than 1,500 cm^3 and ground clearance less than 170 mm;
- Sport utility vehicle: Passenger vehicles with total length greater than 4 m, engine capacity greater than 1,500 cm^3 and ground clearance above 170 mm;
- Light commercial vehicle: Commercial vehicles with gross vehicle weight less than metric 7.5 t; and
- Heavy commercial vehicles: Commercial vehicles with gross vehicle weight greater than 7.5 t.

II. LITERATURE REVIEW

Previous studies considered effect of geometry on speed of vehicle at two lane rural highways. These studies resulted that speed of vehicle is largely affected by radius of curve (02). Length of curve, change in the ratio of curvature and vehicle speed at the beginning of a curve is found to be impacted on operating speed at middle of the curve (MC). However, operating speed of vehicle were not disturbed by radius of curvature above 450m, and it is similar to speed of vehicle at tangent section 800m (07). previously researcher have tried to develop a speed prediction model inputting above geometric parameters as explanatory variable Moreover, ordinary least square modeling methods were taken into account (04). Though, routine of supplementary methods such as panel data modeling and artificial neural network (ANN) are not infrequent what's more (06). explanatory variables techniques and Relevant modeling adopted in vehicle operating speed estimation modeling are summarized further. Excluding a scarce, all the available operating speed estimation models were for two-lane undivided highways (01). four lane highway models were developed by developed for operating speed estimation. Nevertheless, Semeida and Morris and Donnell multilane highways speed models were developed (03).

Most of the operating speed estimation models were for passenger cars and a few were available for light and heavy commercial vehicles such as trucks. Further, the choice of speed data collection devices depended on factors such as ease of installation, data collection duration, and details required. It is evident that existing studies vary widely (05). The independent variables studied, models developed, vehicle types adopted, and data collection setup considered were different in those studies. It indicated that studies were highly context sensitive and outcomes were geographic region specific. Hence, more studies on various vehicle types for four-lane divided highways are required for better design of highways.

III. SITE SELECTION

It is a Two-lane divided rural highway with a provision of grade-separated intersections. Sites satisfying the criteria given subsequently were selected for the study. These sites meet the geometric design standards of IRC: SP-73 (IRC 1983). The highway geometric data of the study sites will be obtained with the help of Google earth and AutoCAD Civil3D. It was observed from data that these sites had no variations in superelevation rate, carriageway width, and shoulder width. Site consideration is strictly as per the following steps:

- Horizontal curves had radius 450 m or less;
- Sites were free from influence due to intersections or median openings;
- No pedestrian activity, work zones, narrow bridges in the vicinity of the site;
- Embankment of 3m or more were protected by traffic barrier such as guardrail;
- Pavements were marked for at least 3.5 m wide lanes and in good condition;
- Presence of paved shoulder of at least 1.5 m width in good condition;
- Presence of transition curves before and after the horizontal curve.

Vasad- Dakor state highway (SH-183) located in state of Gujarat is fulfilling above all criteria so it was selected as study area. Eight selected horizontal curve locations are shown in fig.1

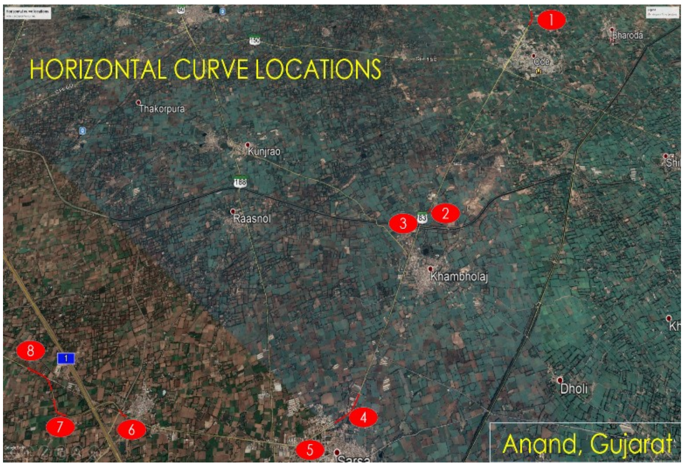


Figure 6 Horizontal curve locations

IV. DATA COLLECTION

The collected data have two main components: geometric data and speed data. The database contains the details of 15 horizontal circular curves and their preceding tangent sections. Among them eight critical sites were selected based on data made available from highway designing software AutoCAD Civil3D. The selected sites satisfied the following requirements:

- Two-lane two-way undivided at least 100m away from Intersection,

Table 7 Descriptive Statistics of Geometric Parameters for Selected Sites

Statics	Radius	Speed	Length Of Curve	Deflection Angle	Tangent Length	G_{PC50}	G_{PC}	G_{MC}	G_{PT}	G_{PT50}
MIN	60	30	20.316	8.111	55	-4.1	-1.55	-0.9	-1.5	0
MAX	345	60	157.063	26.084	80	0.3	1.5	3.6	0.9	2.6
MEAN	181.875	48.75	53.975	15.629	65.75	-0.79	0.244	0.47	-0.17	0.537
SD	88.557	12.464	51.886	9.714	18.077	1.509	0.875	1.45	0.953	0.889

- Tangent length equal to or greater than 50m,
- Grade of road between +4 and −4%, and
- Away from the vicinity of intersections.

Vehicles can decelerate well before entering the horizontal curve (Jacob and Anjaneyulu 2013; Poe et al. 1998). Therefore, speed of the vehicle is determined with data collected at five locations of each curve; 50 m initial to point of curvature (PC50), point of curvature (PC), middle of the curve (MC), See Fig. 2 for the speed data collection setup. Traps of 15 m length will be noticeable on the pavement at these locations. The speed of vehicle at PC50 specifies the speed on tangent section, at PC the speed while incoming a curvature, at MC the speed that driver understand suitable to maneuver a

Figure 7 Data extraction Using software

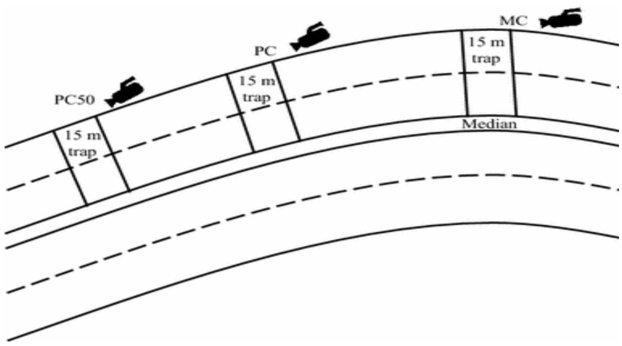


Figure 3 Data collection setup

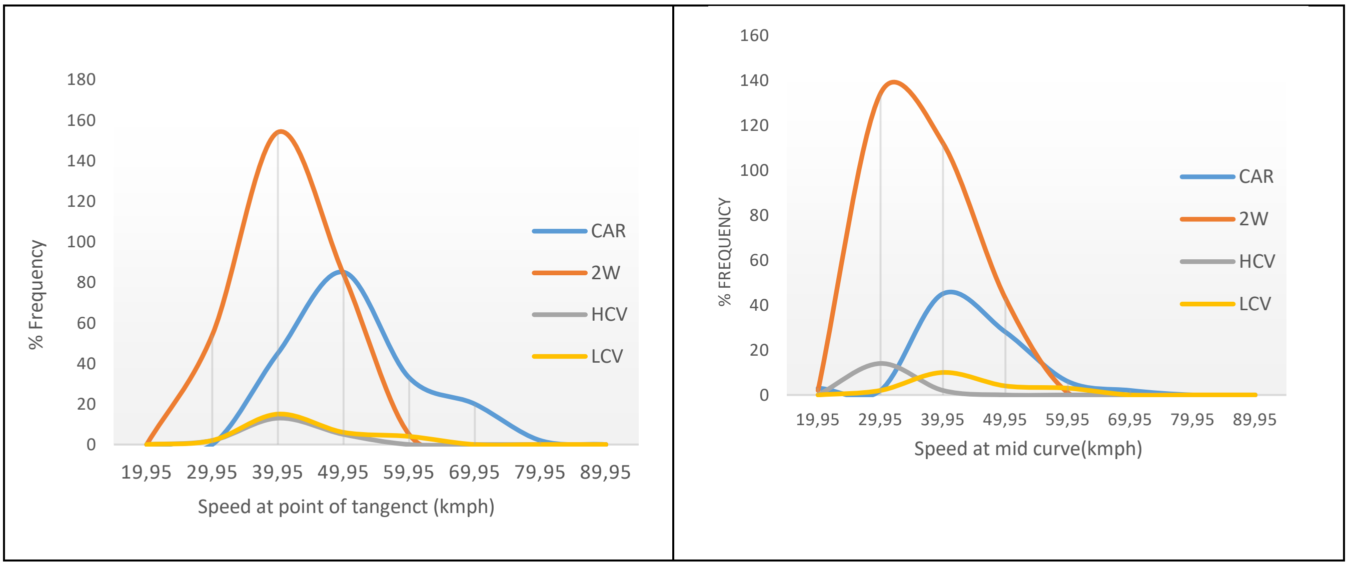
Video cameras will be installed at vantage points and will be inconspicuous to drivers for data collection. The video logs will be recorded between Jan 2020 and Mar 2020 for approximately 3 hrs. a day with good weather and adequate daylight only.

However, to ensure accuracy and minimize error in the video logs, the following precautions will be adopted:

- The camera view will not block by signboards, roadside plantations, etc.
- Cameras will be installed at a height of 2.1m on tripods for clear visibility of the trap lines
- Cameras will be located close to the trap lines to minimize parallax error but ensured to remain unobtrusive to the Tripods. will be protected firmly on the ground to avoid trouble from vibration and wind gust due to high-speed traffic movements.

V. DATA ANALYSIS

The spot speed data obtained with the help of avidmux software of data extraction and then analysis in excel. Later, Normality of data will be checked using Jarque Bera test. The normal distribution curve for mean data of operating speed model obtained is shown in following graph. From the frequency distribution curve, it can be stated that Car and 2W data has the maximum frequency and wide variation of speeds as compare to HCV and LCV data which can be stated firmly from following graph shown in Fig.4. Speed at point of tangency having a higher median speed compared for same vehicle at mid curve which was previously stated in Jacob and Anjaneyulu MVLR (2013).



VI. Speed Estimation Models

The sites used did not demonstrate variations in lane width, shoulder, width, shoulder type, and superelevation. However, geometric design parameters such as radius, deflection angle, curve length, preceding tangent length, and vertical gradients and traffic parameters such as vehicle speed and vehicle type. study the independent variables considered were horizontal curve radius, curvature, length of curve, deflection angle, preceding tangent length, and vertical gradient at 50 m prior to the point of curvature (GPC50), point of curvature (GPC), midcurve (GMC).

A stepwise multiple linear regression method was used in developing the intended speed estimation models. The obtained models are shown in Eqs. (1) – (16). In these equations, speed is expressed in km/h and the predictor variables in SI units. All models were obtained at 95% confidence limit and the predictor variables in the obtained models are significant at 95% confidence level (i.e., p-value ≤ 0.05).

A. 85th percentile speed estimation model

1) Model for MID CURVE

1. $V_{85CAR\text{-}MC} = 37.898 - 0.204L_C + 0.471\Delta + 230.45/R$ Adjusted $R^2 = 0.63$
2. $V_{85TW\text{-}MC} = 40.022 – 0.015L_C - 0.158T_L -311.224/R$ Adjusted $R^2 = 0.56$
3. $V_{85HCV\text{-}MC} = 37.228 + 0.048L_C + 0.369\Delta – 3.79G_{MC}$ Adjusted $R^2 = 0.34$
4. $V_{85LCV\text{-}MC} = 42.392 + 0.048L_C + 1.22G_{MC} – 1.45G_{PC}$ Adjusted $R^2 = 0.426$

2) Model for PC

5. $V_{85CAR\text{-}PC} = 47.244 - 0.079L_C + 1.03\Delta$ Adjusted $R^2 = 0.99$
6. $V_{85TW\text{-}PC} = 46.61 -0.076 L_C + 0.526T_L$ Adjusted $R^2 = 0.614$
7. $V_{85HCV\text{-}PC} = 36.051 - 0.056L_C – 3.236G_{PC} + 3.375G_{MC}$ Adjusted $R^2 = 0.768$
8. $V_{85LCV\text{-}PC} = 41.569 - 0.022L_C + 0.427\Delta – 1.09G_{PC}$ Adjusted $R^2 = 0.637$

3) Model for PC50

9. $V_{85CAR\text{-}PC50} = 50.167 + 0.194L_C – 0.307\Delta + 3.69G_{MC}$ Adjusted $R^2 = 0.656$
10. $V_{85TW\text{-}PC50} = 51.257 + 0.175L_C – 0.258\Delta + 1.897T_L$ Adjusted $R^2 = 0.484$
11. $V_{85HCV\text{-}PC50} = 32.924 – 59.391/R + 0.202L_C – 0.44\Delta + 7.55G_{MC}$ Adjusted $R^2 = 0.862$
12. $V_{85LCV\text{-}PC50} = 44.022 + 0.081L_C – 0.369\Delta – 1.34G_{MC}$ Adjusted $R^2 = 0.64$

B. 98th percentile speed estimation model development

1) Model for MID CURVE

13. $V_{98CAR\text{-}MC} = 44.053 - 0.062L_C + 0.863\Delta + 860/R$ Adjusted $R^2 = 0.63$
14. $V_{98TW\text{-}MC} = 57.078 – 0.405T_L - 1412/R$ Adjusted $R^2 = 0.56$
15. $V_{98HCV\text{-}MC} = 46.78 + 0.062L_C + 0.37\Delta – 2.98G_{MC}$ Adjusted $R^2 = 0.44$
16. $V_{98LCV\text{-}MC} = 50.987 – 1.165G_{MC} – 1.339G_{PC} + 1.51G_{PC50}$ Adjusted $R^2 = 0.426$

These models indicate that the 98th percentile speed of all vehicle types [Eqs. (13), (14), (15) and (16)] can be estimated from its 85th percentile speed at the midcurve region. The 85th percentile speed estimation model of car at midcurve is dependent on geometric parameters. But for other vehicle types (i.e., LCV and HCV) it is dependent on the 85th percentile speed at PC [Eqs. (3) and (4)], which in turn depends on its 85th percentile speed at 50 m prior to PC [Eqs. (7) and (8)]. The 85th percentile speed of LCV and HCV at 50 m prior to PC depends on the highway geometric features [Eqs. (11) and (12)]. For example, the 85th percentile speed of LCV at 50 m prior to PC depends on length of the horizontal curve. Researchers have noted that the speed at mid-curve can depend on approach tangent speed (04).

C. Speed Model of Car and Two-Wheeler

The 85th percentile speed of car at midcurve [Eq. (1)] is reliant on curve length (LC) and deflection angle (Δ). Note that the 85th percentile speed of car increases with increase in LC, but decreases with increase in Δ. The influence of LC and Δ on the 85th percentile speed of car is in conformation with the available literature (02). Possibly, longer curves with a similar deflection angle appear pleasing and make the car driver comfortable even at higher speed. Likewise, curves with larger deflection angle but similar curve length may appear kinky and discontinuous making car drivers uncomfortable. In other words, longer curve with lower deflection angle would encourage higher speed. Highway designers can effectively manipulate these two geometric parameters to achieve the desired operating speed of cars in the horizontal curves.

The 98th percentile speed of car at midcurve can be predicted from Eqs. (13). Considering the adjusted R2 values of these two equations, Eq. (13) may be preferred to estimate the 98th percentile speed of car at the midpoint of a horizontal curve. Further, the speed predicted from one of these two equations might be useful to compare with the adopted design speed of a horizontal curve for consistency and safety. Eq. (13) indicates that the 98th percentile speed of car at midcurve increases with increase in LC and is in conformation with the 85th percentile speed estimation model. Likewise, the 98th percentile speed of car at midcurve is found to increase with radius and is in conformation with speed estimation models available in literatures (08). For same curve length, the deflection angle reduces with increase in radius, and hence the speed is expected to increase.

D. LCV and HCV Speed Model

The 85th percentile speed of LCVs and HCVs at midcurve [Eqs. (3) and (4)] were eventually found to be dependent on its 85th percentile speed at 50 m prior to PC. The 85th percentile speed of LCV at 50 m prior to PC [Eq. (12)] depended on LC only. But for HCVs [Eq. (11)] it depended on Δ and gradient at 50 m beyond PT (GPT50). Eye height of drivers in LCVs and HCVs is higher than a car and thus has longer clear view along a highway. Further, acceleration and deceleration rate of LCVs and HCVs are lower than a car. Knowledge of upcoming road geometry and lower deceleration rate could make commercial vehicle drivers choose appropriate desired speed well before entering a horizontal curve. The 85th percentile speed of LCVs at 50 m prior to PC indicated that alike cars, longer curve length encourage higher LCV speed. The eye height of HCV drivers is usually higher than LCV drivers. Possibly, it makes them cognizant about vertical gradient beyond the horizontal curve and influence speed at 50 m prior to PC as well. The influence of vertical gradient beyond the horizontal curve on HCV speed is in conformation with the literature (06). However, the positive effect of deflection angle on HCV speed remains unexplained in this study and requires further investigation in future. The 98th percentile speed of HCV can be obtained from Eqs. (15). Considering the adjusted R2 values, Eq. (15) might be preferred to estimate the 98th percentile of HCV at midcurve. However, these equations indicated that geometric features such as gradient at PC and LC could influence the 98th percentile speed of HCV.

VI. Model Validation

The developed models were validated using data from two sites, not used in the model development. It was found that the root-mean square error (RMSE) values for the 85th percentile speed of car, two-wheeler, LCV, and HCV were 4.56, 8.36, 5.38, and 7.32 km/h, respectively. Similarly, it was 6.96, 8.34, 7.19, and 8.50 km/h. when the 98th percentile speed of car, LCV, and HCV were estimated from its 85th percentile speed at midcurve. These values were within the range reported in the literature (Jacob and Anjaneyulu 2013; Gong and Stamatiadis 2008; Semeida 2013; Morris and Donnell 2014).

VII. Sensitivity Analysis

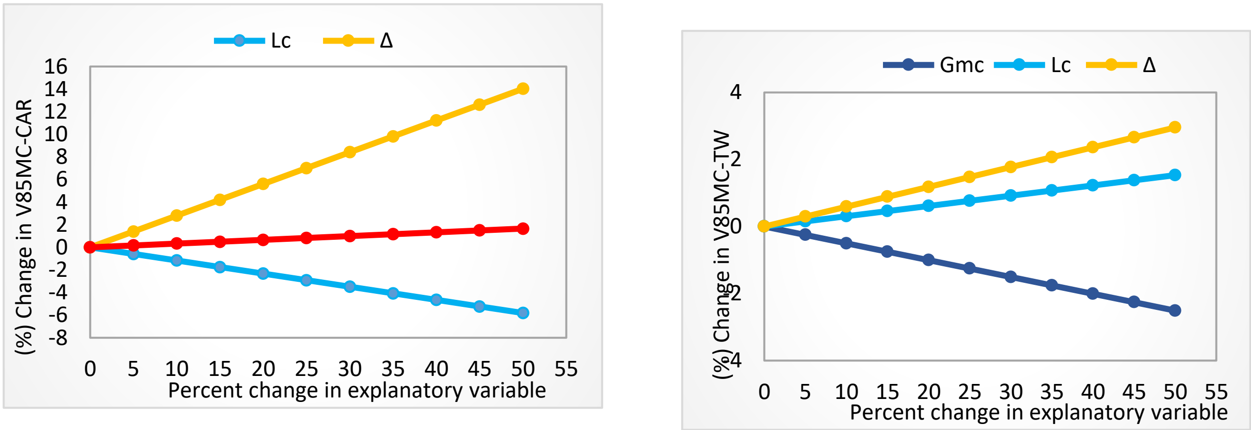


Figure 8 sensitivity Analysis

Sensitive analysis revealed that car speed is greatly influenced by Deflection angle. similarly, TW, HCV and LCV speed was highly impacted by Tangent Length, GMC and GPC respectively. That means change in explanatory variable leads to a higher change in speed. The similar results were found for sensitivity analysis of 98th percentile speed.

VIII. CONLUSION

The main objective of this study is to develop a 98th and 85th percentile speed estimation model. At first five category of vehicle (Passenger Car, SUVs, TW, LCV, HCV) were considered. Nevertheless, 98th and 85th percentile speed data of car and SUVs are not having noteworthy difference. Therefore, they were combined into one and represented as car for further analysis. Highway geometric features such as radius of horizontal curve, preceding tangent length, length of horizontal curve, deflection angle and vertical gradient, and the 85th percentile speeds in the preceding sections of highways were taken as independent variables for the model development using the stepwise multiple linear regression method. The 85th percentile speed of car and two-wheeler at midcurve was resulted to be reliant on geometric parameters. But the 85th percentile speed of LCV and HCV were resulted to be dependent on its 85th percentile speed at PC. Further investigation revealed that the 85th percentile speed at all five locations is influenced by length of curve and deflection angle.

Driver of the HCV and LCV get most influenced by gradient at curve locations. All explanatory variables of these models were found to be significant at 95% confidence limit.

The coefficient of determination value (i.e., adjusted R2 values) of the 85th percentile speed estimation model for car at midcurve was at par with similar models available in literatures (02). Although low, the coefficient of determination values of the 85th percentile speed estimation model for LCV and HCVat various locations were comparable with truck speed estimation models available in the literature (04). The cargo load and mechanical characteristics of LCVand HCV may affect its speed, but required data was not accessible for analysis in this study.

The values of the constant in the attained speed estimation models were also in conformation with available the literature (03). The curve length was found to be one of the statistically significant explanatory variables for predicting 85th percentile speed of all class of vehicle, and 98th percentile speed of car and HCV. This prompted a recommendation to include curve length in the present highway geometric design procedure. This study considered a limited number of geometric features and free-flow condition at mid-curve for developing the speed estimation models. Future research could consider the relationship between vehicle speed and additional independent variables such as vehicle platoon, roadside features, presence of vehicle in adjacent space and access density.

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PERFORMANCE ANALYSIS OF MULTI-BAND PSS IN MODERN LOAD FREQUENCY CONTROL SYSTEMS

Arvind Kumar, Preeti Sharma, Mahendra Bhadu, Hukam Chand Kumawat, S. K. Bishnoi, K.G. Sharma

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Department of Electrical Engineering, Govt. Engineering College Bikaner, Rajasthan, India
akbharia8@gmail.com, preetisharmma3782@gmail.com, mbhadu@gmail.com, hukamchandkumawat@yahoo.in, bishnoi_sk@yahoo.com, kgsharma05@rediffmail.com

Abstract

The large-scale power systems are subjected to continuous disturbance due to the existence of sudden load perturbations, parameter uncertainties, basic variation etc. The Load Frequency Control (LFC) is a part of the power system stability for controlling power interchange and frequency deviation. In this paper, the LFC problem is analyzed with various types of Power System Stabilizers (PSSs) like PSS2B, PSS3B and PSS4B, to overcome the effect of load disturbance. Performance of PSSs, with and without notch filter, is examined. Further, the PSSs are designed to operate in both continuous and discrete mode for the given test LFC system. The continuous mode PSS4B having notch filter connected in cascaded, gives better time domain response among other types of PSSs. The proposed approach is simulated in MATLAB/Simulink environment for a five-area test power system consisting of five generating units having a non-reheated turbine, to highlight the efficacy in terms of robustness.

Keywords: Load Frequency Control, MB-PSS, Five-Area Power System, Notch Filter, Power System Stabilizers

I. Introduction

The successful operation of interconnected power system shows that there is necessary generation available to meet the total load demand, with least system losses. In Single area LFC system having the primary loop, a change in the load condition will result in steady state frequency deviations, based on governor speed regulation. For reducing this deviation, a reset action is required. This is achieved through an integral controller, which change the speed set point. At last, it will turn the final frequency deviation to zero [1], [2]. For determining the power in Automatic Generation Control (AGC), an economic dispatch process and gain insights into the economic characteristics of the generating units are taken into consideration to formulate the real time value [3]. The LFC of two area thermal power plants, with Generation Rate Constraint (GRC) and integral controller are demonstrated in [4]. The authors in [5], develop a control strategy to consider the DFIG. As per [6], Integral-Double Derivative Controllers shows the better dynamic responses among the Integral, Proportional-Integral, and Integral-Double Derivative controllers in the automatic generation of multi area interconnected thermal system. Similarly, a Sliding Mode Load Frequency Control strategy is designed in [7]. Design of the fuzzy gain scheduling controllers is presented in [8]. Tilt Integral Derivative Controller with Filter in [9]. The tunings of a PID controller by Ziegler-Nichols Methods or Simplex Search Method shows the far better performance than the conventional controllers [10]. In [11], A fractional order fuzzy proportional-integral-derivative controller is presented for LFC of 4-area interconnected power systems [12]. A two-level coordinated control frame based on multi-agent system is presented in [13]. The work in [14] deals with the unequal multi-area AGC with integral derivative along with filter and proportional derivative secondary controllers. In [15], a two-level coordinated control frame based on multi-agent system is proposed. Four area power system is designed in [16. In [17], cascade combination of integer order integral-derivative with filter and fractional order proportional derivative is considered as a secondary controller. The [18], presents the impact of Demand Response(DR) control loop with communication delay. an adaptive control strategy [19], [20], Multi-Band Stabilizers [21], Analysis of noise extenuation techniques [22], Discrete time mode PSS controller [23], Robust LQG [24], WADC [25], Discrete and continuous mode PSS [26] are presented.

The main objective of this paper is to compare the performance of various types of MB-PSS (PSS 2B, PSS 3B, PSS 4B) in both continuous and discrete mode of operation, in given LFC system. The time domain performance of complete system is compared with conventional and MB-PSS system. The performance is also evaluated with various frequency bands {i.e. Low (L), intermediate (I) and high (H)}, with cascaded connected notch filter and without any notch filter in the corresponding band. In next step of analysis, the time domain response is compared for the given Load Frequency Control (LFC) system with continuous and discrete mode operation of MB-PSS. Further, the effect of using speed transducer in cascaded with continuous and discrete mode MBPSS, is also analyzed.

II. Five Area Systems for Load Frequency Control

In this paper, five area systems are considered with a number of generators and loads as illustrated in Fig. 1. The transfer function for the plant model is given by eq. (1), when droop characteristics are neglecting,

$$G = G_g G_t G_p \tag{1}$$

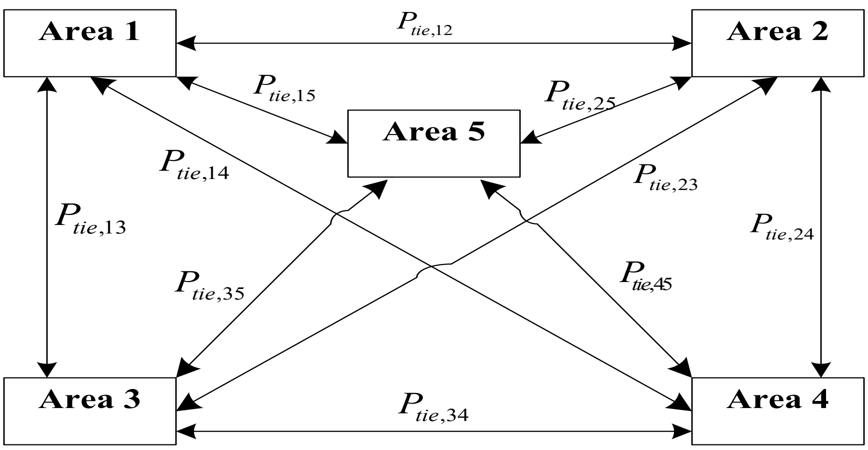

Figure 1: *Block diagram of five area interconnected system*

Where, $G_g = 1/(1+T_g s)$ is the transfer function of governor, $G_t = (1+K_r T_r s)/(1+T_t s)(1+T_r s)$ is the turbine transfer function, $Gp = K_p/(1+T_p s)$ is the power system transfer function which represents the load and machine dynamics. Since the reheat turbine used has different stages of low and high pressures of steam, it is modelled as a second-order unit. The transfer function for the plant model considering droop characteristics is given by eq. (2),

$$G = \frac{G_g G_t G_p}{1 + G_g G_t G_p \left(\frac{K_I}{s} + \frac{1}{R} \right)} \tag{2}$$

Power transported in ith area is given by eq. (3),

$$P_{tie,i} = \frac{|V_i| * |V_j| * \mathrm{Sin}(\delta_i - \delta_j)}{X_{ij}}, (i, j = 1, 2, ..., 5) \tag{3}$$

During normal condition, the active power of i^{th} control areas,

$$ACE_i = B_i \Delta F_i + \Delta P_{tie,i}, (i = 1, 2, ..., 5) \tag{4}$$

Where, B_i = biasing factor, ACE_i = area control error of i^{th} area and $\Delta P_{tie,i}$ = tie line power of i^{th} area. The control inputs for the five area systems is given by eq. (5),

$$u_i = -k_{ij} \int ACE_i dt = \Delta P_{ci}(S), (i, j = 1, 2, ..., 5) \tag{5}$$

III. Multi-Band Power System Stabilizers (MB-PSS)

The MB-PSS is used to achieve the precise compensation over a wide range of frequencies of oscillations, as it may difficult to control a wide range of oscillations using conventional lead-lag compensator. Further, the system experiences low and high frequency oscillation too, the tuning strategy of the single-band stabilizers need to trade off and won't accomplish optimal damping in any of the oscillation [27]. The MB-PSS considered here are PSS2B [28], PSS3B [29] and PSS4B [30].

IV. Simulation Results

The five-area interconnected reheat thermal power system investigated in this paper is modelled and implemented in MATLAB/Simulink environment. Following 10 different cases are considered for analysis purpose:

- Case I. Performance with various types of MB-PSSs only.
- CASE II: Performance with MB-PSSs considering notch filter.
- CASE III: Performance with Low, Intermediate and High band pass of PSS4B.
- CASE IV: Performance considering Low-Intermediate (LI) Band and Low Intermediate High (LIH) Band, with notch filter of PSS4B.
- CASE V: Performance comparison of PSS4B and Low-Intermediate (LI) band MBPSS only.
- CASE VI: Performance comparison of PSS4B with and without notch filter.
- CASE VII: Comparison of various types of MB-PSSs in continuous and discrete mode.
- CASE VIII: Performance analysis with notch filter in cascaded with discrete mode MB-PSSs.

I. Performance analysis of Various types of MB-PSS (PSS2B, PSS3B, PSS4B)

The PSS2B, PSS3B and PSS4B are implemented in the given LFC test system. Figure 2 and figure 3 show the speed deviation and power deviation with respect to time respectively, after perturbation in the system. The time domain responses are improved with the application of PSS4B as compared to PSS3B and PSS2B, as reflected from figure 2 and 3.

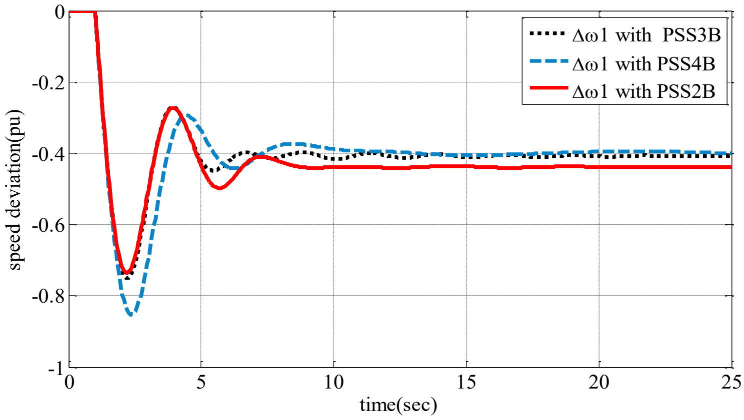

Figure 2: *Speed deviation (in pu) of area 1 with different types of MBPSSs*

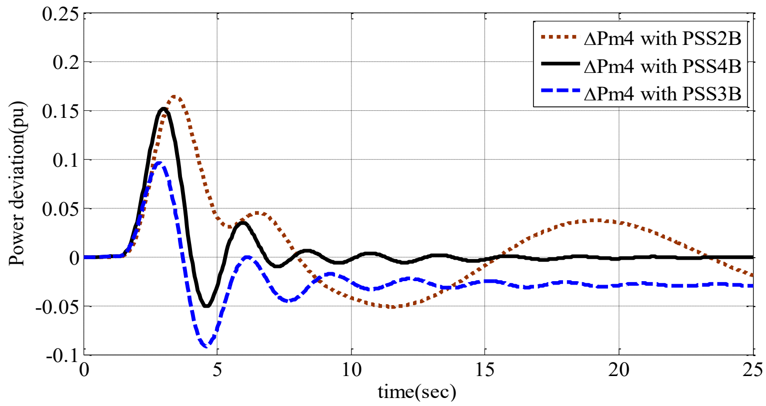

Figure 3: *Power deviation (in pu) of area 4 with different types of MBPSS*

II. Performance with MB-PSSs considering notch filter

Various types of MBPSSs with notch filter connected in cascaded, is used for the analysis purpose. Notch Filter is attenuating signal within a very narrow band of frequency. Here 6th order notch filter with 0.5 Hz center frequency and 0.25 quality factor is used in the test system. Speed deviation of area 2, using various types of MBPSSs with notch filter, are demonstrated in figure 4. It can be observed that the settling time and peak overshoot magnitude is reduced with application of PSS4B having notch filter.

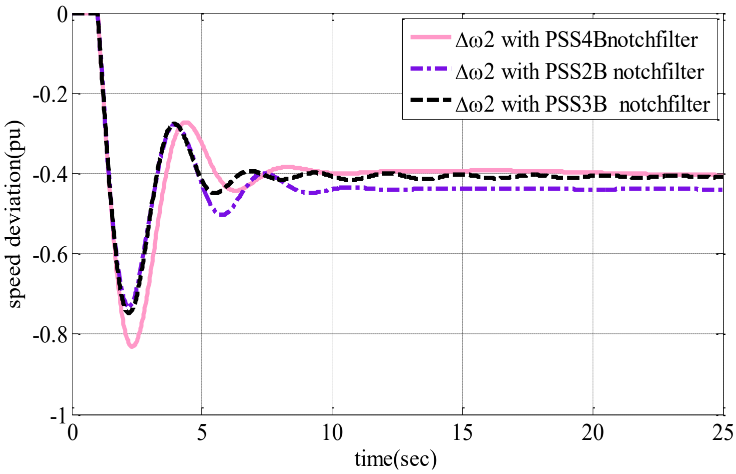

Figure 4: *Speed deviation (in pu) of area 2 with different types of MBPSS with notch filter*

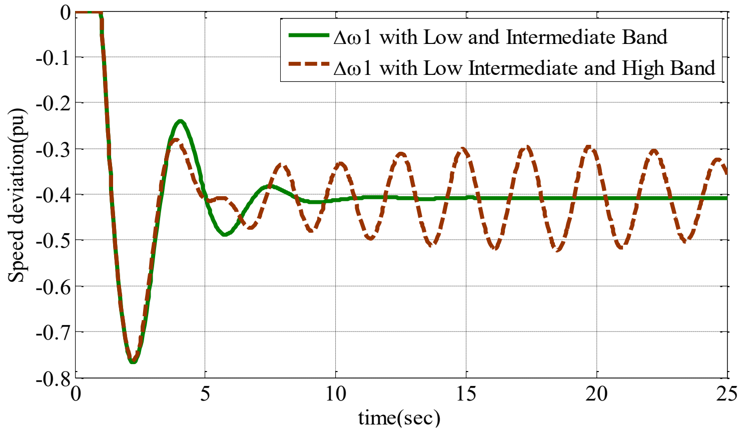

Figure 5: Speed deviation of generator in area 1 without speed

III. Performance with Low, Intermediate and High band pass of PSS4B

PSS4B has a separate differential filter as a band, to provide phase lead at low (0.01-0.1 Hz), intermediate provides (0.1-1Hz), and high frequency (1-4Hz) bands. Low and intermediate band filter getting it's input signal as speed deviation and high frequency band filter receiving it's input signal as electrical power deviation. Without speed transducer, low and intermediate band or low intermediate and high band filter are given in figure 5. The figure 6 shows that the change in power in area 3, , with low intermediate (LI) and Low-Intermediate-High (LIH) Band. It shows that LI Band has lower damping as compared to LIH Band for given LFC test system.

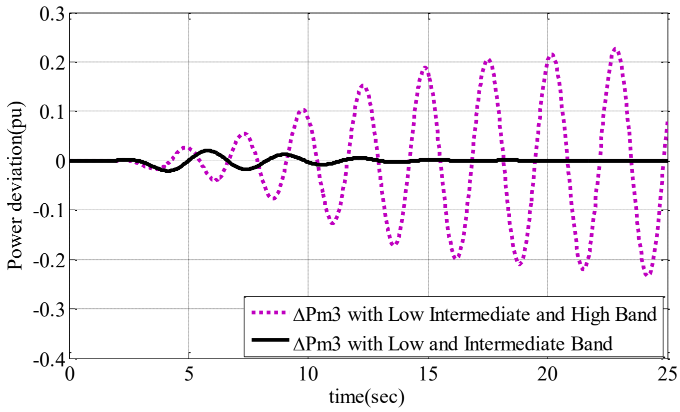

Figure 6: *Power deviation response of area 3 without speed transducer cascaded with PSS4B*

IV. Performance considering Low-Intermediate (LI) Band and Low Intermediate High (LIH) Band, with notch filter of PSS4B

Fig. 7 shows the frequency deviation of area 3 with LI or LIH band PSS having notch filter. From the plot obviously the settling time and oscillation magnitude is reduced by LI with notch filter. It has effectively reduced the peak overshoot. The figure 8 shows, the change in power in area five, with LI and LIH band having notch filter. It shows LI band with notch filter has lower damping as compare to LIH Band with notch filter.

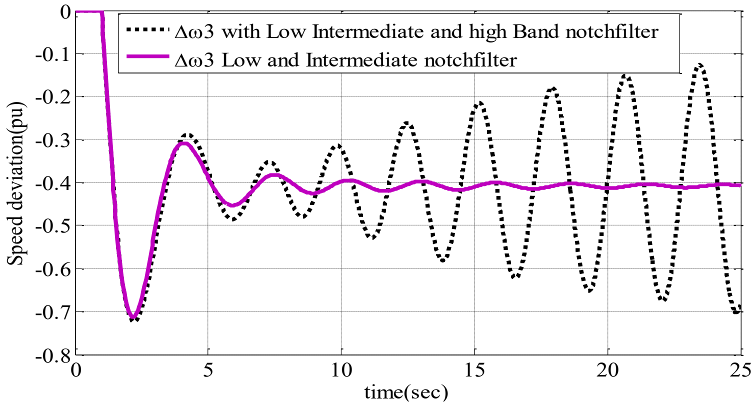

Figure 7: *Speed deviation response of area 3 without considering speed transducers but having notch filter with PSS4B*

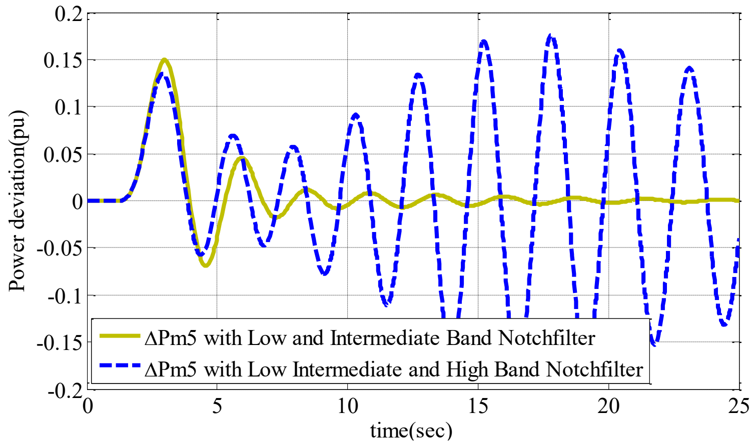

Figure 8: *Speed deviation response of area 5 without speed transducers but having notch filter with PSS4B*

V. Performance comparison of PSS4B and Low-Intermediate (LI) band MBPSS only

It can be seen from Fig. 9, 10, and 11, that with complete PSS4B, there is lower damping as compared to LI band in both cases having notch filter for given LFC system.

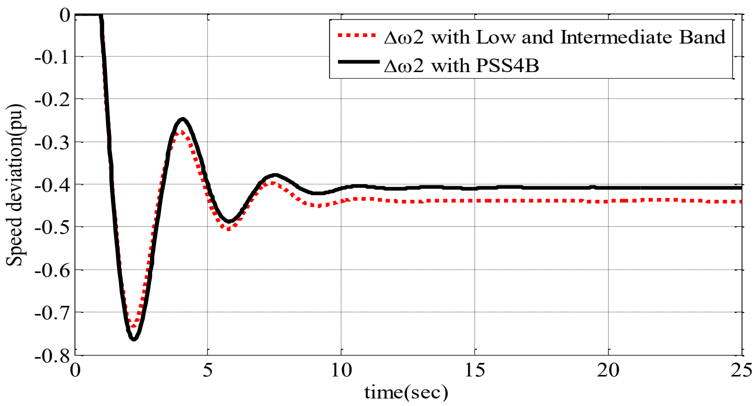

Figure 9: *Comparison of speed deviation in area 2 with PSS4B or Low and intermediate filter*

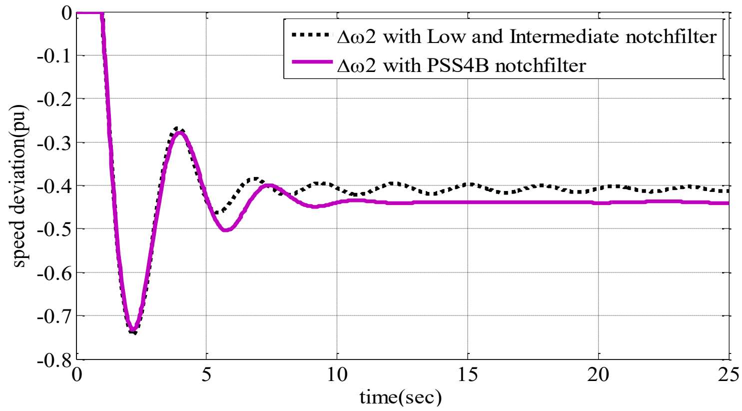

Figure 10: *Comparison of speed deviation in area 2 with Low and intermediate (LI) band having notch filter in PSS4B*

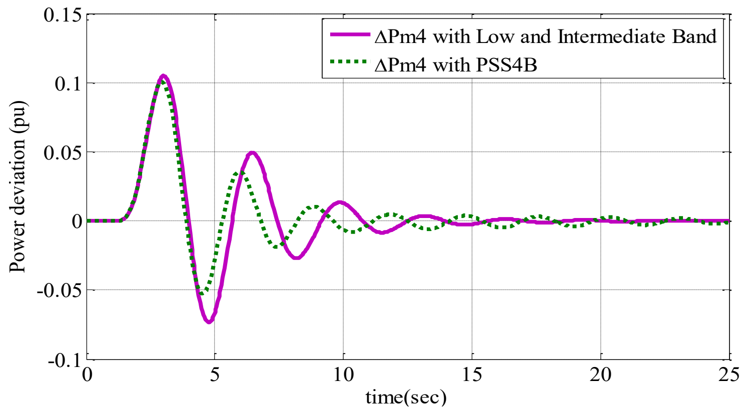

Figure 11: *Comparison of Power deviation response of area 4 with complete PSS4B and with LI Band PSS only*

VI. Performance comparison of PSS4B with and without notch filter

Critical analysis of Fig.12, and Fig.13 shows that PSS4B with notch filter have transient response. From the plot it can be derived that the settling time and oscillation magnitude is reduced. The designed PSS4B with notch filter mitigates the oscillation time and amplitude and brings the system again into the stable operation.

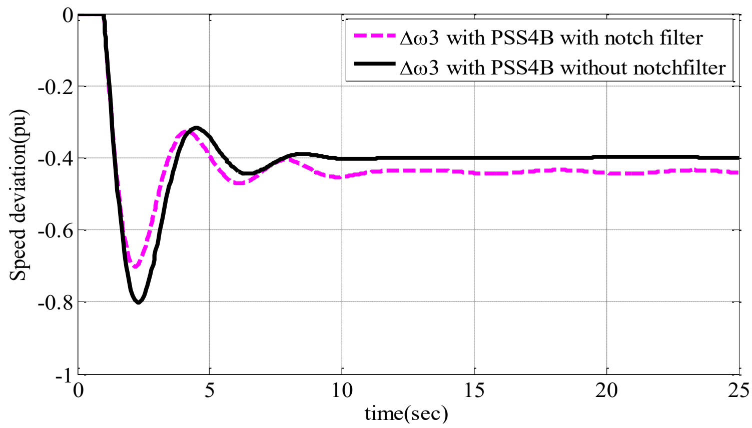

Figure 12: *Comparison of speed deviation in area 3 of PSS4B with or without notch filter*

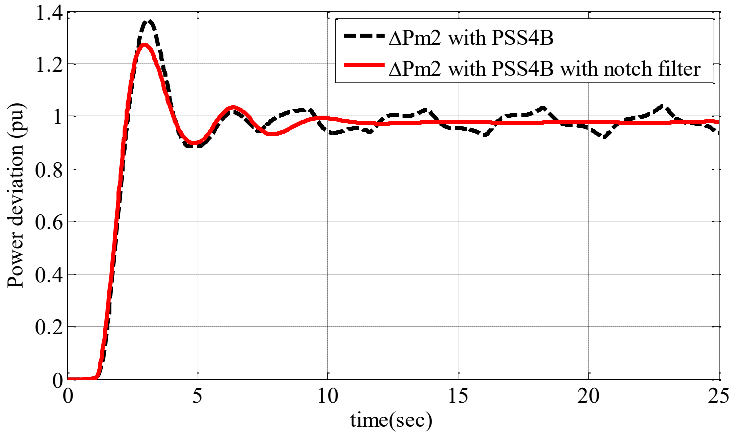

Figure 13: *Comparison of power deviation in area 2 of PSS4B with or without notch filter*

VII. Comparison of various types of MB-PSSs in continuous and discrete mode

PSS2B, PSS3B, PSS4B are studied for both continuous and discrete signal. Comparison of these things are shown below. The sampling time of discrete function is 0.04 Hz. Discrete time shows better accurate than continuous time signal. From the Fig.14, Fig.15, Fig.16, and Fig. 17 analyzed that the different type of MBPS in discrete and continuous (PSS 2B, 3B, 4B), conclusion drawn from plots is continuous mode shows better performance than discrete mode.

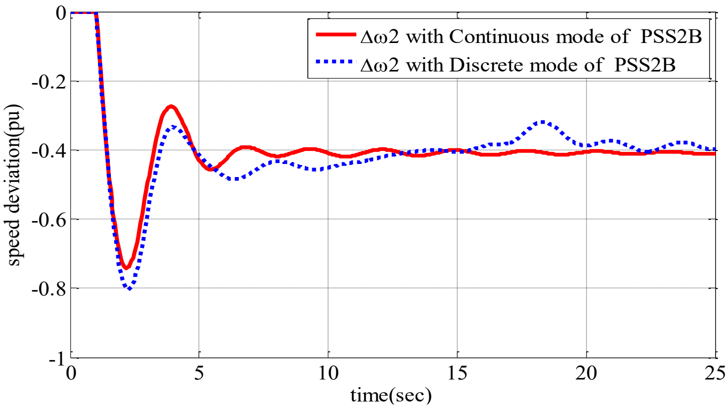

Figure 14: *Comparison between speed deviation of area 2 with discrete and continuous and discrete PSS2B*

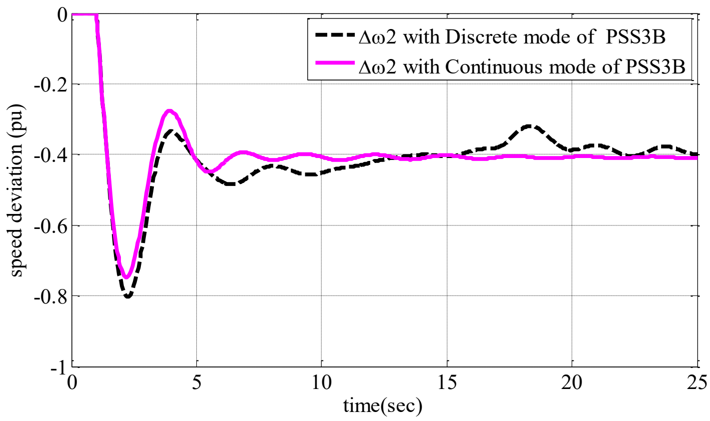

Figure 15: *Comparison between speed deviation of area 2 with discrete and continuous and discrete PSS3B*

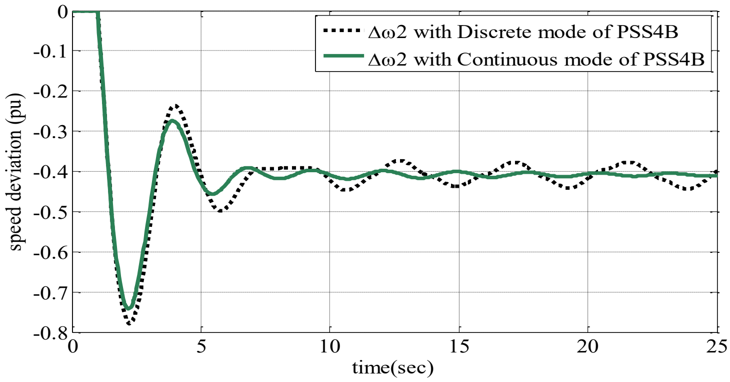

Figure 16: *Comparison b/w frequency deviation step responses of area 2 continuous and discrete mode of PSS4B*

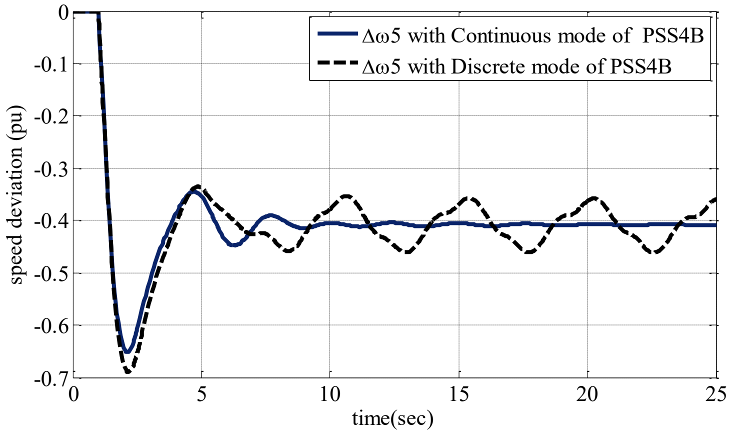

Figure 17: *Comparison between frequency deviation of area 5 with continuous and discrete mode of PSS4B*

VIII. Performance analysis with notch filter in cascaded with discrete mode MB-PSSs

Critical analysis of Fig. 18, Fig. 19, and Fig. 20 shows that the settling time and oscillation magnitude is reduced by PSS4B with notch filter in discrete time signal.

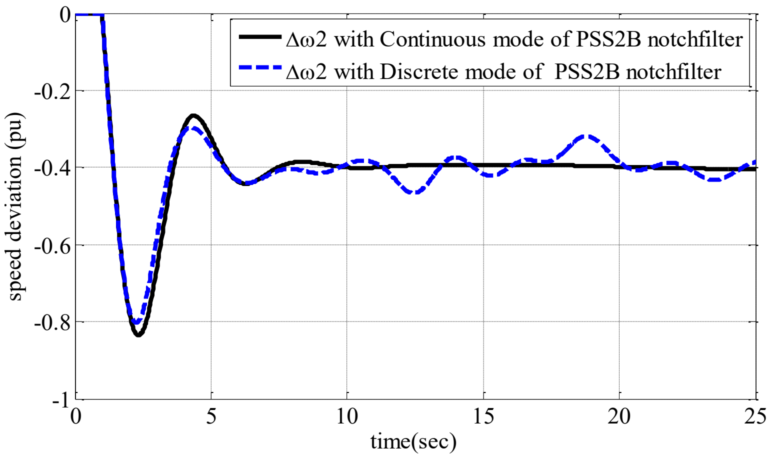

Figure 18: *Comparison between speed deviation of area 2 with continuous and discrete mode of PSS2B having notch filter*

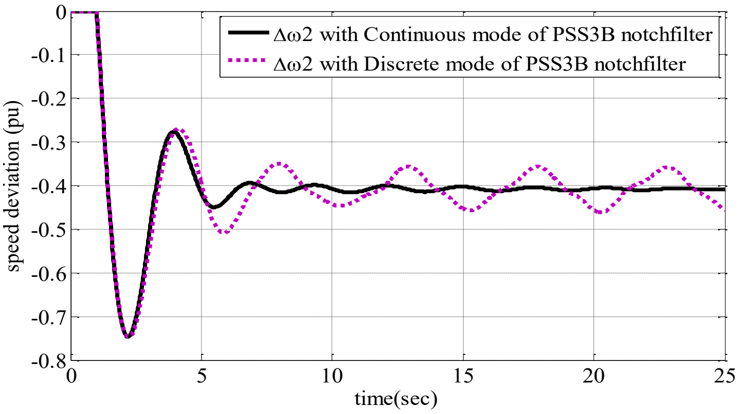

Figure 19: *Comparison between speed deviation of area 2 with continuous and discrete mode of PSS3B with Notch Filter*

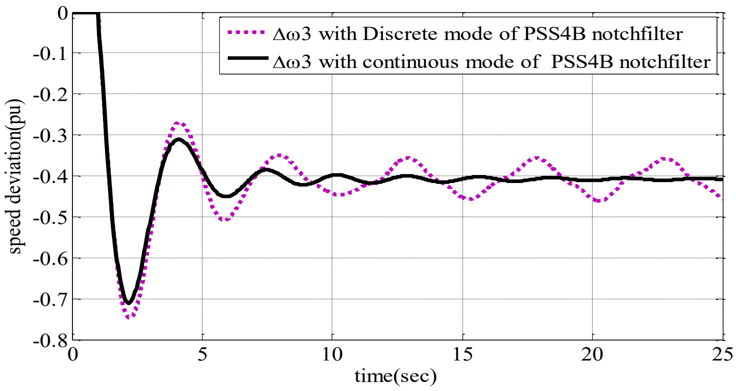

Figure 20: *Comparison between speed deviation of area 3 with continuous and discrete mode of PSS4B with Notch Filter*

V. Conclusion

This work gives a comparative performance analysis between the various types of MB-PSS along-with continuous and discrete mode MB-PSSs. The 5-area reheat thermal power system is taken for complete analysis purpose. For this test system, it has been observed that PSS4B gives better load frequency control performance as compared to PSS2B and PSS3B, both with and without notch filter consideration. Particularly in PSS4B, LI band of MB-PSS gives improved time domain performance as compared LIH band of MB-PSS. The discrete mode MB-PSSs are analyzed at sampling time of 0.04 sec, for given test system. It has been found that continuous mode MB-PSSs gives better time domain performance corresponding to their discrete counterpart. Along-with time domain response, a comparative time domain specifications are also mentioned to verify the performance

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DISTANCE RELAY PERFORMANCE DURING SINGLE-POLE TRIPPING AND POWER SWING CONDITION

Vijaykumar Dhumale, Anil Vaidya, Vijay Mohale

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Shivaji University, Kolhapure
vdhumale49@gmail.com

Abstract

Power swing enters the power system network due to various disturbances such as fault, application and removal of large load, loss of generation and switching of a transmission line etc. Generally, it is assumed that power swing is the symmetrical phenomenon which imposes an identical effect on three-phase currents and voltages of a power system. Therefore most of the literature surveys are carried out to study the symmetrical power swing and its impact on the performance of distance relay. Nonetheless, there is another type of power swing which is asymmetrical in nature. It enters into the power system when single-pole tripping is performed in a long transmission line which is heavily loaded. The consequence of this type of power swing on distance protection is widely studied in this paper. The undesired operation of distance relay owing to the existence of zero sequence current under asymmetrical power swing is restrained by using a proposed earth fault detection algorithm. The proposed algorithm and effect of single-pole tripping on distance relay is analyzed using the two test systems.

Keywords: Transmission line, single-pole tripping, distance protection, asymmetrical power swing.

I. Introduction

The power system operates very near to its nominal system frequency under steady-state conditions. During the power system's normal operating state, there is a balance between power generated and the load power demand. Also, the variation of sending end and receiving end voltage is within 5%. The various abnormalities in the power system such as loss of generation, faults, transmission line switching and switching of large loads, etc. create oscillations in the synchronous machine rotor angle. This problem further causes the oscillation in transferred power, and finally, the resulting phenomenon is termed as power swing. Depending upon the severity of disturbance, the ensuing power swing is stable or unstable [1]. The large power swing may be stable or unstable, which causes the unwanted tripping of the distance relay. This problem further leads to cascading tripping and power blackout [2]. Distance protection in transmission and meshed distribution network provides reliable protection [3]. During the fault and power swing condition, the impedance calculated by distance relay enters into its operating zone. Therefore distance relay is not able to distinguish the power swing and fault. To solve this problem, the power swing blocking (PSB) feature is incorporated in the distance relay. The primary function of PSB is to detect the power swing and restrict the operation of distance relay during a power swing condition. The operating principle of PSB depends upon the rate of variation of impedance with time under power swing and fault condition.

The power system is under stressed condition during power swing. If a fault or any other disturbance happens under this situation, major oscillations the system will experience could also

endanger the entire system stability. Some distance relays use a zero-sequence current to distinguish the fault and power swing [4]. However, this approach is not sufficient during symmetrical power

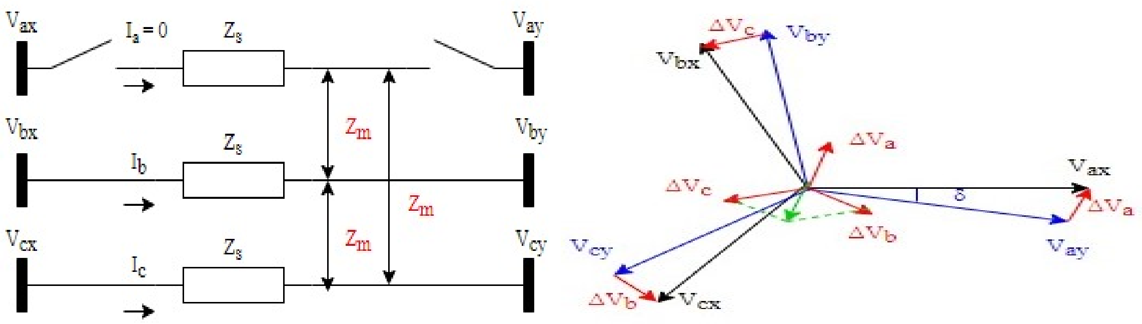
swing. The three-phase fault detected during power swing in [5] by observing the energy content in high-frequency components of forward and backward traveling waves. The wavelet transform is able to divide the signal into a different frequency range. This ability is used in [6] to differentiate the fault and power swing.

In the present day, the fault under power swing is detected by using artificial intelligent technique [7], but the method requires more time in the training procedure. The wavelet singular entropy is calculated in [8] to distinguish the power swing and fault, but the sampling frequency used in this method exceeds the available numerical based distance relay. In some numerical distance relays, the impedance calculation is dependent on the pharos estimation of voltage and current [9]. Distinction of Symmetrical fault from power swing is achieved in [10] by using the transient changes in dynamic vector.

Single-pole tripping (SPT) and single-pole reclosing (SPR) is common procedure for improving the transient stability of a power system. Asymmetrical power swing enters into the power system when SPT is performed in a long transmission line which is heavily loaded [1], [11], [12]. Therefore there is an undesired distance relay operation owing to the existence of earth current under asymmetrical power swing [13]. To solve this problem, the PSB function should detect the fault and power swing on each phase individually [14]. The consequence of SPT on distance relay studied in section II. The impact of asymmetrical power swing on distance relay carried out in section III. After that, the earth fault detection algorithm and simulation results are studied in section IV and V respectively.

II. Consequence of SPT on Distance Relay

To protect the transmission line from symmetrical and unsymmetrical types of fault, the distance relay integrated with six distance protection units, consisting of three phase units and three ground units. During SPT of phase *a* of transmission line shown in Fig. 1(a), the magnitude of voltage and current of each phase is different, which may cause the undesired operation of the protection system. Before examining the effect of SPT on distance protection, the healthy phases current during the SPT condition are extracted as:



(a) (b)

Figure 1: *Evaluation of 3-phase transmission line under the SPT of faulted phase a: (a) SPT of phase a; (b) vector diagram of voltage.*

I. Healthy Phases Currents during SPT

To find the healthy phases currents during SPT situation consider Fig. 1(a). During SPT of phase a, the following equation can be written as:

$$V_{bx} - V_{by} = Z_s I_b + Z_m I_c \ , V_{cx} - V_{cy} = Z_s I_c + Z_m I_b \tag{1}$$

Where, Zm and Zs are the mutual impedance and self-impedances of the transmission line, respectively. Consider the transmission line is to be transposed, the zero sequence and positive sequence impedances of the line are Z_0 =Zs+2 Zm and Z1= Zs - Zm.

The earth current I_E during the SPT condition is given by the following equation:

$$I_E = 3I_0 = I_a + I_b + I_c = I_b + I_c \tag{2}$$

Using (2), the (1) can be written as:

$$\triangle V_b = (Z_s - Z_m) I_b + Z_m I_E , \triangle V_c = (Z_s - Z_m) I_c + Z_m I_E \tag{3}$$

With the help of K_0 define in (4); the healthy phase currents are obtained as:

$$K_0 = \frac{Z_m}{Z_1} = \frac{Z_0 - Z_1}{3Z_1} \tag{4}$$

$$I_b = \frac{\triangle V_b}{Z_1} - K_0 I_E , I_c = \frac{\triangle V_c}{Z_1} - K_0 I_E \tag{5}$$

Currents are expressed in terms of voltage difference using (2) and (5)

$$\begin{cases} I_b = \left(\frac{1+K_0}{1+2\,K_0}\right)\frac{\triangle V_b}{Z_1} - \left(\frac{K_0}{1+2\,K_0}\right)\frac{\triangle V_c}{Z_1} \\ I_c = \left(\frac{1+K_0}{1+2\,K_0}\right)\frac{\triangle V_c}{Z_1} - \left(\frac{K_0}{1+2\,K_0}\right)\frac{\triangle V_b}{Z_1} \end{cases} \tag{6}$$

Form (2) and (6), I_E is expressed as:

$$I_E = \frac{1}{Z_1}\left(\frac{1}{1+2\,K_0}\right)(\triangle V_b + \triangle V_c) \tag{7}$$

Assuming that magnitudes of the voltages at buses x and y are same and separated by an angle, δ the per phase voltage is given by

$$\triangle V = |V|\angle 0 - |V|\angle -\delta \tag{8}$$

The phase a is taken as reference and $\alpha = 120\ \angle 0^0$

$$\triangle V_b + \triangle V_c = \left(\alpha^2 + \alpha\right) \triangle V = -\triangle V \tag{9}$$

The healthy phase's currents before the SPT are given as follows:

$$\begin{cases} I_{b,ini} = \frac{\triangle V_b}{Z_1} = \frac{\alpha^2 \triangle V}{Z_1} = \alpha^2 I \\ I_{c,ini} = \frac{\triangle V_c}{Z_1} = \frac{\alpha \triangle V}{Z_1} = \alpha\, I \end{cases} \tag{10}$$

Where, the subscript '*ini*' indicate the initial value. Using (9), the expression of I_E in (7) is written as:

$$I_E = -\left(\frac{1}{1+2K_0}\right)\frac{\triangle V}{Z_1} = -\frac{1}{1+2\,K_0}\, I \tag{11}$$

In (11) the relationship between earth current I_E and K_0 is inversely proportional. Therefore as K0 increases, the earth current IE during SPT condition decreases. At the same time, healthy phase's currents in (6) expressed as:

$$\begin{cases} I_b = K_b, K_b = \frac{(1+K_0)\,\alpha^2 - K_0\alpha}{1+2\,K_0} \\ I_c = K_c\, I\,, K_c = \frac{(1+K_0)\alpha - K_0\alpha^2}{1+2\,K_0} \end{cases} \tag{12}$$

Fig. 3 of [13] indicates the variation in ratios of *Ib / Ib,ini* and *Ic / Ic,ini* both in magnitude and phase angle versus the K_0. In the overhead transmission line, the value of K_0 is typically between 0.6 to 1 [3]. Fig. 3 of [13] represents as K_0 increases, the magnitudes of *Ib / Ib,ini* and *Ic / Ic,ini* decreases slowly. For K_0 value between 0.6 to 1, the magnitude of healthy phases current I_b and I_c during SPT are nearly 85% of their values prior to SPT.

The main result of the above analysis is that under the SPT condition, the earth current is present in the system. Therefore there is a need to block the operation of a protection system whose action is based on the earth current during the SPT condition.

II. Healthy Phases Currents during SPT

Consider Fig. 1(a), the impedance measured by phase b ground distance unit Z_{bE} is:

$$Z_{bE} = \frac{V_{bE}}{I_b + K_0 I_E} \tag{13}$$

Using the (11), (12), and assuming the voltage after and before the SPT is identical, the (13) can be written as:

$$Z_{bE} = \frac{\alpha^2 V}{\left(K_b - \frac{1}{1+2K_0}\right) I} = \frac{V}{I} \tag{14}$$

The impedance measured by ground distance unit Z_{bE} during the normal operating condition of a system is

$$Z_{bE,ini} = \frac{V_{bE,ini}}{I_{bE,ini}} = \frac{\alpha^2 V}{\alpha^2 I} = \frac{V}{I} \tag{15}$$

According to (14) and (15), the impedance measured by the ground distance unit under the steady-state condition of the system and during the SPT condition is identical. Moreover, the impedance measured by phase distance relays are given as follows:

$$Z_{ab} = \frac{\alpha^2 V}{K_b I}, Z_{bc} = \frac{(\alpha^2 - \alpha) V}{(K_b - K_c) I}, Z_{ca} = \frac{\alpha V}{K_c I} \tag{16}$$

The ratio of impedance measured by phase distance units, after the SPT and before the occurrence of SPT, is given as follows:

$$\frac{Z_{ab}}{Z_{ab,ini}} = \frac{\alpha^2}{K_b}, \frac{Z_{bc}}{Z_{bc,ini}} = 1, \frac{Z_{ca}}{Z_{ca,ini}} = \frac{\alpha}{K_c} \tag{17}$$

In Fig.4 of [13], for K_0 values between 0.6 to 1, the impedance measured by the phase distance units *ab* and *ca* during the SPT condition are higher than the impedance measured during the steady-state condition of a system by 1.15.

III. Asymmetrical Power Swing Impact on Distance Relay

The Performance of a distance relay under asymmetrical power swing is analyzed with the help of Fig. 1(a). For healthy phase *b* the following equation can be written by using the (1), (5), and (13).

$$V_{bx} = V_{by} + (Z_s - Z_m) I_b + Z_m I_E \tag{18}$$

$$I_b + K_0 I_E = \frac{V_{bx} - V_{by}}{Z_1} \tag{19}$$

$$Z_{bEx} = \frac{V_{bx}}{\frac{V_{bx} - V_{by}}{Z_1}} = Z_1 \frac{1}{1 - \frac{|V_{by}|}{|V_{bx}|} \angle -\delta(t)} \tag{20}$$

The (20) in Cartesian form is given as follows:

$$Z_{bEx} = \frac{Z_1}{1 - K_v(\cos\delta(t) + j\sin\delta(t))} \tag{21}$$

From (21), it is clear that for different values of *Kv*, the Variation of Z_{bEx} depends upon the power angle δ. From [13, Fig.7], it is observed that for some value of power angle δ, the impedance calculated by ground distance unit Z_{bEx} enters into the tripping zone of the relay. If the disturbance is severe, then the power angle separates by a large angle, and the impedance trajectory passes into opposite side of the RX plane represents that, the ensuing power swing is unstable.

The impedance measured by phase distance unit *bc* during the SPT of phase a is calculated by using (1) and (12).

$$V_{bx}\text{-}V_{cx} = (\alpha^2 - \alpha)V \text{ , } I_b\text{-}I_c = (\alpha^2 - \alpha)\frac{\Delta V}{Z_1} \tag{22}$$

$$Z_{bc} = \frac{V_{bx} - V_{cx}}{I_b - I_c} = Z_1 \frac{1}{1 - K_v \angle -\delta(t)} \tag{23}$$

Considering (16), the impedance calculated by phase distance unit *ab* and *ca* are given as:

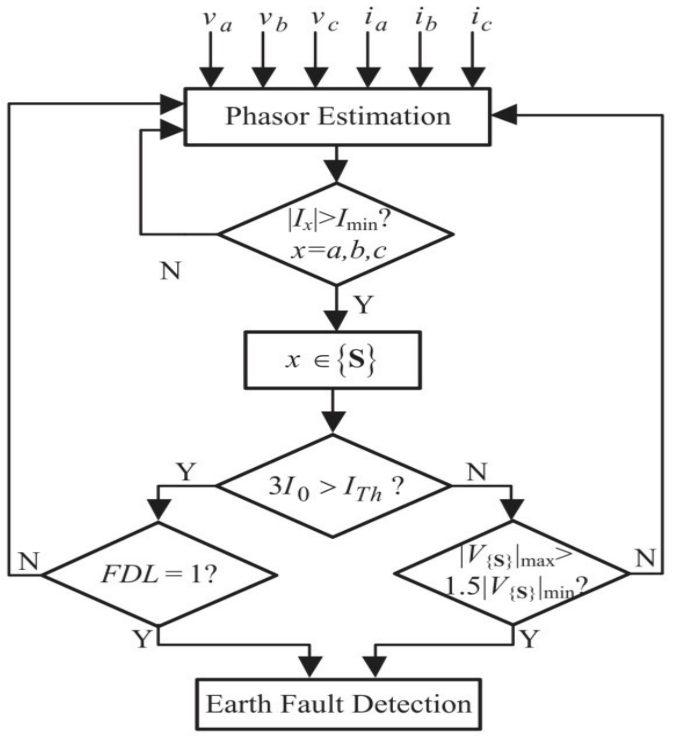
$$Z_{ab} = \frac{\alpha^2}{K_b} \cdot \frac{Z_1}{1 - K_v \angle -\delta(t)}, \quad Z_{ab} = \frac{\alpha}{K_c} \cdot \frac{Z_1}{1 - K_v \angle -\delta(t)} \tag{24}$$

It can be concluded from (16), (24) and [13, Fig. 4], that under the SPT condition, the impedance measured by the phase distance units *ab* and *ca* are higher than the impedance measured during the normal operating condition of a system. Therefore, the impact of asymmetrical power swing on the phase distance unit is less. However, the impedance measured by phase distance unit *bc* is identical to the impedance measured by ground distance units *bE* and *cE.*

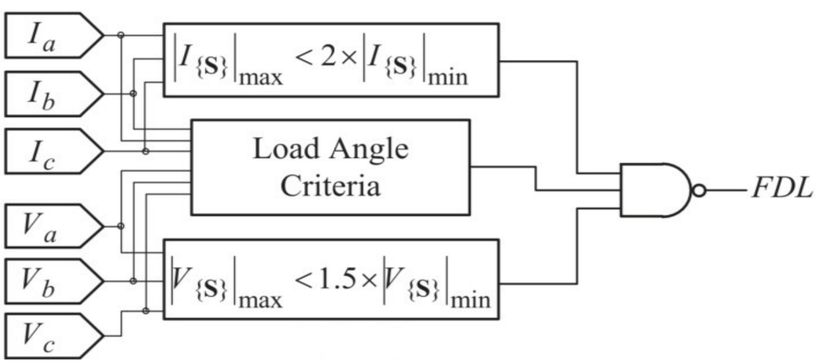
IV. Proposed Earth Fault Detection Algorithm

Some recent numerical based distance relays incorporate an advanced earth fault detection algorithm under the SPT condition to restrain the undesired operation of ground distance relays. Such algorithm is defined in [14], suitable only under SPT conditions, and it does not consider the consequence of earth current on the adjacent line distance relays. Therefore to solve these issues, the earth fault detection algorithm is defined in Fig. 2. In the given algorithm, *Im* is the minimum value

Of the current used to identify any phase opened during the SPT. It is set as 10% of phase current (In) under normal operating conditions of the system. The load angle criteria block in Fig. 2 (b) monitor the angle ∣∠ V{s}/ I{s}∣ is above or below the load angle, 300.



(a)



(b)

Figure 2: *Algorithm to restrain the operation of ground distance relay under power swing: (a) Flowchart (b) Fault detection logic signal generation block.*

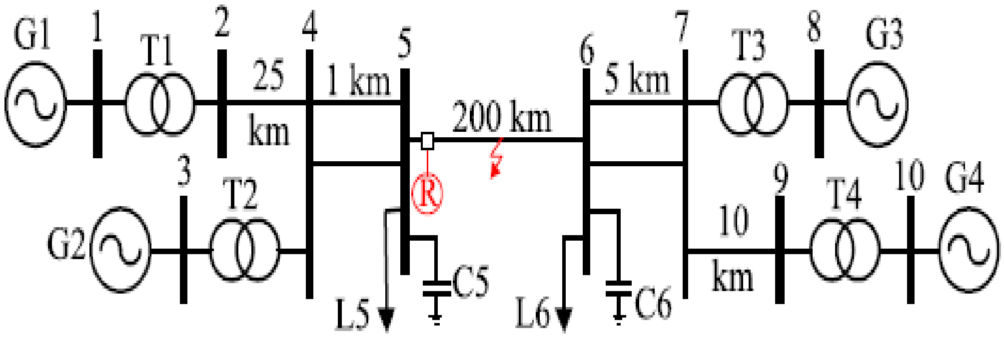


Figure 3: *Modified kundur four-machine 10 bus system*

V. Simulation and Result

To show the presented analysis two test systems are used in this section. Both the test systems are simulated in MATLAB software. The proposed algorithm is developed in Python language and tested on IEEE 9 bus system.

I. Modified Kundur four-machine 10 bus System

The modified kundur four-machine 10 bus system shown in Fig. 3 is used to show the impact of reclosing dead time on the performance of ground distance units. The relay under observation is connected at bus 5. The simulation parameters and it's data are given in [15]. The simulation scenario is discussed below:

Case 1: Consider an SLG fault at the midway of a line 5-6 at t = 2sec on phase a. To avoid the separation of two areas of the system, SPT needs to be performed under this situation. The SPT of phase a is performed at t = 2.06 sec, and finally, single-pole is reclosed at t = 2.3 sec due to the transient nature of the fault. Under this condition, the zero-sequence current is observed in line 5-6, which causes the unwanted operation of healthy phase ground distance units. Fig. 4 show the zero sequence current of line 5-6 during the SPT condition.

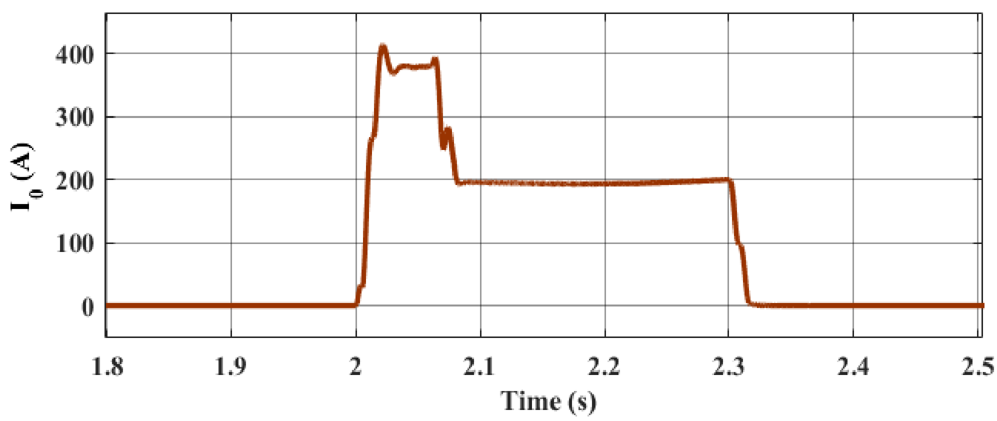
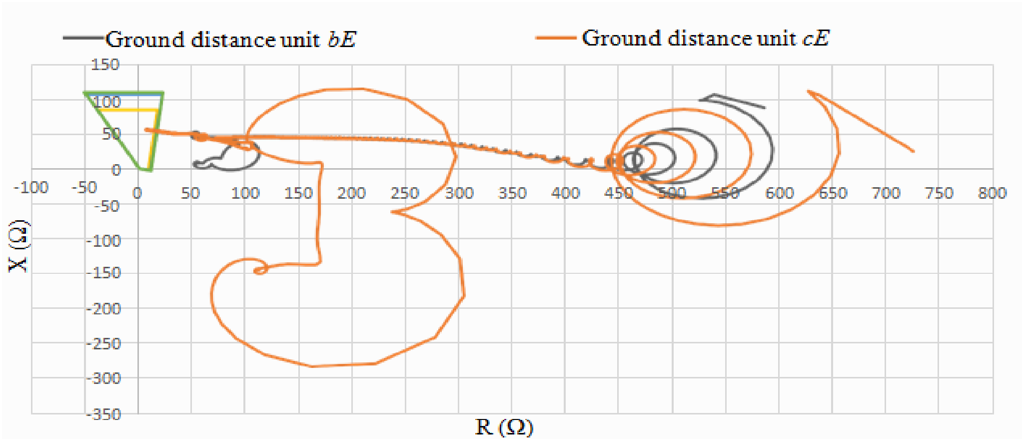
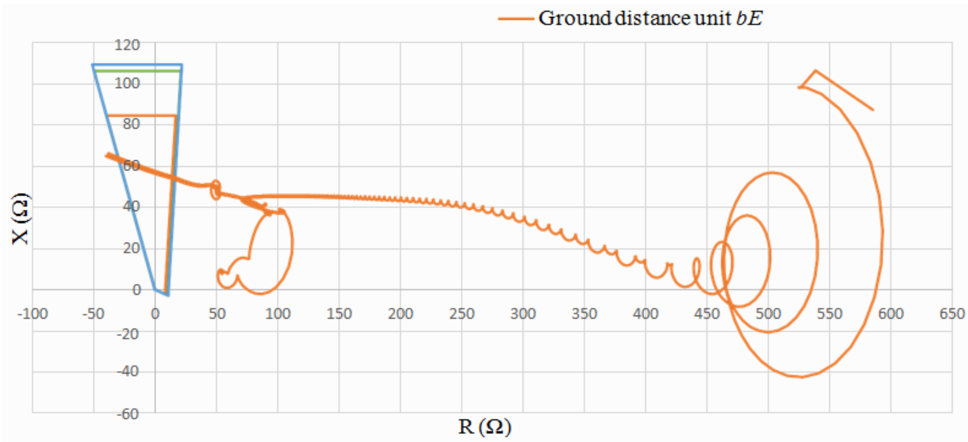


Figure 4: *Zero-sequence current of line 5-6 during SPT*

Case 2: Consider the SLG fault at the midway of line 5-6 at t = 3sec on phase a. The faulted phase a, is opened at t = 3.06 sec, and ultimately for defined dead time, the opened phase is reclosed. Fig. 5 show the behavior of the ground distance unit for two distinct reclosing dead times. The dead time is 35 cycles in Fig. 5(a) and 37 cycles in Fig. 5(b). For both this dead time, the impedance calculated by ground distance units enters into its tripping zone. Fig. 5 demonstrates that the ensuing power swing is stable for shorter dead time and unstable for the longer dead time.



(a)



(b)

Figure 5: *Behavior of ground distance relay under SPT of phase a of line 5-6: dead time = (a) 35 cycles, (b) 37 cycle.*

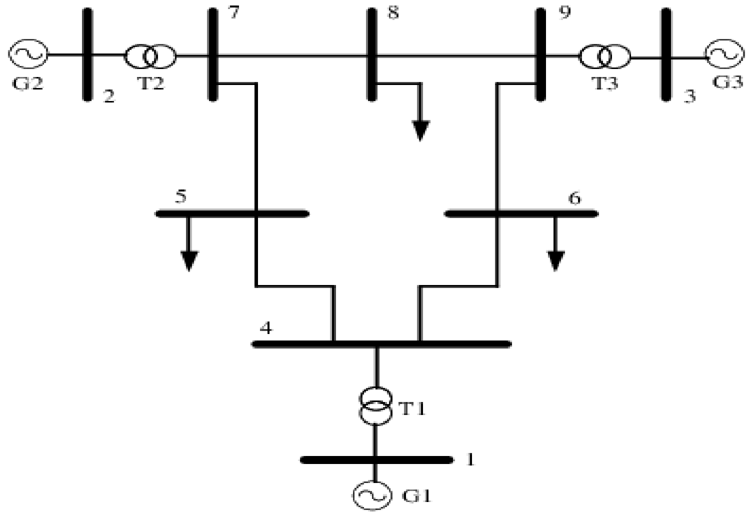


Figure 6: *IEEE 9-bus system*

II. IEEE 9 Bus System

The IEEE 9 bus system shown in Fig. 6, used to understand the impact of asymmetrical power swing on the adjacent line distance relays. It consists of three transformer, three generators, six transmission lines, and three loads. The data for all these parameters are given in [16]. The simulation scenario is as follows:

Consider the SLG fault at the midpoint of the line 6-9 at t = 1sec on phase a. The SPT of faulted phase is performed at t = 1.02 sec, and finally, the single-pole is reclosed at t = 1.3 sec. Under this situation, the considerable magnitude of zero sequence current is observed in adjacent line 4-6, which causes the unwanted operation of the ground distance units at bus 4. The zero sequence current in line 4-6 during SPT of line 6-9 shown in Fig. 7. The unwanted operation of ground distance units at bus 4 is restrained by using the algorithm defined in Fig. 2. In earth fault detection algorithm, max (∣ Ia ∣, ∣ Ib ∣, ∣ Ic ∣) is greater than 2×min (∣ Ia ∣, ∣ Ib ∣, ∣ Ic ∣) during SPT. However, under these same situations, the max (∣ Va ∣, ∣ Vb ∣, ∣ Vc ∣) is less than 1.5× min (∣ Va ∣, ∣ Vb ∣, ∣ Vc ∣). When SLG fault occurs at the midway of adjacent line 4-6 at t = 1.1 sec during the SPT of line 6-9, max (∣ Va ∣, ∣ Vb ∣, ∣ Vc ∣) becomes greater than 1.5× min (∣ Va ∣, ∣ Vb ∣, ∣ Vc ∣). Therefore, it is possible to restrain the operation of main line and its adjacent line distance relays during SPT condition by using the combination of voltages and currents which are defined in Fig. 2. The three phase voltages and currents shown in Fig. 8 are used during the testing of an algorithm.

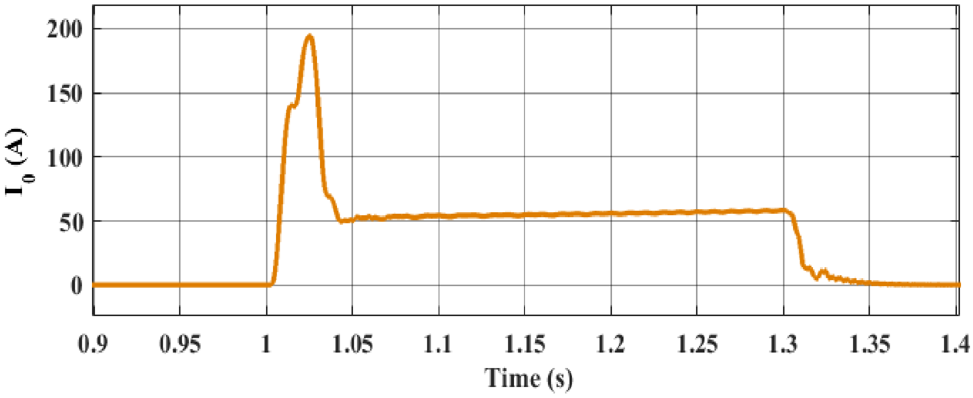


Figure 7: *Zero sequence current of line 4-6 during SPT of line 6-9*

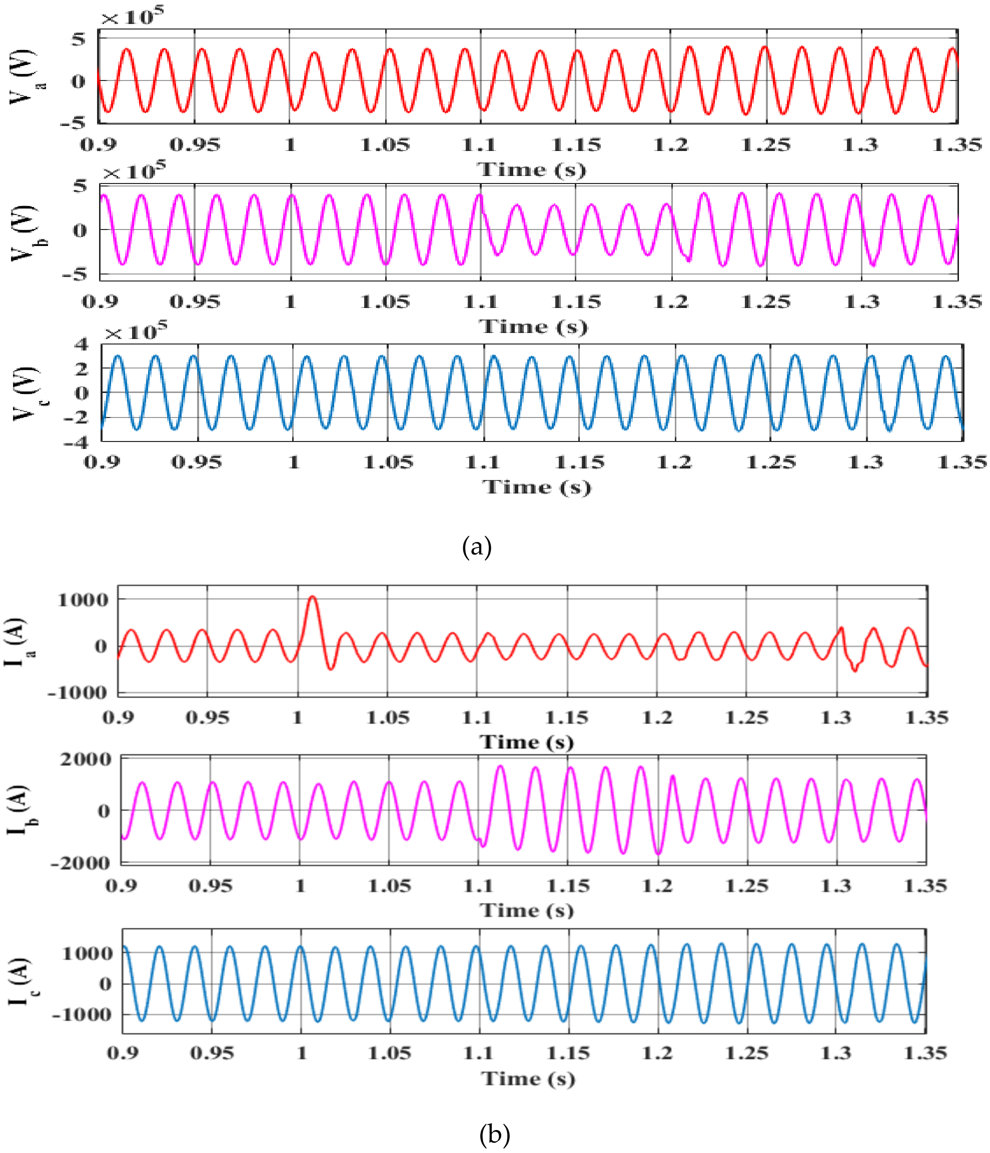


Figure 8: *Simulation result of IEEE 9 bus system: (a) Three-phase voltage of line 4-6; (b) Three-phase current of line 4-6.*

VI. Conclusion

The distance relay performance under SPT condition and effect of asymmetrical power swing on distance relay are studied in this paper. The earth current is present in the system under the SPT condition, which causes the unwanted tripping of healthy phase ground distance units. This problem is solved in this paper by using the combination of voltages and currents which are defined in the earth fault detection algorithm. The earth fault detection algorithm takes care of undesired tripping of both the adjacent line and main faulted line distance relays, and it can be used in any situation regardless of SPT.

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REVIEW PAPER ON CANCER CELL DETECTION USING MATHEMATICAL ALGORITHM

Vatsal Shah, Prof. G.B. Rathod, Neel Macwan
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BirlaVishvakarmaMahavidyalaya
shahvatshubh@gmail.com

Abstract

Digital Signal Processing (DSP) plays an important role in the study of genes and genomics in today's time. DSP is applied to the DNA sequences and then by applying the various DSP algorithms like DFT, (Discrete Fourier Transform), DWT (Discrete Wavelet Transform). We can predict the coding region of DNA and also find out abnormality present in the coding region. This algorithm is used to find out the cancer cells. As cancer is caused due to some mutation or abnormalities present in the DNA. So this algorithm is tested in on the several cancer gene databases and normal gene databases present in the Gene bank and NCBI website that provides satisfactory results.

Keywords: Coding region, DFT Power Spectrum DWT, DSP algorithm, DNA sequences, Genomic Signal Processing

I. Introduction

Cancer is one of the most dangerous diseases in the world it is caused due to genetic mutation in the DNA.DNA means Deoxyribonucleic acid. DNA consist of information that is essential for an organism to grow and reproduce. It is made up of molecules that are known as nucleotides. Each nucleotide consists of the Phosphate group, A Sugar group, and Nitrogen base. The four types of nitrogen bases present in it are adenine(A), thymine(T), guanine(G), cytosine(C). Fig1 shows the structure of the DNA.

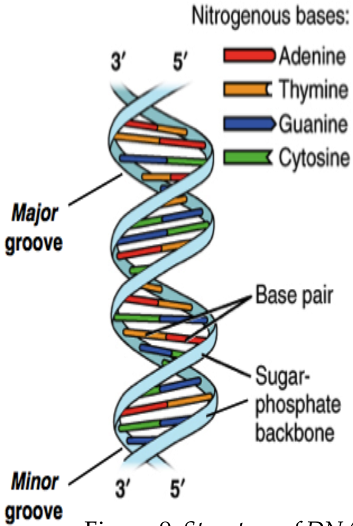

Figure 9: *Structure of DNA*

Genes are the sequences of the nucleotides present in the DNA. Organisms get the genes to inherit from the parents. Mutation in the genes causes cancer in the organism. Figure2 clearly shows the difference between normal genes and mutated cancer genes. Mutation in the genes means it is a permanent change in the sequence of the DNA which affects the chromosomes of the organism which causes several diseases these mutations can be inherited from the parent genes.

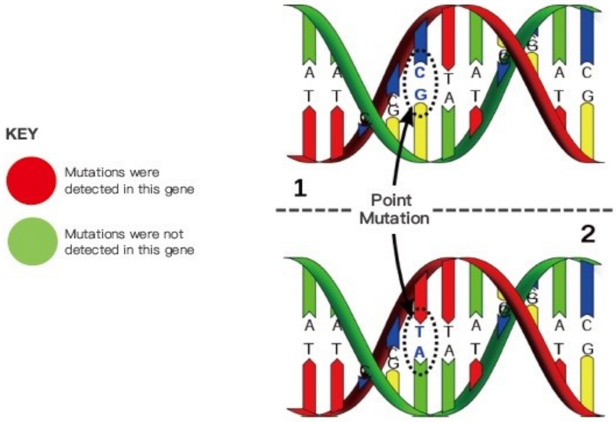

Figure 10: *Genetic Mutation*

Genomic signal processing(GSP) helps to find with the genetic mutation in the coding region of the DNA which is useful to predict the cancerous cell. Genomic signal processing deals with the study of genes database by converting the DNA sequence to the signal which helps to study the cancer cell easier other than the traditional or conventional method. It helps the mathematician, scientist, and researcher to study any kind of disease by mapping the DNA sequence properly. Further, the algorithms like Discrete Fourier transform and Discrete wavelet transform helps them to find out several Properties of the DNA like Coding region. These help them to do mathematical modeling of cells and analysis of the cell. So this helps the no biologist to study and to predict several diseases by these algorithms. So this paper deals with the mathematical modeling of the cancer cell to predict the cancer disease. The methods that are proposed in this paper is the efficient one rather than a traditional or conventional method.

II. VARIOUS CANCER DETECTION TECHNIQUES - A SURVEY

Prediction of Cancer cells using the DSP technique was proposed by G.N. Satapathi, Dr.P. Srihari, Senior, Aruna Jyothi, S. Lavanya [1]. In this paper, the authors have described the DFT algorithm on the coding region of the DNA to predict the cancerous cell. DFT means Discrete Fourier Transform it means to apply the Discrete-Time Fourier transform at the particular sample of the Signal so here the author has, first of all, mapped the bases of the DNA (A, C, G, T) to the binary it means the A and T is converted to binary value 0 and C and G is converted to binary sequence 1. Then after they have applied the DFT to the binary sequence. The formula of DFT is:

$$X_s\left[k\right] = \sum X_s[n]e^{-2\Pi kn/N} \tag{1}$$

for k=0,1,2, …. N-1 and n=0,1, 2, N-1.

Then the author has also applied the Power spectrum density to the sequence the formula of PSD is:

$$P_s[k]=\sum X_s[k]^2 \qquad (2)$$

Then by plotting the PSD (Power Spectrum Density) on DFT of cancer cells and normal cells they have to predict cancer cells. They have applied the IIR filter to denies the PSD signal. If the ratio of mean amplitude and mean frequency is greater than 1 then the cell is normal otherwise it is a cancer cell. DWT based Cancer Identification using EIIP was proposed by Shelli Chakraborty, Vinita Gupta. [2]. In this paper, the authors have mapped the DNA bases (A, C, G, T) to the 0.1260 0.1335, 0.0806, 0.1340. This method is known as the EIIP mapping method. Then they have applied the Discrete wavelet transform to the signal. A discrete wavelet transform is a unique algorithm to do feature extraction of the signal and to find out the statistic of the signal. The formula of the Discrete Wavelet Transform is:

$$Y[n]=(x*g)[n]=\sum x[k]\, g[n-k] \qquad (3)$$

If the ratio of the mean amplitude of the signal and standard deviation of the signal is greater than 1 then Normal cell otherwise it is Cancer cell. Figure3 shows the Discrete wavelet analysis of the signal. And the different level of decomposition of the signal is shown in the figure. The flow chart of the algorithm is shown below:[2]

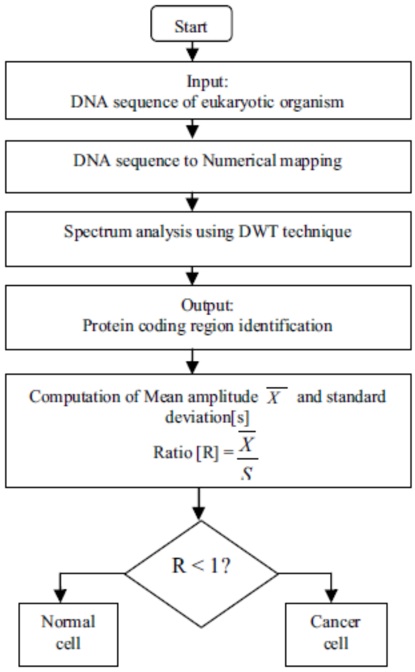

Figure 11: *Flowchart of the Research*

Detecting genetic variants of Breast cancer using different power spectrum methods was proposed by Safaa M. Naeem, Mohamed A. Eldosoky, Mai S. Mabrouk [2]. In this paper, the author has implied both the methods of mapping the DNA sequence has mentioned in both the methods they are binary mapping also known as the Voss representation method and EIIP mapping method. They have applied the method on the DNA sequence of Breast Cancer. Then they have applied Discrete Fourier transform and PSD (Power Spectrum Density) on DFT of DNA sequence of Breast Cancer. Figure 4 shows the discrete wavelet transform[2].

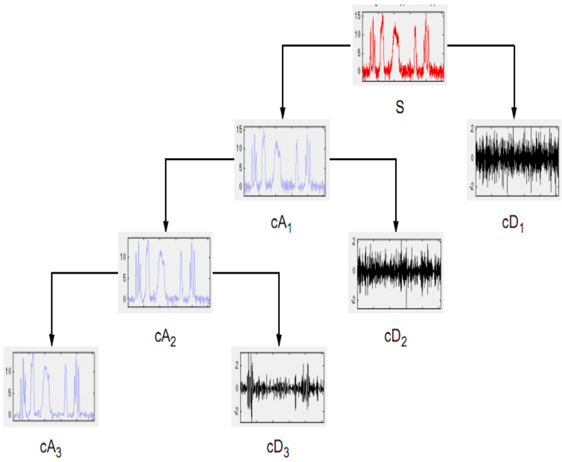

Figure.4: *Discrete Wavelet Transform*

The author has applied the other algorithm in the paper known as Welch Power Density on DFT of DNA sequence of breast cancer. Welch Power Density is used to determining the power of the signal at the different frequency is based on the concept of periodigram spectrum which includes the conversion of a signal of time domain to frequency domain. Then after they have concluded that the EIIP mapping method is best than the conventional method to predict cancer cell. Figure6 and 7 prove the same. [3]. The figure below shows the general block diagram of such kind of research:

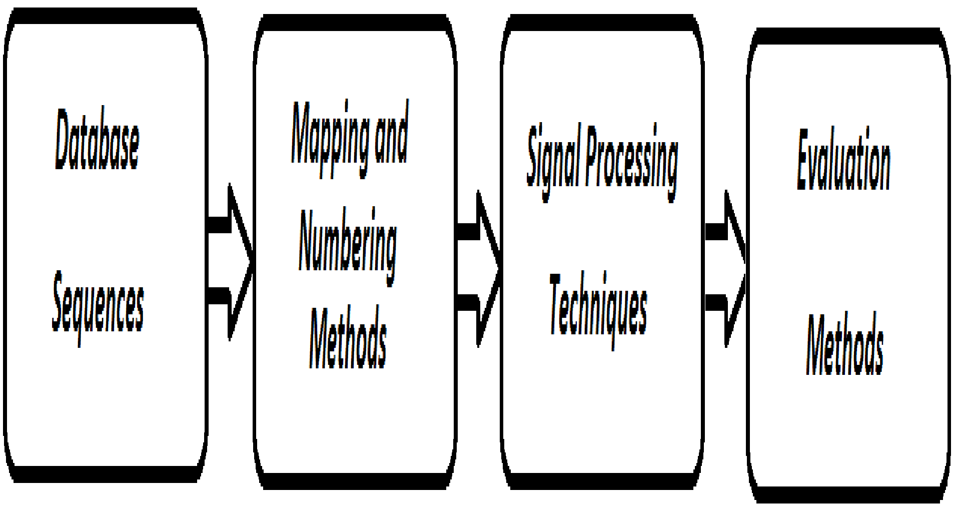

Figure.5: *General block diagram of GSP*

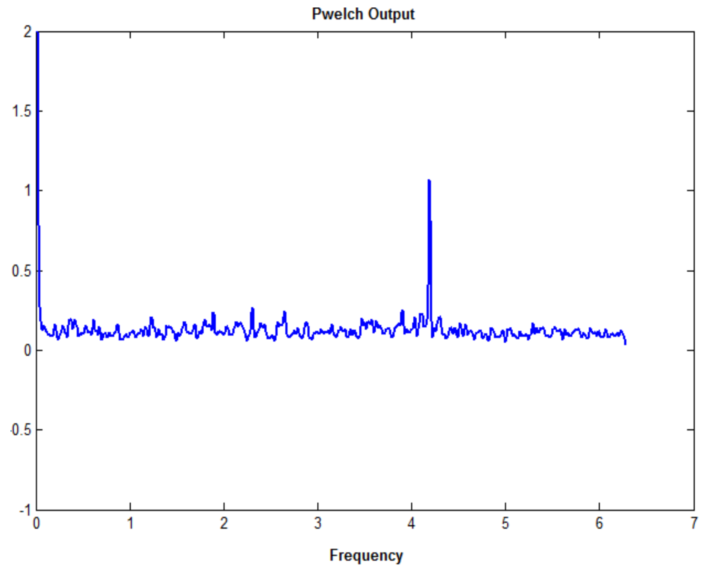

Figure .6: *Welch power Density Spectrum of Voss representation*

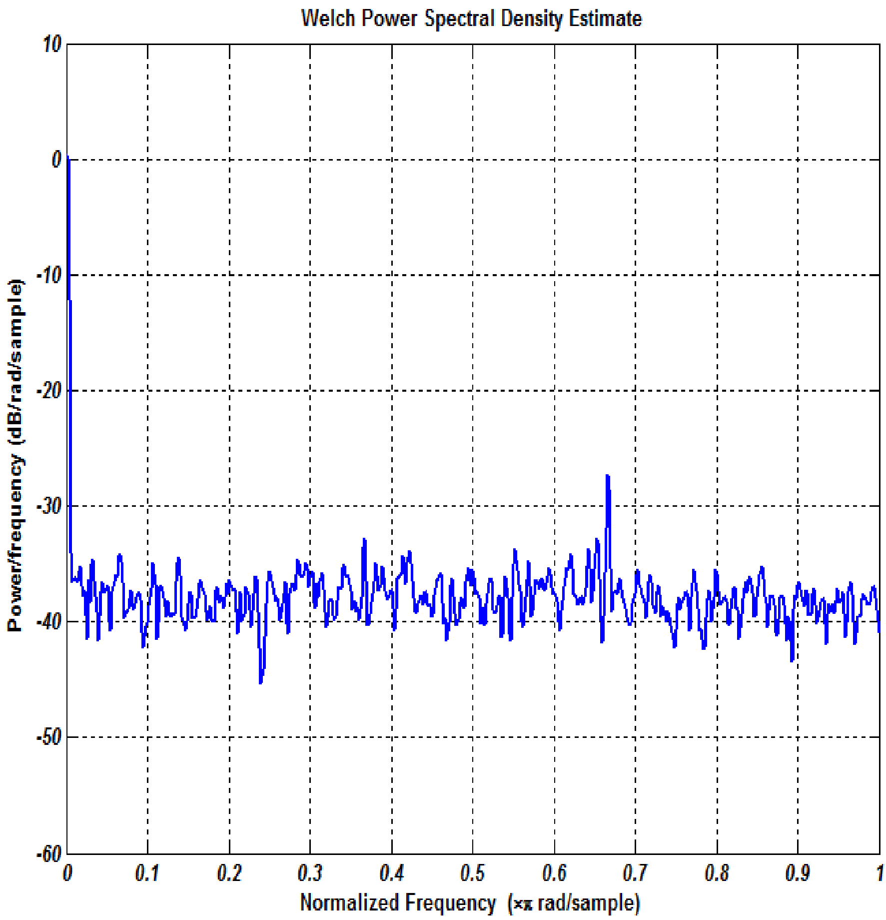

Figure. 7: *Welch Power Density Spectrum of EIIP representation*

III. Conclusion

This paper concludes the work done to the prediction of the cancerous cell which is caused by a genetic mutation in the DNA sequence by applying the various DSP algorithms like DFT (Discrete Fourier Transform), DWT (Discrete Wavelet Transform), PSD (Power Spectral Density) and Welch Power Spectrum. The mapping of DNA by Voss representation and EIIP method. By applying these algorithms on the coding region of the DNA one can predict the cancer cell-like if the ratio of mean amplitude by its mean frequency is greater than 1 then it is normal cell otherwise cancer cell in case of DFT or if the ratio of mean amplitude by standard deviation is greater than one then it is normal cell otherwise it is a cancer cell in case of DWT. In the future, the work will be done to increase the accuracy and improving the efficiency of the plots so that cancer cells can be predicting very efficiently. These algorithms mentioned above is very efficient rather than the conventional biological approach to do prediction of the cancerous cell. The data of the cell-like DNA database is available on the NCBI website, so one should know about the name of genes, so one can easily predict the cancer cell by applying the algorithms.

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PERFORMANCE ANALYSIS OF ROBUST CONTROL TECHNIQUES FOR LOAD FREQUENCY CONTROL OF MULTI AREA POWER SYSTEM

Arvind Kumar[1], Preeti Sharma[2], Mahendra Bhadu[3], Hukam Chand Kumawat[4], Kusum Verma[5]

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Department of Electrical Engineering, Engineering College Bikaner, Rajasthan, India[1,2,3,4]
Department of Electrical Engineering, MNIT Jaipur, Rajasthan, India[5]
akbharia8@gmail.com, preetisharmma3782@gmail.com, mbhadu@gmail.com, hukamchandkumawat@yahoo.in, kverma.ee@mnit.ac.in

Abstract

Robust control techniques are presented here for performance analysis of load frequency control in a five area interconnected power systems considering the impact of time delay and noise. The different controllers investigated in this paper are, fuzzy logic controller, station-to-grid supplementary controller and linear quadratic gaussian controller. The robust controllers are design to palliate the time delay response by using pade approximations and mitigate the measurement noise effects. Intelligent and supplementary controllers can perform better than the conventional controllers, proportional integral controller. When the impact of time delay is considered in area control error signal, fuzzy logic controller gives better dynamic response. When both time delay and noise are considered in area control error signal of system, LQG controller gives better dynamic performance.

Keywords: Load Frequency Control, Linear Quadratic Gaussian controller, Fuzzy Logic Controller, Station-to-Grid, Robust Controller.

I. Introduction

Load Frequency Control (LFC) is a part of the power system stability for controlling the frequency. The proper operation of interconnected power system maintains power balance among total generation and the total load demand with lesser system losses. However, with respect to the time for changing in load demand, the operating point of a power system also changes and produces fluctuations in both the frequency as well as a tie line power resulting in instability [1], [2]. The objective of the LFC is to maintain the system frequency within permissible limits when there is a change in real power load demand. The rotor angle changes with the small changes in real power which results in frequency deviation. In addition to this, LFC loop is also accountable for dividing the load between the generators and controlling the tie-line power [3].

In the past decades, the researchers have done lot of work on the LFC problems of power systems and various control strategies have been designed. The importance of control frequency or tie line power flow in the power system for stability is discussed in [4]. Various Control strategies like integral control [5], discrete time sliding mode control [6], optimal control [7], adaptive and auto-tuning control [8], conventional controller (PI/PID) [9], [20], robust control [10], [11], [12], [13], genetic algorithm [14], GWO algorithm [15], quasi-oppositional whale optimization algorithm (WOA) [25] have been implemented in the existing LFC solution. A fractional order fuzzy PID using biogeography based optimization in four-area system is discussed in [24].

In the present work, intelligent controller and supplementary controller are used to restore the frequency to its nominal value and their dynamic responses are compared for five area test system. Time delay and noise signal are considered in area control error signal of system. Fuzzy Logic Controller, Station-to-Grid, Linear Quadratic Gaussian Controller is compared with conventional controller. Further, it shows that implemented techniques are better than conventional technique for the test system. Fuzzy Logic Controller is not affected by the time delay response and LQG controller is not affected by the noisy signal.

II. Five Area Systems for Load Frequency Control

In this paper, five area systems are considered with a number of generators and loads as illustrated in Fig. 1. The transfer function for the plant model is given by eq. (1), when droop characteristics are neglecting,

$$G = G_g G_t G_p \tag{1}$$

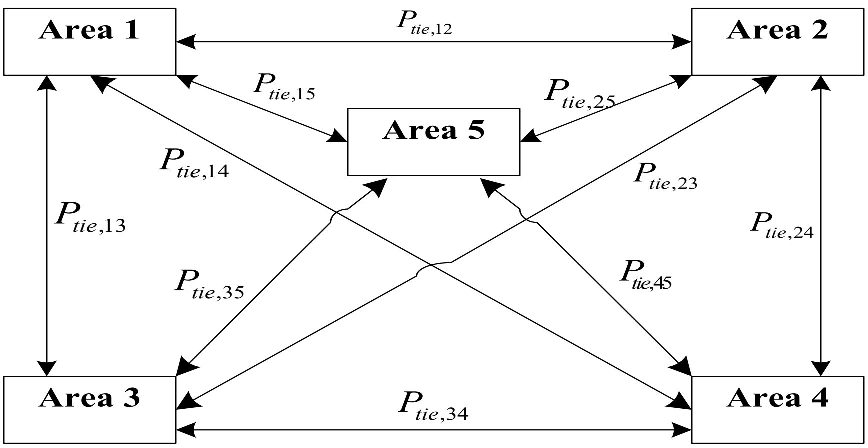

Figure 1: *Block diagram of five area interconnected system*

Where, $G_g = 1/(1+T_g s)$ is the transfer function of governor, $G_t = (1+K_r T_r s)/(1+T_t s)(1+T_r s)$ is the turbine transfer function, $Gp = K_p/(1+T_p s)$ is the power system transfer function which represents the load and machine dynamics. Since the reheat turbine used has different stages of low and high pressures of steam, it is modelled as a second-order unit. The transfer function for the plant model considering droop characteristics is given by eq. (2),

$$G = \frac{G_g G_t G_p}{1 + G_g G_t G_p \left(\frac{K_I}{s} + \frac{1}{R} \right)} \tag{2}$$

Power transported in ith area is given by eq. (3),

$$P_{tie,i} = \frac{|V_i| * |V_j| * \mathrm{Sin}(\delta_i - \delta_j)}{X_{ij}}, (i, j = 1, 2, ..., 5) \tag{3}$$

During normal condition, the active power of i^{th} control areas,

$$ACE_i = B_i \Delta F_i + \Delta P_{tie,i}, (i = 1, 2, ..., 5) \tag{4}$$

Where, B_i = biasing factor, ACE_i = area control error of i^{th} area and $\Delta P_{tie,i}$ = tie line power of i^{th} area. The control inputs for the five area systems is given by eq. (5),

$$u_i = -k_{ij} \int ACE_i dt = \Delta P_{ci}(S), (i, j = 1, 2, ..., 5) \tag{5}$$

A. Impact of Noise

In the power systems, random fluctuations occur in the form of noise (energy) which is an unwanted signal and must reduce to a low level [16]. In this paper, Gaussian noise is used which effect on the controllers.

B. Impact of Time Delay (Pade Approximations)

This system model is modified to include the time delay into the control loop for multi-area interconnected load frequency control [17]. Second order Pade approximations of is given by eq. (6), for a delay of 0.25 s,

$$TF_{\text{Pade}} \approx \frac{-\frac{1}{120}s^3T^3 + \frac{1}{12}s^2T^2 - \frac{1}{2}sT + 1}{\frac{1}{120}s^3T^3 + \frac{1}{12}s^2T^2 + \frac{1}{2}sT + 1} \tag{6}$$

III. CONTROL STRATEGIES

In this section following control strategies such as Fuzzy Logic Controller, Station-to-Grid (S2G) control technique, Linear Quadratic Gaussian (LQG) controller proposed for investigation of 5-area LFC system.

A. Fuzzy Logic Controller

The fuzzy logic is developed by Zadeh in 1965, today implemented in all industrial systems all over the world [18]. The control vector for the controller can be given by the eq. (7) and eq. (8) when ACE as the system response,

$$u_i(t) = -k_p(ACE_i) - \int k_i(ACE_i)dt$$

(7)

$$u_i(t) = -k_p(B_i \Delta F_i + \Delta P_{tie,i}) - \int k_i(B_i \Delta F_i + \Delta P_{tie,i})dt$$

(8)

B. Station-to-Grid (S2G) Control Technique

Station-to-Grid is termed as the, interconnection between the battery swapping station (BSS) and power grid. The BSS is a concept which introduced in EV industry for getting a rapid swap between an empty or a near empty battery from a fully-charged battery within a short period of time. Implementing this concept in load frequency control strategy, BSS will store the onset point of frequency and whenever deviation in frequency and power occur. In this scheme Monte-Carlo stochastic simulation method is used to estimate controllable capacity of BSS storage, and then a lumped equivalent model of S2G subjected to state of charge limit and CC constraints are presented in multi-area interconnected load frequency control for managing the speed deviation [19], [23]. BSSs energy storage is an emerging from of storage which having battery swapping of Electrical vehicles and the batteries are in charging mode. The scheme from which all the power of BSSs is adjusted when it is required in power grid, this scheme is called the S2G power. The storage capacity of the system is not always constant; it varies continuously with the number of controllable batteries (CBs) in BSSs of the control area [20].

C. Linear Quadratic Gaussian (LQG) controller

Linear Quadratic Gaussian (LQG) [21], [22] scheme is a robust control technique for controlling the random noise signal in state and output equation. The quantitative information about the noise is used in this controlling strategy. A Kalman filter [30] is used as an observer for getting the optimal solution. Firstly, it finds an optimal state estimation signal $\hat{x}(t)$ which minimize the covariance $E[(x-\hat{x})(x-\hat{x})^T]$, and further it is used to estimate the to replace the actual state variables [19], [20]. the gain K_f is given by,

$$K_f = P_f C^T \Theta^{-1} \tag{9}$$

Where, $P_f =$ algebraic Riccati equation (ARE) i.e. a symmetrical semi positive-definite matrix, K_f = gain.

$$P_f = P_f^T \geq 0 \tag{10}$$

$$P_f A^T + A P_f - P_f C^T \Theta^{-1} C P_f + \mathbb{F} \Xi \mathbb{F}^T = 0 \tag{11}$$

The syntax for Kalman matrix is,

$$\lfloor G_k, K_f, P_f \rfloor = kalman(G, \Xi, \Theta) \tag{12}$$

IV. RESULTS AND DISCUSSION

The five-area interconnected reheat thermal power system investigated in this paper is modelled and implemented in MATLAB/Simulink environment.

A. Performance analysis of Fuzzy Logic Controller

The frequency deviation step responses of generator 1 and generator 3 with fuzzy logic controller are shown in fig. 2, and fig. 3 respectively. It is illustrated in fig. 2 and fig. 3, that when the system was operated with fuzzy logic controller, the dynamic performance of the system is significantly improved with comparison to conventional PI controller. Fig. 4 shows the power deviation step responses of generator 1 with fuzzy logic controller and PI controller.

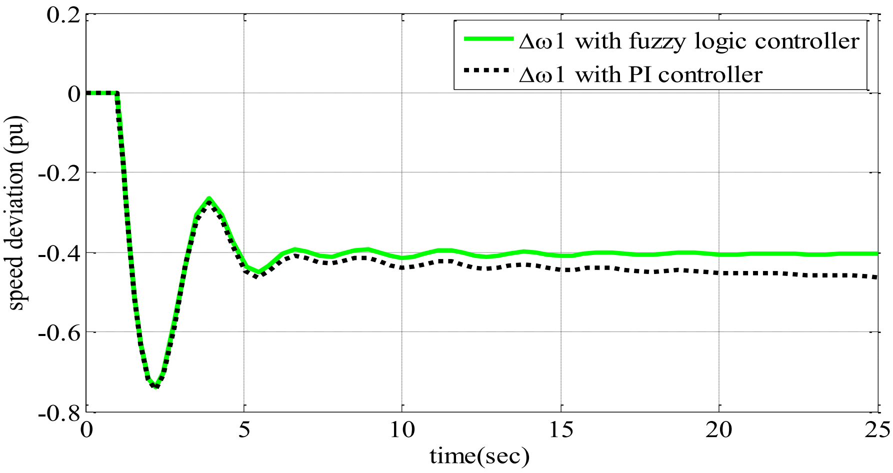

Figure 2: *Comparison between frequency deviation step responses of area 1 with fuzzy logic controller and PI controller*

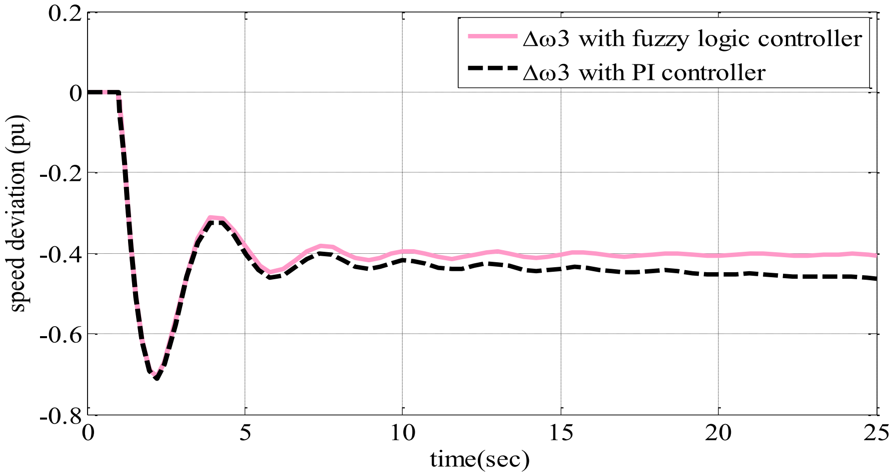

Figure 3: *Comparison between frequency deviation step responses of area 3 with fuzzy logic controller and PI controller*

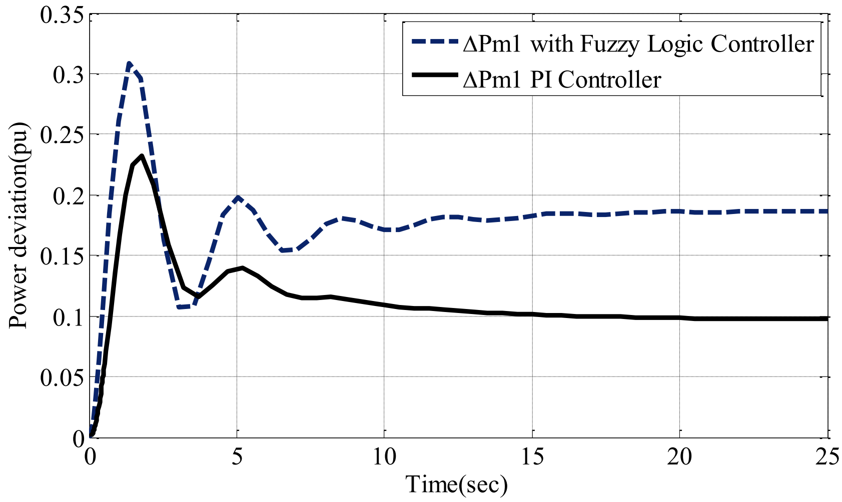

Figure 4: *Comparison between power deviation step responses of area 1 with fuzzy logic controller and PI controller*

B. Station-to-Grid Supplementary Controller

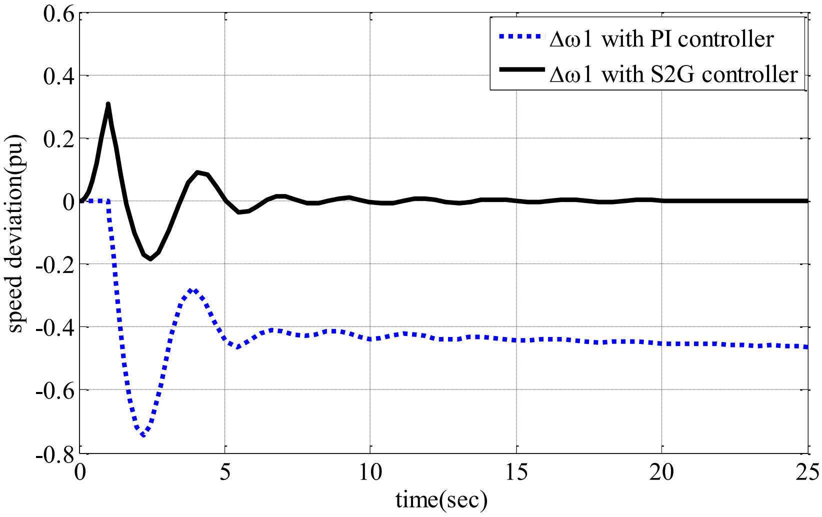

Figure 5: *Comparison between frequency deviation step responses of area 1 with s2g controller and PI controller*

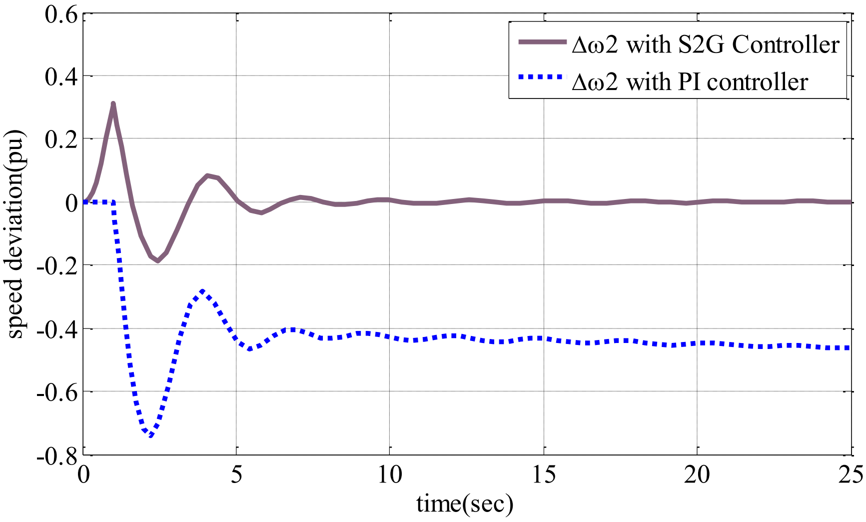

Figure 6: *Comparison between frequency deviation step responses of area 2 with s2g controller and PI controller*

The frequency deviation step responses of generator 1 and generator 2 with S2G are shown in fig. 5, and fig. 6 respectively. From the fig. 5 and fig. 6, it is observed that supplementary controller S2G has less damping oscillation compared to PI controller. It is a scheme that stored energy on BSS, and whenever speed deviation it occurs it pass the stored energy and further it gets the steady state position. Fast-cyclic component (less than 1 min) is followed by BSS storage and short-cyclic component (1-15 min) followed by thermal units of interconnected system. From this scheme the entailed capacity of BSS storage can be diminished and thermal units can be operated at undeviating state.

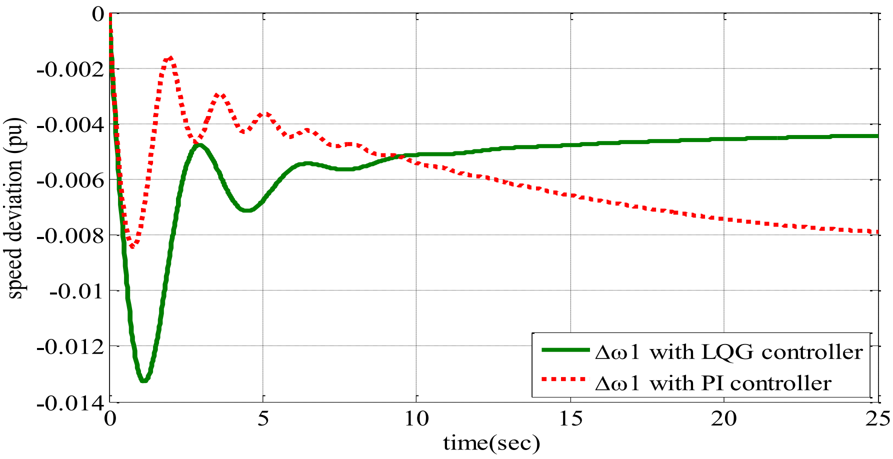

Figure 7: *Comparison between frequency deviation step responses of area 1 with LQG controller and PI controller*

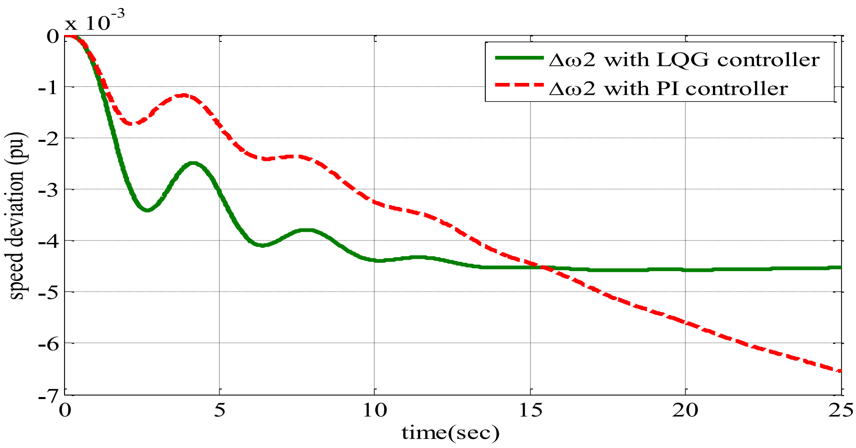

Figure 8: *Comparison between frequency deviation step responses of area 2 with LQG controller and PI controller*

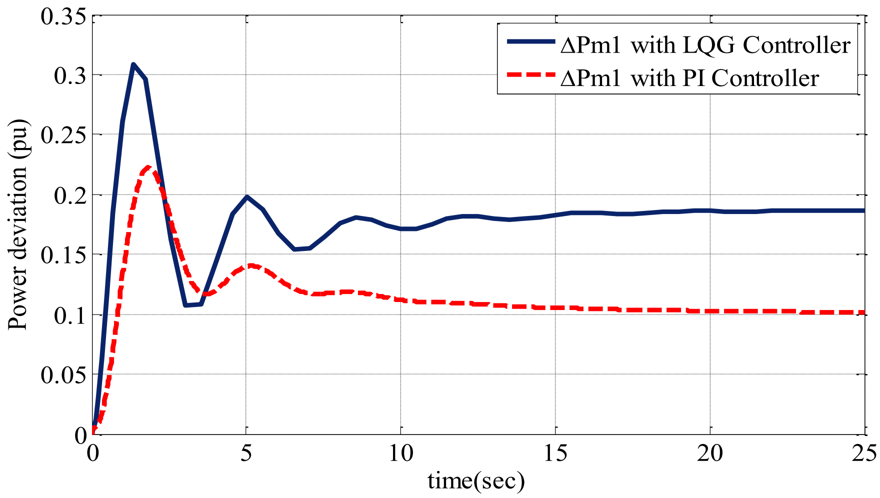

Figure 9: *Comparison between power deviation step responses of area 1 with LQG controller and PI controller*

C. Linear Quadratic Gaussian (LQG) Controller

The frequency deviation step responses of generator 1 and generator 2 with LQG controller are shown in fig. 7, and fig. 8 respectively. It is illustrated in fig. 7 and fig. 8, the optimal technique LQG has fewer damping oscillations as compared to the conventional PI controller. From the time domain response, obviously the settling time, oscillation magnitude, amplitude brings the system again into stable operation inside short span. Power deviation step responses of area 1 with LQG controller and PI controller is shown in fig. 9.

D. Impact of time delay on Fuzzy Logic Controller

Speed deviation of generator 2 having Fuzzy logic controller, with and without time delay is shown in fig. 10. The damping abilities of fuzzy logic controller, with and without time delay, nearly same damping capacities for frequency in all the areas. It is illustrated in fig. 10, that the delay margin is not affected the performance of fuzzy logic controller.

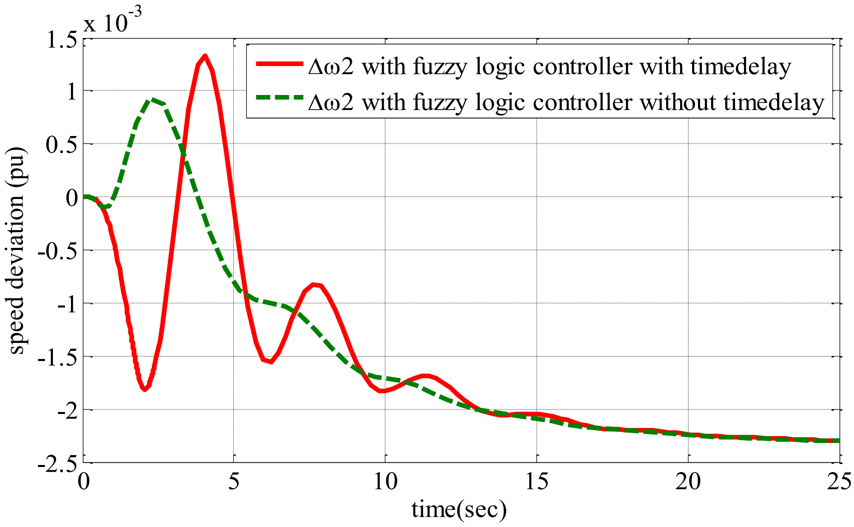

Figure 10: *Comparison of speed deviation of generator 2 having Fuzzy logic controller, with and without time delay*

E. Impact of time delay on Station-to-Grid Controller (S2G)

Speed deviation of generator 1 with and without time delay, having S2G Controller is shown in fig. 11 and fig. 12.

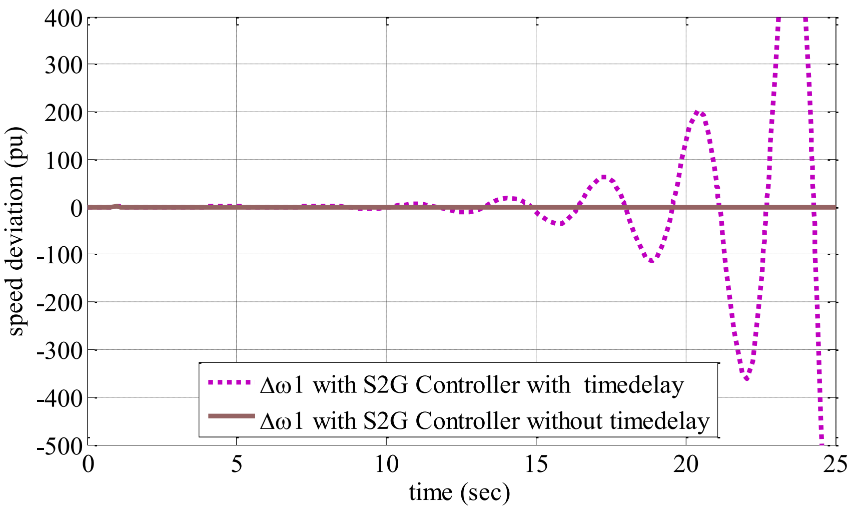

Figure 11: *Comparison of speed deviation in area1 with and without time delay with S2G*

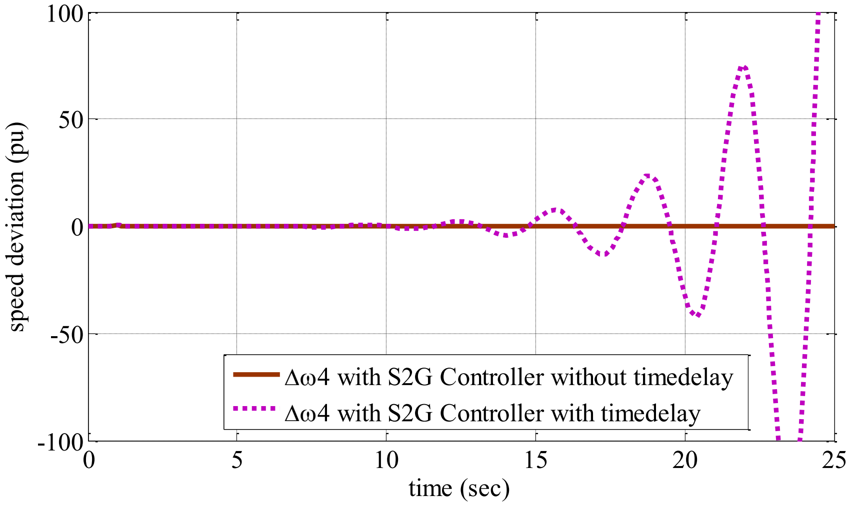

Figure 12: *Comparison of speed deviation in area 4 with and without timedelay with S2G*

F. Impact of time delay on Linear Quadratic Gaussian Controller (LQG)

The damping abilities of LQG controller with and without time delay are shown in figure 13. It can be seen from figure 13, that the system with or without time delay nearly same damping capacities for frequency in all the areas.

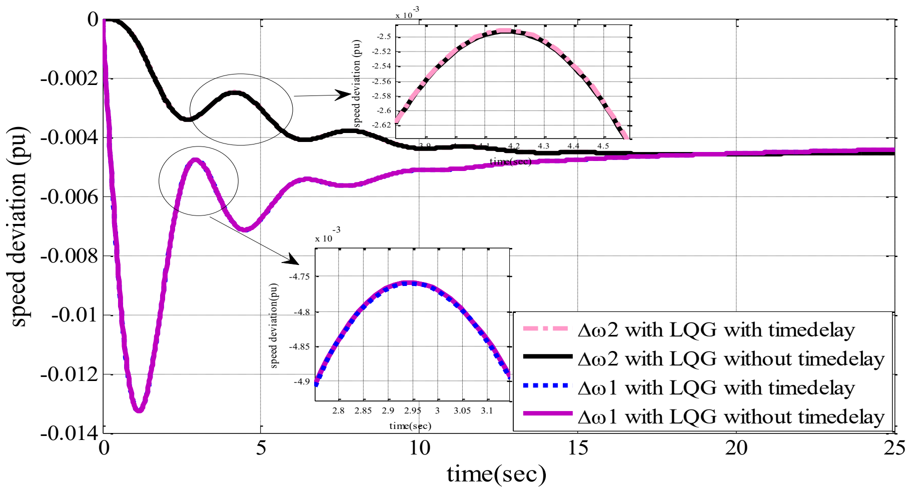

Figure 13: *Comparison of speed deviation in area1 and area 2 with and without time delay having LQG controller*

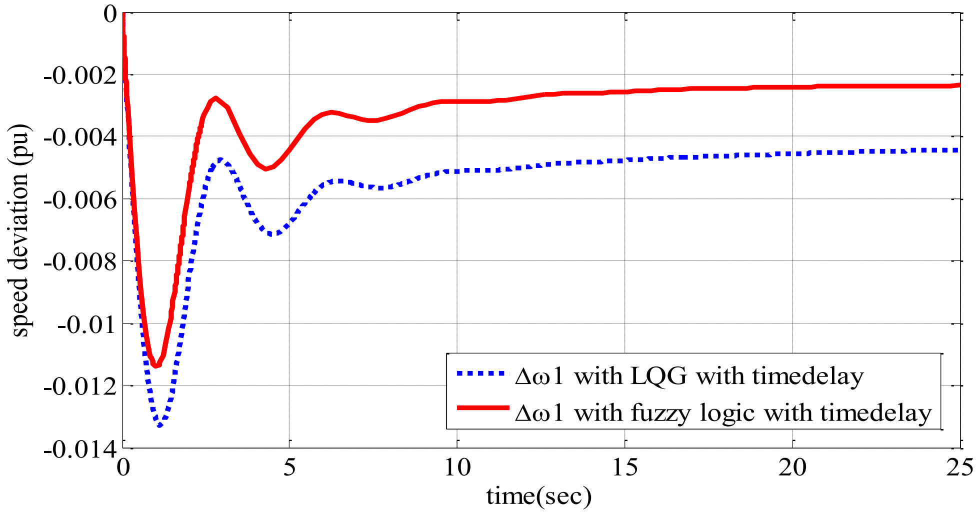

Figure 14: *Comparison results of fuzzy logic and LQG having time delay*

G. Comparison of Fuzzy Logic and LQG controller including time delay

It is illustrated in fig. 14 that the time domain response, obviously the settling time, oscillation magnitude and the impact of the delay margin is reduced by utilizing the Fuzzy controller. The designed Fuzzy appears to better than the others as it mitigates the delay margin and brings the system back into stable zone.

H. Impact of Noise on Fuzzy Logic Controller

Gaussian noise [22] is associated to an unwanted electrical signal with a frequency generally lower than 200 kHz [4]. The damping abilities of generator 1 and 3 having fuzzy logic controller with and without noise signal are shown in fig. 15.

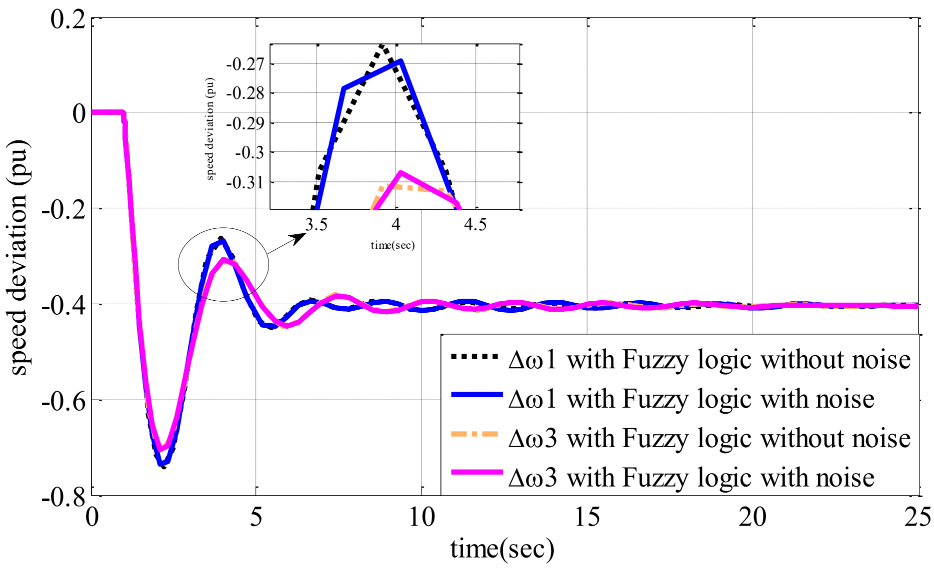

Figure 15: *Comparison of speed deviation with fuzzy logic controller, with and without noise*

I. Impact of Noise on Station-to-Grid Controller (S2G)

Figure 16 shows comparison result of speed deviation of generator 2 with or without noise signal. Critical analysis of plot providing delay margin in S2G controllers shows a higher damping oscillation, less dynamic performance.

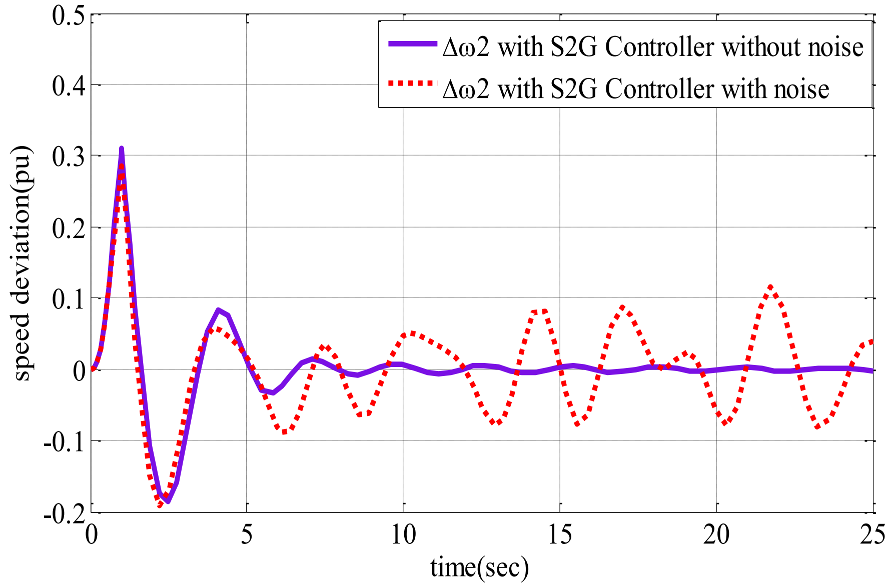

Figure 16: *Comparison of speed deviation having S2G with and without noise*

J. Impact of Noise on Linear Quadratic Gaussian (LQG) Controller

Speed deviation having LQG controller with and without noise of generator 1 and 2 is shown in fig. 17. Amplitude of noise signal is 0.01. It can be observed from result that the system with or without noise signal similarly damping capacities for frequency in corresponding areas. That shows the noise is not affected the performance of LQG controller.

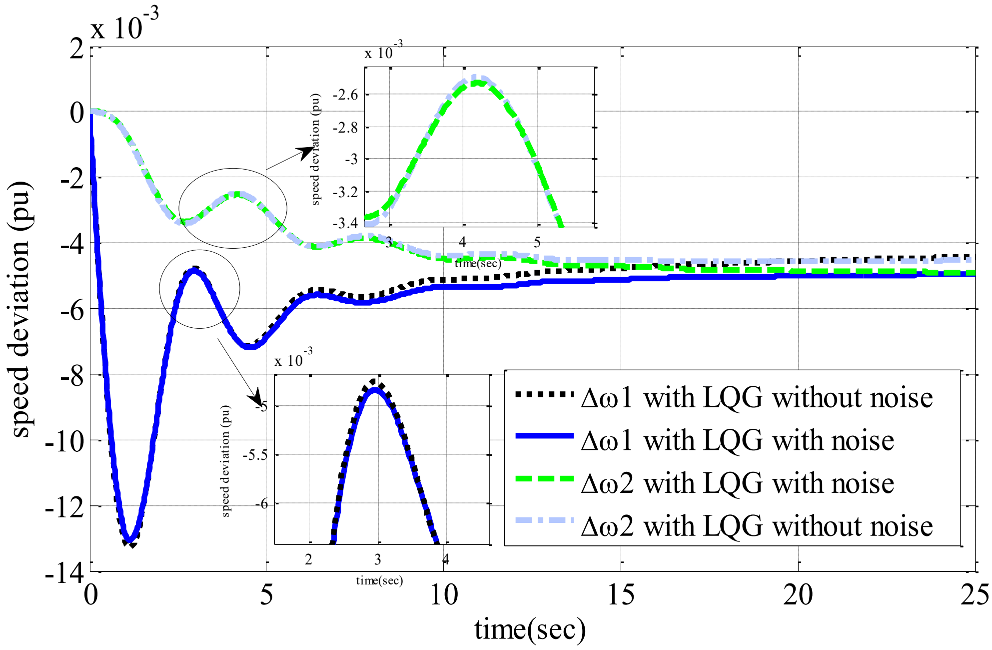

Figure 17: *Comparison of speed deviation having LQG controller with and without noise*

K. Comparison of Fuzzy Logic Controller and LQG controller including noise

Performance of linear quadratic gaussian controller and fuzzy logic controller with 0.01 amplitude of noise signal response is shown in fig. 18. It is illustrated in fig. 19 that LQG controller appears to be better than the fuzzy logic controller. From the time domain response, obviously the settling time, oscillation magnitude and effect of the noise signal is utilized by LQG and it mitigates the noise effect and brings the system back to set up point.

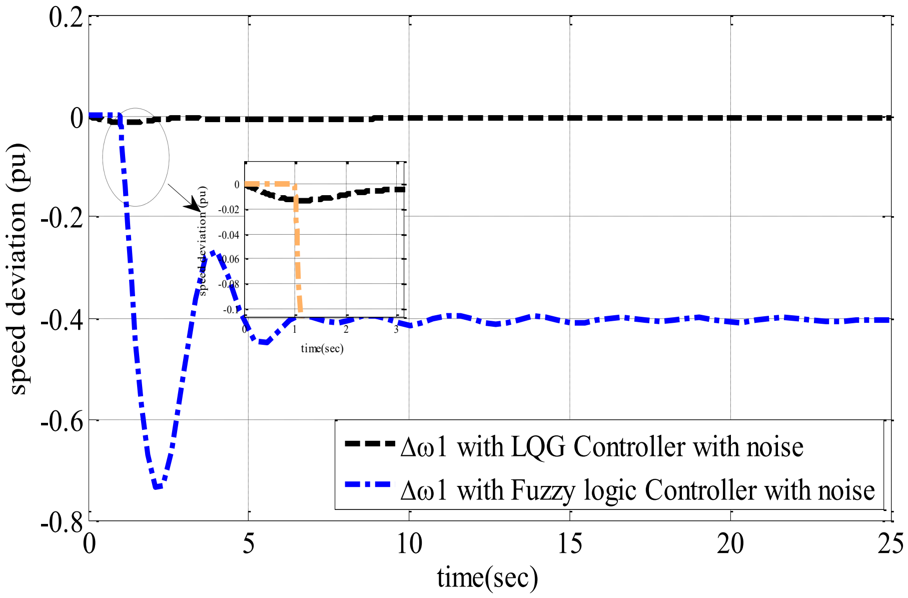

Figure 18: *Comparison of speed deviation having LQG controller and fuzzy logic controller with noise*

V. Conclusion

This study intended to assess the impact of time delay and noise in a robust LFC problem. Initially, three inference controllers are designed, including input and output rules based Fuzzy Logic Controller, Supplementary Controller Station-to-Grid which is based on Battery Swapping Concept and Linear Quadratic Gaussian technique designed through the Kalman filter. These all the techniques give better performance from conventional techniques (PI Controller). It should be pointed out that there are some disturbances occur in the multi-area LFC system. Station-to-Grid is not a robust controller but it has an advantage that it stores the system data as a back-up plan and further when deviation occurs it restores the system data. Further, time delay and noise are implemented in these control strategies. More remarkably, when time delay is implemented Fuzzy Logic approach resulted in more robust performance and when noise is implemented LQG approach result in more robust performance in LFC problem.

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DESIGN OF DISCRETE SLIDING MODE CONTROLLER FOR HIGHER ORDER SYSTEM

S. R. Shiledar, G. M. Malwatkar, I. S. Jadhav, G. V. Lakhekar

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Department of Instrumentation Engineering
Government College of Engineering, Jalgaon-425002, India.
shaktishiledar@gmail.com

Abstract

This paper presents a discrete sliding mode controller for higher order systems without using model order reduction techniques for single input single output systems. The proposed controller is designed with discrete form of PID as a sliding surface. To find the PID sliding surface controller tuning parameters, the traditional method of PID design or pole placement method can be used. The designed controller has flexibility in terms of range of the parameters to decide the stability and robustness of the closed loop performance and existence in terms of Lyapunov function and/or stability. Generally it is difficult to design proper controller due to inaccurate identified model of system or its parameters and external unmesaurable disturbance. The proposed controller has a simple and flexible structure having a set of tuning equations as a function of the desired performance of the systems. The discrete form of sliding surface and system states provide highly useful information to control necessary parameters of the interest for many higher or lower order systems. The systems available in real time or plant model identified by different method in the context of design of the controllers results in higher order; therefore it is necessary to direct the automation applications of systems towards higher order systems. In this paper, the examples are simulated using Mathwork's MATLAB to show and compare results proposed law with prevalent available controllers.

Keywords: Discrete sliding mode control, Higher order system, Sliding mode control, Robustness, Simulation.

I. Introduction

Generally the performance of the PID controller are not achievable properly for the higher order model unless it reduced to first or second order systems [1-3]. The main aim to design the robust controller for higher order system to minimize offset and uncertainty in the plant for that purpose design strategies for controller developed model mismatch themselves the era of the variable structure controller (VSC) and latter days it modified and is famous as the sliding mode control techniques. Sliding mode control (SMC), first introduced in the early 1950s, has been a focus to tackle system uncertainties and external disturbances with good robustness [4]. Many researchers found good results from discrete sliding mode control (DSMC) over the continuous sliding mode control [1],[4,7]. Sliding mode control recently widely used in many control engineering applications due to its robustness and simplicity of computation. It has been successfully applied to underwater vehicle, automotive transmissions engines, power systems, induction motor, robotics etc [4,6-7]. Design of Sliding mode control (SMC) mainly consists of two important phases one is the design of a sliding surface and the second is the switching law. In literature, the design methods of PI/PID controllers for higher order delayed system with model reduction method and it is required complex computation [8-9]. Many times it is observed that higher ordered model not reduced exactly to plant behavior because of model mismatch, uncertainty and disturbance occurs in the plant. Therefore it directly affects the performance and stability of the system. [3,10]

The discrete version of SMC has been used in system control whenever digitized system has good stabilization with low level acceptable sampling period [10]. It should be pointed out that DSMC is not the counterpart of the continuous sliding mode controller [4]. The literature found that state observer is usually developed to realize the DSMC, which increases the burden on controller design. An unstable control system produces due to the inappropriate design of the state observer or control law. Hence, the method was preferable to reduce the workloads of state observer design for the DSMC [11]. The delay in the system has another factor to affect the stability of the process so it is difficult to control the variables in the process. The common strategy to eliminate it required to design delay-free process pointed out in the framework of Smith's predictor and use it for controller design[12],[13]. The robustness properties of SMC are found when the system reaches the sliding surface, but it observed that during the system moves toward reaching phase system becomes undesired high-frequency oscillation (chattering) occurs, because of the discontinuous switching function, which causes to control signal oscillated around the switching surface. The chattering-effect is undesirable to the final control elements, it will be possibility to damage the control elements in the field [7,12]. To overcome this problem one way to minimize the chattering effects is to select continuous approximation for the discontinuous function signum in the controller, which is replaced by a smooth function like saturation or hyperbolic function with the appropriate binding of error within some predefined boundary [3,14]. The second approach is to introduce an adaptive switching gain, which adapts the gain as per the present conditions. Design higher order sliding mode control is another way to eliminate the chattering effect. We observed that from past increasing the computing power of electronic devices and discrete-time sampler computer-based control has become popular to design control tasks.

A key step in the design of sliding mode controllers is to introduce a proper sliding surface so that tracking errors and output deviations can be reduced to a satisfactory level. In this work a DSMC with velocity form of discrete sliding surface is used to obtain a desired set point tracking. The system used in the simulation is typically higher order with considerable time delay. The discrete time form of the continuous system is obtained using a matched pole zero method and represented in state space using controllable Canonical form. The parameters of equivalent controllers are obtained by means of traditional approach of PID control design. In this simulation both non oscillatory and moderately oscillatory but higher order with time delay systems are experimentally used to validate usefulness of the proposed control law in discrete form.

Many available SMCs are designed based on PD type sliding surface [14], [12,15]. which introduce to large steady state error due to external disturbances it overcome this drawback, SMC with PID-type sliding surface design so, that integral term introduced into the sliding surface formulation.

In overall the major contribution of this study can be summaries as follows

- The DSMC resolved limitation of CSMC in case of slow system where sampling time of digital implementation is considerably large.
- The proposed method is applicable to higher order plus dead time process with oscillatory behavior and work satisfactory under the influence of system uncertainties.
- The developed control scheme eliminates steady state error and chattering problem.

- The simulation result are presented to make qualitative comparison with traditional continues SMC and improved PID controller.

The organization of the paper is as follows section II includes short information of continuous controller and discrete sliding mode control law, section III includes simulation examples and its performance analysis while section IV remarked as the conclusion of the work .

III. Sliding Mode Controller

A. Continuous Sliding-Mode Control

In Eker's work, a continuous form of PID sliding surface with three parameters has been introduced to achieve a satisfactory closed-loop system performance which is given below

The equivalent controller given by Eker [6] is

$$u_{eq}(t) = \frac{1}{k_d C_n}\left[k_p \dot{e}(t) + k_i e(t) + k_d \ddot{r}(t) + k_d A_n \dot{y}(t) + k_d B_n y(t)\right] \tag{1}$$

and the switching control selected is,

$$u_{sw}(t) = k_{sw} \tanh\left(\frac{s(t)}{\beta}\right) \tag{2}$$

Thus the total control is

$$u(t) = \frac{1}{k_d C_n}\left[k_p \dot{e}(t) + k_i e(t) + k_d \ddot{r}(t) + k_d A_n \dot{y}(t) + k_d B_n y(t)\right] + u_{sw}(t)$$

The switching control law used in this work is

$$u_{sw}(t) = k_{sw} \tanh\left(\frac{s(t)}{\beta}\right)$$

B. Proposed Discrete Sliding Mode Control Law

As per the design of sliding controller formulation, there are two control laws first is equivalent control and switching control law. Nowadays there are many advantages of digital control technologies due to the rapid evaluation of digital devices. Therefore it is natural to have growth of the researcher's attitude towards implementation and simulation of discrete SMC laws [12,14]. As the sampling rate is not near to infinity in practical systems, therefore, continuous term in discrete time control law introduces an unwanted phenomenon of chattering and instability. Therefore it is essential to keep discontinuous term very small to avoid instability of the system.

The representation of system in the form of discrete state space state space as

$$x(k+1) = \emptyset x(k) + Hu(k) + l(k)$$

$$y(k) = Cx(k-d) \tag{3}$$

Where $\phi \in \mathbb{R}^{n\times n}$,$H \in \mathbb{R}^{n\times 1}$ and $C \in \mathbb{R}^{1\times n}$ represent discrete time state space matrices, and x(k) is state vector. The term $l(k) \in \mathbb{R}^{n\times 1}$ represents the lumped uncertainty and it is bounded. The system model (10) used to calculate the equivalent control law. The term d is used for the number of delay samples.In this paper chosen as the sliding surface is design as discrete sliding surface

$$S(k) = Kx(k) - K_t \begin{bmatrix} e(k) + kp[e(k+1) - e(k)] + kie(k) \\ +kd[e(k+1) - 2e(k) + e(k-1)] \end{bmatrix} \tag{4}$$

Where K=[K1,K2….Kn] is the gain matrix calculated through pole placement method and it used as tuning parameters for DSMC, x(k) is the state vector and Kt is the constant for controller gain. In pole placement design desired values of settling time and damping factor required to compute state feedback gain based on Ackermann's formula The error function formulated as

$$e(k) = r(k) - y(k) \tag{5}$$

Where e(k) is the error signal, r(k) is reference input and y(k) represents systems output. Formulation for the equivalent control law in discrete form when condition that S(k)=0 is the sliding surface in equation(4) the response of sliding at (k+1)th instant

$$S(k+1) = Kx(k+1) - K_t\,[u(k+1) + kp[e(k+2) - e(k+1)\,] + kie(k+1) + kd[e(k+2) - 2e(k+1) + e(k)\,]\,] \tag{6}$$

Using (3) and (6) formulated the equivalent control law as

$$S(k+1) = K\emptyset x(k) + KHu(k) + Kl(k) - K_t\,[e(k+1) + kp[e(k+2) - e(k+1)\,] + kie(k+1) + kd[e(k+2) - 2e(k+1) + e(k)\,]\,] \tag{7}$$

The equivalent control law obtained by equating equation (14) to zero given by

$$u_{eq}(k) = (KH)^{-1}\left[-K\emptyset x(k) - Kl(k) + K_t\left[e(k+1) + kp\begin{bmatrix} e(k+2) \\ -e(k+1) \end{bmatrix} + kie(k+1) + kd\big[e(k+2) - 2e(k+1) + e(k)\big]\right]\right] \tag{8}$$

The robustness with parameter variation and external disturbance is consider by introducing of high frequency discontinues function term by sgn(s(k)) function generally used. It found that the boundary layer hyperbolic function given the smooth change in the switching signal within the specified range due to which reduced the chattering

$$u_{sw} = -\tanh\left(\frac{s(k)}{\beta}\right) \tag{9}$$

The complete control law as per DSMC is

$$u(k) = u_{eq}(k) + u_{sw}(k) \tag{10}$$

III. Simulation examples

Example 1

Consider the non-oscillatory system process with open loop transfer function [2 12]

$$G(s) = \frac{1}{(s+1)(s+5)^2}e^{-0.5s}$$

The discrete time model obtained by pole placement method with sampling interval Ts=0.1 sec is

$$G(z) = \frac{0.0001473z^2 + 0.0002947z + 0.0001473}{z^3 - 2.1182z^2 + 1.466z - 0.3329}z^{-5}$$

This can be represented in the form of state space matrix in controllable canonical form as

$$\phi = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0.3329 & -1.466 & 2.118 \end{bmatrix}, \quad H = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, \quad C^T = \begin{bmatrix} 0.0001473 \\ 0.0002947 \\ 0.0001473 \end{bmatrix}$$

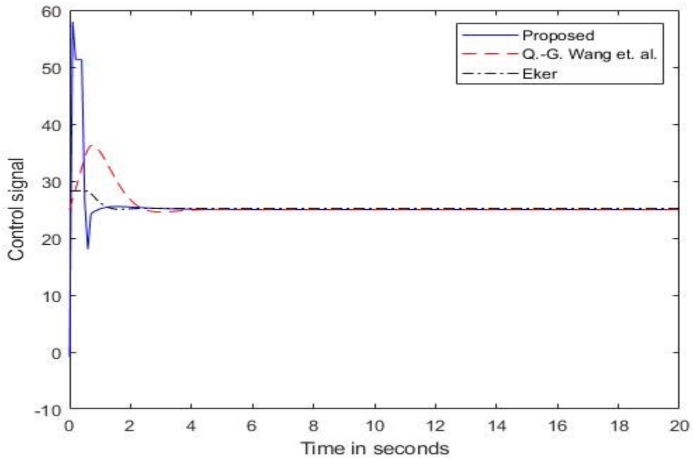

Fig. 1. Control signal generated for example 1

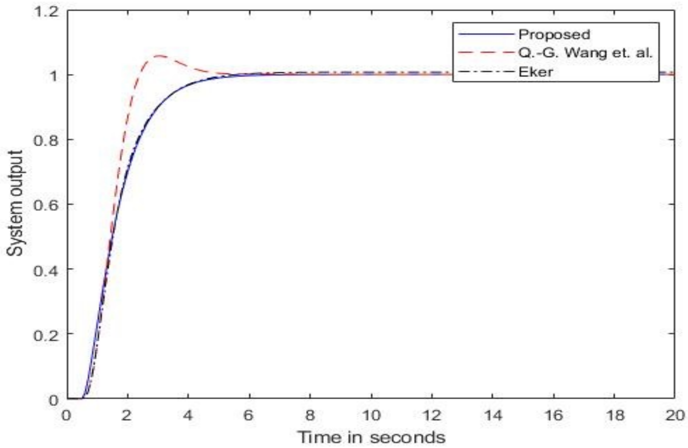

Fig. 2. System output response for example 1

For the simulated example 1 and example 2, consider the control setting values shown in Table 1.

TABLE 1 *Control setting values and*

Simulation Examples	kp	ki	kd	alpha	beta	ksw	Kt
(1)	2.3	0.01	1.65	1.999	0.09	120	17.08
(2)	2.45	0.0123	1.25	0.99	0.99	40	60

The value of pole placement with settling time (+/- 2% band) ts=2s and damping factor is 1.Gives gain matrix parameter K=[0.2493 -0.6474 0.3979].The value of Kt , alpha and beta are selected as share found from the desired performance the selected values shown in table1 , it is observed that output without chattering and obey the stability criteria. The controller parameter for Eker's SMC are kp, ki kd, and switching surface constant choosing as ksw are shown in table1.The boundary level constant β=10 chosen. For proposed study select the tuning parameters calculated with traditional method gives (12.3,-9.794, 1.032)

The Wang et al's gives the controller equation

$$G_{cwang} = 25 + \frac{18.2}{s} + 5.5s$$

As can be seen in figs(1-2),control signal response and system output compare with from proposed DSMC comparison found that large deviation in the set point tracking performance with oscillatory behavior noticed in PID response. Also less overshoot, less settling time as compare with Eker's SMC and Wang et al. In fig(1) control signal of proposed method converges faster to steady state value within 1.5sec as compare to existing method

Example 2

Consider the moderately oscillatory process with open loop transfer function [2]

$$G(s) = \frac{1}{(s^2 + 2s + 3)(s + 3)} e^{-0.3s}$$

The discrete time model obtained by pole placement method with sampling interval Ts=0.1 sec is

$$G(z) = \frac{0.0001953z^2 + 0.0003905z + 0.0001953}{z^3 - 2.1182z^2 + 1.466z - 0.3329} z^{-3}$$

This transfer function represent in the form of state space matrix in controllable canonical form as

$$\phi = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0.6065 & -2.1462 & 2.5324 \end{bmatrix}, \quad H = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}, \quad C^T = \begin{bmatrix} 0.0001953 \\ 0.0003905 \\ 0.0001953 \end{bmatrix}$$

Obtained gain matrix for tuning parameter K=[0.5633 -1.3937 0.8304].The value of Kt, alpha and beta are selected as shown in table1 are found from the getting appropriate performance of output without chattering and follow the stability criteria. The controller parameter for Eker's SMC are kp, ki kd, Here switching surface constant choosing as ksw with boundary level constant β=10.For proposed study select the tuning parameters calculated with traditional method gives (2.109, 8.925, 0.1194).The PID controller by Wang et al's method gives

$$G_{cwang} = 5 + \frac{7.146}{s} + 3.008s$$

The comparing DSMC with output response and control signal with from Eker's SMC and Wang et al's, it is remarked as the response obtained from proposed algorithm is better than that of Eker et al's and Wang et al's technique.

In fig(3) control signal of proposed method converges faster to steady state value within 0.3sec as compare to existing method. Therefore it can be concluded that the results obtained by DSMC are better than that of the CSMC for the system with higher order dynamics

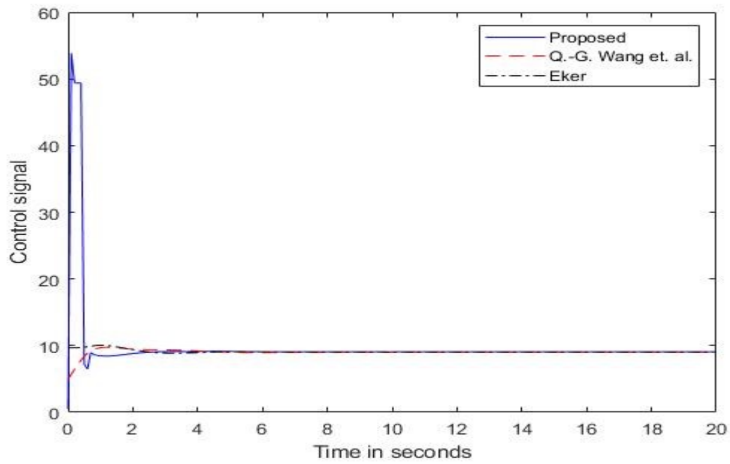

Fig. 3. Control signal genrated for example 2

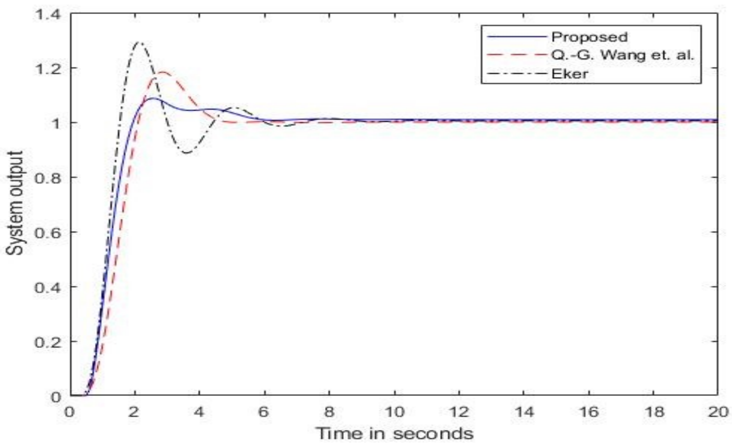

Fig. 4. System output response for example 2

IV. Conclusions

In this work, a discrete part of PID controller is used as a sliding surface to obtain the discrete sliding mode control law. The proposed discrete mode control law is applied to higher order plus delay time systems. The traditional approach of PID controller is used to obtain the tuning parameters of the discrete time sliding mode control. The design procedure given in the work looks simple and straightforward because less complexity of computations are involved in DSMC technique. Two simulation examples are included in the work are of the typical nature, the first example is monotonic with higher order plus delay time while second example is moderately oscillatory systems with higher order dynamics. The proposed DSMC is applied for set point tracking and the performance of the proposed law seem to be effective with less tracking and settling time with possibly minimum overshoot. The effort taken by the control action is also acceptable and can be useful for real time practical system. Therefore it can be concluded that the results obtained by DSMC are better than that of the CSMC for the system with higher order dynamics

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MATHEMATICAL ANALYSIS OF A VACCINATION MODEL WITH IMMIGRATION AND GENERALIZED SATURATED INCIDENCE RATE FUNCTION

Deepti Mokati[1] , V.H. Badshah[1], Nirmala Gupta[2]

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[1] School of Studies in Mathematics,Vikram University, Ujjain (M.P.), India
[2]Govt. Girls P.G. College, Ujjain(M.P.),India
mahe.deepti@gmail.com

Abstract

In the paper , we propose a vaccine-dependent mathematical model for the treatment of diseases at the population level. Determine equilibrium points : disease-free and endemic and basic reproduction number R_0 .We formulate theorems on stability and establish the proof of the theorems by Ruth-Hurwitz criteria..In addition, numerical simulations of the model is carried out to show the efficacy of the vaccine . Moreover, graphically it is clearly seen the effectiveness of vaccine for SIR epidemic model with vaccination and without vaccination.

Keywords: Basic reproduction number, Equilibrium, Vaccine, Stability, Ruth-Hurwitz Criteria

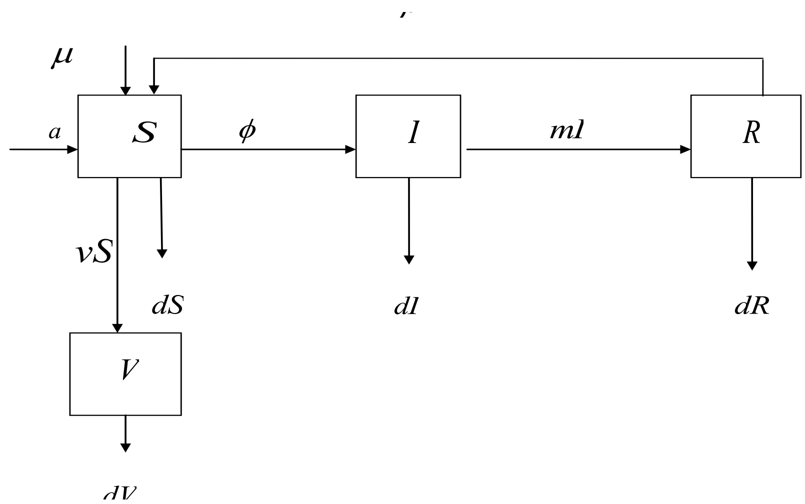
I. Introduction

Mathematical Modeling is the art of capturing natural phenomenon of real life in the form of mathematical equations. It is a method of simulating real life situations with mathematical equations to forecast their future behavior. Mathematical modeling uses tools such as decision theory, queuing theory and linear programming and requires large amounts of number crunching. In 2013, Agrawal Ankit and Saxena G. studied an SIR epidemic model with generalized saturated incidence rate function[1]. They have analyzed stability of the disease free equilibrium and the endemic equilibrium with the help of a non linear incidence rate. In1993, Derrick W.R and team formulated a general SIRS disease transmission model under assumptions that the size of the population varies, the incidence rate is nonlinear and the recovered (removed) class may also be directly re-infected[2]. Vaccination is the administration of antigenic material (a vaccine) to stimulate an individual's immune system to develop adaptive immunity to a pathogen. Vaccines can prevent or ameliorate morbidity from infection. Gumel A.B., Moghadas S.M. [3] have proposed a new deterministic model for the dynamics of an infectious disease in the presence of a preventive (prophylactic) vaccine and effective therapeutic treatment in 2003. Many models for the spread of infectious diseases in populations have been analyzed mathematically and applied to specific diseases by Hethcote H.W. in 2000 [4]. In 2013, Jasmine D. E.C. and Henry Amrithraj proposed an epidemic model with non-monotonic incidence rate under a limited resource for treatment to understand the effect of the capacity of the treatment [5,6,7]. In 2014 , Jasmine D.E.C., Henry Amirtharaj a modified SIR epidemic model with generalized saturated incidence rate is incorporated on account of the effect of limited treatment resources on the control of epidemic disease [8].

II. Model Formulation

In the paper , considered a population of size $N(t)$,which is divided into disjoint classes $S(t), I(t), V(t)$ and $R(t)$ which denote the number of susceptible , infected, vaccinated and recovered individuals respectively at time t with the saturated incidence rate function $\dfrac{\lambda SI}{\rho+\alpha_1 I+\alpha_2 I^2}$.

The flow diagram of the model [**figure 1**] is given below :



where the symbols stand for

S	Number of susceptible individuals
I	Number of infected individuals
R	Number of recovered individuals
V	Vaccinated population
a	Recruitment rate of population
d	Natural death rate
m	Natural Recovery rate of infective
β	Rate at which recovered individuals lose immunity and return to susceptible
μ	Increase of susceptible at constant rate
v	Rate at which susceptible population is vaccinated
$\phi = \dfrac{\lambda SI}{\rho+\alpha_1 I+\alpha I^2}$	Transmission rate(non linear incidence rate function)

λ	proportionality constant
$\rho \geq 1$	a positive constant
α	a positive parameter
λSI	infection force of the disease

All parameters assumed here are greater than or equal to zero .

III. Derivation of model

The differential equations corresponding to figure 1 are

$$\begin{aligned}
\frac{dS}{dt} &= a + \mu + \beta R - \frac{\lambda SI}{\rho + \alpha_1 I + \alpha_2 I^2} - (d + v)S \\
\frac{dI}{dt} &= \frac{\lambda SI}{\rho + \alpha_1 I + \alpha_2 I^2} - (d + m)I \\
\frac{dR}{dt} &= mI - (d + \beta)R \\
\frac{dV}{dt} &= vS - dV
\end{aligned} \tag{1}$$

Because of the biological meaning of the components $(S(t), I(t), V(t), R(t))$, We have focused on the model in the first octant of R^3 that is
$S(t) \geq 0, I(t) \geq 0, R(t) \geq 0, V(t) \geq 0$ and
$N(t) = S(t) + I(t) + R(t) + V(t)$.

IV. Equilibrium Points

a) <u>Disease-freee equilibrium</u> E_0

At disease-free equilibrium state,

$$\begin{aligned}
& a + \mu + \beta R - \frac{\lambda SI}{\rho + \alpha_1 I + \alpha_2 I^2} - (d + v)S = 0 \\
& \frac{\lambda SI}{\rho + \alpha_1 I + \alpha_2 I^2} - (d + m)I = 0 \\
& mI - (d + \beta)R = 0 \\
& vS - dV = 0
\end{aligned} \tag{2}$$

Assume that $I = 0$ then on solving all equations of system (2) ,we have disease-free equilibrium points such that

$$E_0 = \left(\frac{a + \mu}{d + v} \ , \ 0, \ 0, \frac{v(a + \mu)}{d(d + v)} \right).$$

b) Endemic equlibrium E^*

Assume that $I \neq 0$ then system (1) becomes

$$\begin{aligned}
&a+\mu+\beta R^* - \frac{\lambda S^* I^*}{\rho+\alpha_1 I^* + \alpha_2 I^{*2}} - (d+v)S^* = 0\\
&\frac{\lambda S^* I^*}{\rho+\alpha_1 I^* + \alpha_2 I^{*2}} - (d+m)I^* = 0\\
&mI^* - (d+\beta)R^* = 0\\
&vS^* - dV^* = 0
\end{aligned} \qquad (3)$$

On solving all equations of system (3) ,we have the endemic equilibrium points such that

$$S^* = \frac{(d+m)(\rho+\alpha_1 I^* + \alpha_2 I^{*2})}{\lambda},$$

$$I^* = \frac{\left[\frac{\beta m}{d+\beta} - (d+m) - \frac{\alpha_1 (d+v)(d+m)}{\lambda}\right]}{2\left[\frac{\alpha_2 (d+v)(d+m)}{\lambda}\right]} \pm \frac{\sqrt{\left[\frac{\beta m}{d+\beta} - (d+m) - \frac{\alpha_1 (d+v)(d+m)}{\lambda}\right]^2 + \frac{4\alpha_2 (d+v)^2 (d+m)^2 \rho (R_0 - 1)}{\lambda^2}}}{2\left[\frac{\alpha_2 (d+v)(d+m)}{\lambda}\right]}$$

,

$R^* = \dfrac{mI^*}{d+\beta}$ and $V^* = \dfrac{v(d+m)(\rho+\alpha_1 I^* + \alpha_2 I^{*2})}{\lambda d}$ respectively

and

basic reproduction number is given by

$$R_0 = \frac{\lambda(a+\mu)}{(d+m)\rho(d+v)}$$

Jacobian matrix of system (2) at disease -free equilibrium is given by

$$J = \begin{pmatrix} -(d+v) & \frac{-\lambda(a+\mu)}{\rho(d+v)} & \beta & 0 \\ 0 & \frac{\lambda(a+\mu)}{\rho(d+v)} - (d+m) & 0 & 0 \\ 0 & m & -(d+\beta) & 0 \\ v & 0 & 0 & -d \end{pmatrix}.$$

and

$$J - zI = \begin{pmatrix} -(d+v)-z & \dfrac{-\lambda(a+\mu)}{\rho(d+v)} & \beta & 0 \\ 0 & \dfrac{\lambda(a+\mu)}{\rho(d+v)} - (d+m) - z & 0 & 0 \\ 0 & m & -(d+\beta)-z & 0 \\ v & 0 & 0 & -d-z \end{pmatrix}.$$

The characteristic equation will be

$$|J - zI| = 0 \ .$$

$$\Rightarrow \ -(d+z)\left[-(d+v+z)\left\{ -(d+\beta+z)\left(\frac{\lambda(a+\mu)}{\rho(d+v)} - (z+d+m)\right)\right\}\right] = 0$$

or $$z = -d \ , \ z = -(d+v) \ , \ z = -(d+\beta)$$ and

$$z = \frac{\lambda(a+\mu) - (d+m)\rho(d+v)}{\rho(d+v)} .$$

For the system (2) to be locally asymptotically stable all $z < 0$.

So, if we consider , $\dfrac{\lambda(a+\mu)}{(d+m)\rho(d+v)} < 1$. Then $R_0 < 1$.

Where $R_0 = \dfrac{\lambda(a+\mu)}{(d+m)\rho(d+v)}$ is called basic reproduction number .

Therefore , the system (2) is locally asymptotically stable if $R_0 < 1$.

And if $z > 0$, then

$$\frac{\lambda(a+\mu) - (d+m)(d+v)\rho}{(d+v)\rho} > 0$$

$$\frac{\lambda(a+\mu)}{(d+m)(d+v)\rho} > 1$$

Or, $R_0 > 1$.

This implies that the system (2) is globally asymptotically stable if $R_0 > 1$.

V.Mathematical Analysis

Lemma 5.1: The plane $S + I + R + V = \dfrac{a+\mu}{d}$ is a manifold of system (1) which is attracting in the first octant.

From the lemma , we have

$S + I + R + V = \dfrac{a+\mu}{d}$ which implies $S = \dfrac{a+\mu}{d} - I - R - V$

Therefore system (1) becomes,

$$\frac{dI}{dt}=\frac{\lambda\left[\frac{a+\mu}{d}-I-R-V\right]I}{\rho+\alpha_1 I+\alpha_2 I^2}-(d+m)I\cong P(I,R,V)$$
$$\frac{dR}{dt}=mI-(d+\beta)R\cong Q(I,R) \tag{4}$$
$$\frac{dV}{dt}=\nu\left[\frac{a+\mu}{d}-I-R-V\right]-dV\cong T(I,R,V)$$

Theorem 5.2 : System (4) does not have non-trivial periodic orbit if
$\alpha_1(3d+\beta+m)>0$.

Proof: Consider,

$$I(t)>0, R(t)>0, V(t)>0 .$$

and consider the Dulac function,

$$D(I,R,V)=\phi^{-1}=\frac{\rho+\alpha_1 I+\alpha_2 I^2}{\lambda SI}$$

i.e. $$D(I,R,V)=\frac{\rho+\alpha_1 I+\alpha_2 I^2}{\lambda\left[\frac{a+\mu}{d}-I-R-V\right]I} .$$

Then ,

$$\frac{\partial(DP)}{\partial I}+\frac{\partial(DQ)}{\partial R}+\frac{\partial(DT)}{\partial V}$$

$$=\frac{-\alpha_1(3d+\beta+m)}{\lambda\left(\frac{a+\mu}{d}-I-R-V\right)}-\frac{2\alpha_2 I(d+m)}{\lambda\left(\frac{a+\mu}{d}-I-R-V\right)}-\frac{\left(\rho+\alpha_2 I^2\right)(2d+\beta)}{\lambda I\left(\frac{a+\mu}{d}-I-R-V\right)}$$
$$\frac{-d\left(\rho+\alpha_1 I+\alpha_2 I^2\right)}{\lambda\left(\frac{a+\mu}{d}-I-R-V\right)^2}-\frac{(dR+dV+\beta R)\left(\rho+\alpha_1 I+\alpha_2 I^2\right)}{\lambda I\left(\frac{a+\mu}{d}-I-R-V\right)^2}$$

.

$$\frac{\partial(DP)}{\partial I}+\frac{\partial(DQ)}{\partial R}+\frac{\partial(DT)}{\partial V}<0 \quad if \quad \alpha_1(3d+\beta+m)>0 .$$

where,

$$\frac{\partial(DP)}{\partial I}=\frac{-(d+m)(\alpha_1+2\alpha_2 I)}{\lambda\left[\frac{a+\mu}{d}-I-R-V\right]}-\frac{(d+m)(\rho+\alpha_1 I+\alpha_2 I^2)}{\lambda\left[\frac{a+\mu}{d}-I-R-V\right]^2} .$$

$$\frac{\partial(DQ)}{\partial R}=\frac{m(\rho+\alpha_1 I+\alpha_2 I^2)}{\lambda\left[\frac{a+\mu}{d}-I-R-V\right]^2}-\frac{(d+\beta)(\rho+\alpha_1 I+\alpha_2 I^2)}{\lambda I\left[\frac{a+\mu}{d}-I-R-V\right]}-\frac{(d+\beta)R(\rho+\alpha_1 I+\alpha_2 I^2)}{\lambda I\left[\frac{a+\mu}{d}-I-R-V\right]^2} .$$

and

$$\frac{\partial(DT)}{\partial V}=\frac{-d(\rho+\alpha_1 I+\alpha_2 I^2)}{\lambda I\left[\frac{a+\mu}{d}-I-R-V\right]}-\frac{dV(\rho+\alpha_1 I+\alpha_2 I^2)}{\lambda I\left[\frac{a+\mu}{d}-I-R-V\right]^2} .$$

This completes the proof .

Now rescaling (4) by

$$x = \frac{\lambda}{d+\beta} I,\ y = \frac{\lambda}{d+\beta} R,\ z = \frac{\lambda}{d+\beta} V\ ,\ \tau = (d+\beta)t.$$

Then

$$\frac{dx}{d\tau} = \frac{dx}{dI} \cdot \frac{dI}{dt} \cdot \frac{dt}{d\tau}\ ,\ \frac{dy}{d\tau} = \frac{dy}{dR} \cdot \frac{dR}{dt} \cdot \frac{dt}{d\tau} \text{ and } \frac{dz}{d\tau} = \frac{dz}{dV} \cdot \frac{dV}{dt} \cdot \frac{dt}{d\tau}$$

Therefore,

$$\frac{dx}{d\tau} = \frac{px\left[A - x - y - z\right]}{\left[1 + qx\right]} - Tx\ ,\ \frac{dy}{d\tau} = sx - y$$

and

$$\frac{dz}{d\tau} = g(A - x - y - z) - hz.$$

Where ,

$$g = \frac{v}{d+\beta}\ ,\ h = \frac{d}{d+\beta}\ \ s = \frac{m}{d+\beta}\ \ p = \frac{1}{\rho}\ ,A = \frac{\lambda(a+\mu)}{d(d+\beta)}\ ,T = \frac{(d+m)}{(d+\beta)}$$

$$q = \frac{(d+\beta)}{\rho\lambda}\left(\alpha_1 + \frac{\alpha_2\left(d+\beta\right)x}{\lambda}\right) = \frac{(d+\beta)}{\rho\lambda}\left(\alpha_1 + \alpha_2 I\right).$$

Thus we have new system of equations,

$$\begin{aligned}
\frac{dx}{d\tau} &= \frac{px(A - x - y - z)}{1 + qx} - Tx \\
\frac{dy}{d\tau} &= sx - y \\
\frac{dz}{d\tau} &= g(A - x - y - z) - hz
\end{aligned} \qquad (5)$$

The trivial equilibrium (0, 0, 0) of (5) is the disease-free equilibrium and endemic equilibrium points after rescaling the system (4) is obtained as

$$x^* = \frac{h(Ap - T) - gT}{ph(s+1) + Tq(g+h)}\ ,\ y^* = sx^*\ ,\ z^* = \frac{g(A - x^* - sx^*)}{(g+h)}.$$

VI. Stability Analysis of Disease-free and Endemic Equilibria after Rescaling

Now the Jacobian matrix of system (5) at disease free equilibrium will be

$$J_1 = \begin{pmatrix} Ap - T & 0 & 0 \\ s & -1 & 0 \\ -g & -g & -(g+h) \end{pmatrix}.$$

Then

$$J_1 - \xi I = \begin{pmatrix} Ap - T - \xi & 0 & 0 \\ s & -1-\xi & 0 \\ -g & -g & -(g+h+\xi) \end{pmatrix}$$

and the characteristic equation is

$$\left| J_1 - \xi I \right| = 0 .$$

$$-(g+h+\xi)\left[-(1+\xi)(Ap - T - \xi)\right] = 0$$

$$\Rightarrow \quad \xi = -(g+h) < 0 \ , \quad \xi = -1 < 0 \quad , \xi = Ap - T \quad .$$

For the third eigen value three conditions arises:

1. Stable hyperbolic node if

$$T - Ap > 0$$

2.Saddle node if

$$T - Ap = 0$$

3.Hyperbolic saddle node if

$$T - Ap < 0 .$$

When

$$T - Ap > 0 \Rightarrow Ap - T < 0 .$$

So ,by Routh-Hurwitz criteria the disease-free equilibrium after rescaling is locally asymptotically stable .

Now , discussing the stability of the endemic equilibrium when

$$T - Ap < 0 .$$

Theorem 6.1: Suppose $T - Ap < 0$ then there is a unique endemic equilibrium (x^*, y^*, z^*) of model (5) which is a saddle node .

Proof: Since $T < Ap$, therefore , we neglect T and so the system (5) can be written as

$$\frac{dx}{d\tau} = \frac{px(A - x - y - z)}{1 + qx}$$
$$\frac{dy}{d\tau} = sx - y \qquad (6).$$
$$\frac{dz}{d\tau} = g(A - x - y - z) - hz$$

And

$$x^* = \frac{Ap}{p(s+1)} \ , \ y^* = sx^* \ , z^* = \frac{g\left[A - x^*(s+1)\right]}{g+h} . \qquad (7)$$

Jacobian matrix of system (6) at endemic points is given by,

$$M=\begin{pmatrix} \left[\frac{px^*\left(qsx^*-(Aq+1)\right)}{(1+qx^*)^2}-\frac{pg\left[A-x^*(s+1)\right]}{(g+h)(1+qx^*)^2}\right] & \frac{-px^*(1+qx^*)}{(1+qx^*)^2} & \frac{-px^*(1+qx^*)}{(1+qx^*)^2} \\ s & -1 & 0 \\ -g & -g & -(g+h) \end{pmatrix}$$

$$|M|=\frac{1}{(1+qx^*)^2}\left[px^*\left\{g\left[-(s+1)+Aq-qx^*(s+1)\right]+h\left[Aq+(s+1)\right]\right\}\right]$$

$$+\frac{Apg}{(1+qx^*)^2}$$

Substituting the value of Ap from (7) ,

$$|M|=\frac{1}{(1+qx^*)^2}\left[px^*\left\{g\left[Aq-qx^*(s+1)\right]+h\left[Aq+(s+1)\right]\right\}\right].$$

Since $q>0$ which implies $\det(M)>0$.

Now , Trace of *M* will be

$$tr(M)=\frac{1}{(g+h)(1+qx^*)^2}\left[\begin{array}{l} px^*\left(qsx^*-(Aq+1)\right)(g+h)-pg\left[A-x^*(s+1)\right] \\ -(g+h)(1+qx^*)^2-(1+qx^*)^2(g+h)^2 \end{array}\right]$$

Sign of *trace (M)* depends on the nature of S_1 which is given as

$$S_1=px^*\left(qsx^*-(Aq+1)\right)(g+h)-pg\left[A-x^*(s+1)\right]$$

using (7) , we have

$$S_1=p\left[\frac{h(Ap-T)-gT}{\left[ph(s+1)+Tq(g+h)\right]^2}\right]\left\{\begin{array}{l} -qsT(g+h)^2-Aqph(g+h)-ph(s+1) \\ (g+h)-Tq(g+h)^2(Aq+1)+ghpA(s+1) \\ -gT(g+h)(s+1) \end{array}\right\}-pgA$$

which implies $S_1<0$ since $q>0$.

$$tr(M)=S_1-1-(g+h)<0$$

Thus, by Routh-Hurwitz Criterion the endemic equilibrium points (x^*,y^*,z^*) are locally asymptotically stable.

7. Numerical Simulation and Graphical Representation

Case I: SIR epidemic model without vaccination:

$$S(0)=4, I(0)=1, R(0)=1, \alpha_1=3.1, \alpha_2=4.7, d=2.29, \beta=1.5,$$
$$\mu=2, \rho=1, a=3.1, m=0.19, \lambda=9,\ R_0=0.8980<1$$

Figure 2 shows that *S(t)* approaches to its steady state value while *I(t)* and *R(t)* approaches zero as time progresses, disease dies out.

Case II: SIR epidemic model with vaccination:

$$S(0)=4, I(0)=1, R(0)=1\ ,\ V(0)=1, \alpha_1=3.1, \alpha_2=4.7,$$
$$d=2.29, \beta=1.5, \mu=2, \rho=1, a=3.1, m=0.19, \lambda=9,\ v=0.5,$$
$$R_0=0.7370<1$$

Figure 3 shows that $S(t)$,$V(t)$ approaches to its steady state value while $I(t)$ and $R(t)$ approaches zero as time progresses, disease dies out.

Case III: SIR epidemic model without vaccination:

$$S(0)=4, I(0)=1, R(0)=1\ , \alpha_1=3.1, \alpha_2=4.7, d=2.29, \beta=1.5,$$
$$\mu=2, \rho=1, a=3.1, m=0.19, \lambda=1, R_0=8.08212>1$$

Figure 4 shows that $S(t)$ approaches to its steady state value while $I(t)$ and $R(t)$ approaches zero as time progresses, disease becomes endemic.

Case IV: SIR epidemic model with vaccination:

$$S(0)=4, I(0)=1, R(0)=1,\ V(0)=1, \alpha_1=3.1, \alpha_2=4.7,$$
$$d=2.29, \beta=1.5, \mu=2, \rho=1, a=3.1, m=0.19, \lambda=1, v=0.5$$
$$R_0=6.63371>1$$

Figure 5 shows that $S(t)$,$V(t)$ approaches to its steady state value while $I(t)$ and $R(t)$ approaches zero as time progresses, disease becomes endemic.

Case I

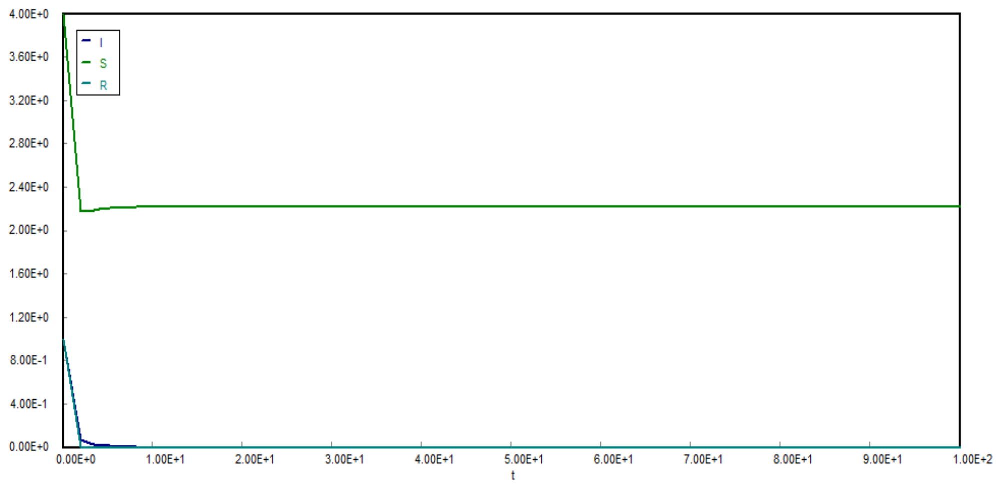


Figure 2: SIR graph without vaccination

Case II

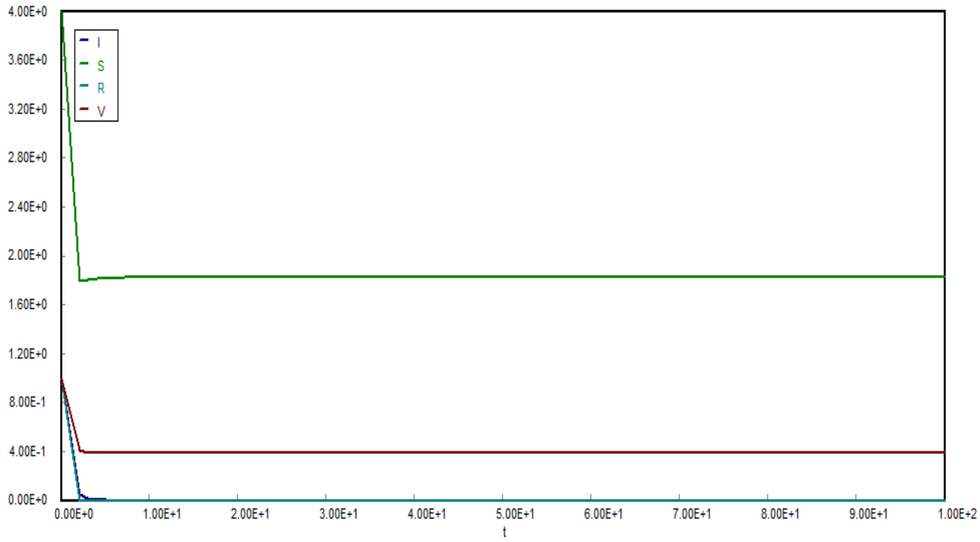


Figure 3: SIR model with vaccination.

Case III

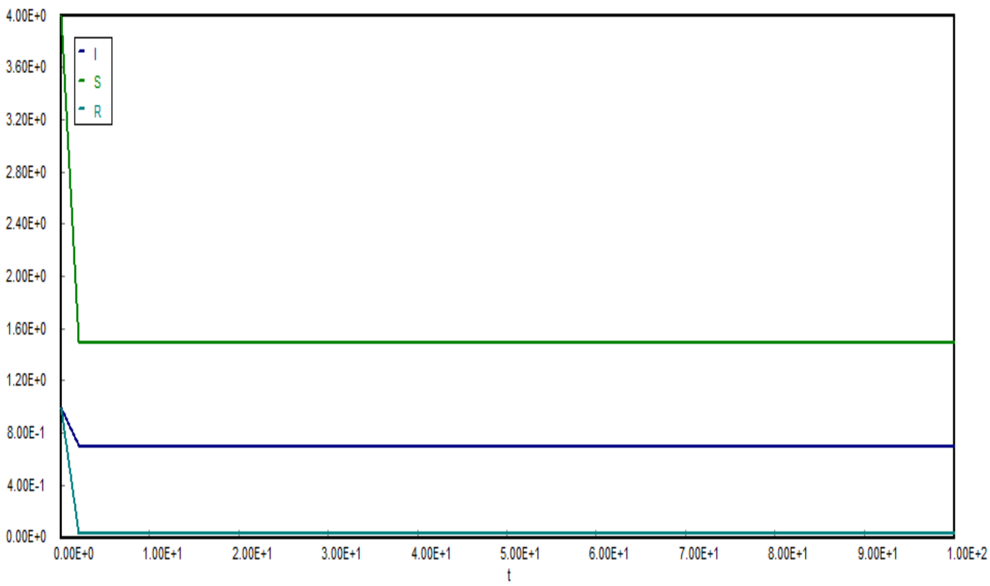


Figure 4: SIR model without vaccination.

Case IV

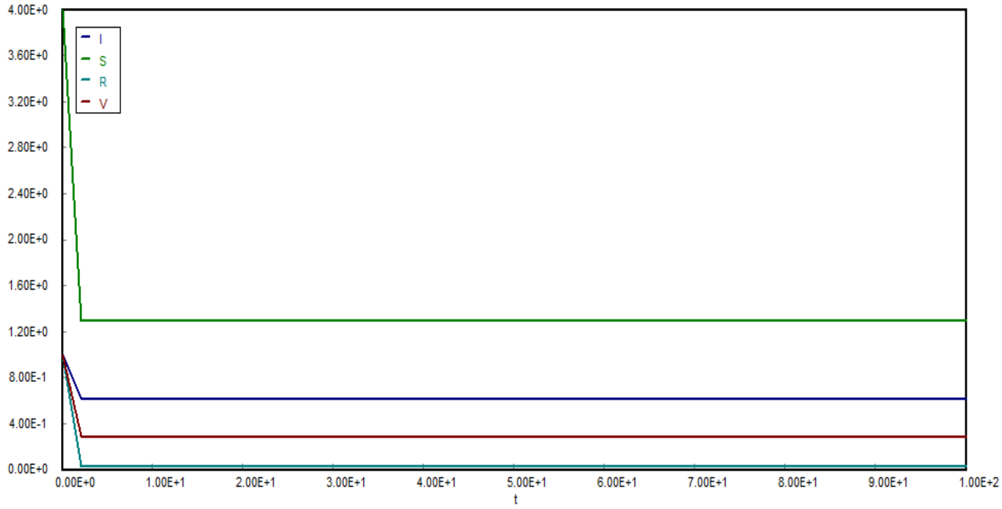


Figure 5: SIR model with vaccination.

VIII. Conclusion

In this paper, we have considered a vaccinated epidemic model with generalized incidence rate function. The global stability of the endemic equilibrium $E^* = (S^*,I^*,R^*,V^*)$ depends on the basic reproduction number. It plays an important role in controlling the disease. When reproduction number is less than or equal to one the disease free equilibrium state is globally attractive in the first octant and is globally stable, that is the disease dies out. When basic reproduction number is greater than one the endemic equilibrium state E^* exists and is globally stable in the interior. I have also plotted *SIR* and *SIR-V* graphs and compared the graphs for both reproduction number greater than one and less than one. These results and parametric conditions help to develop social consciousness about the disease among the susceptible.

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RECRUITMENT, SELECTION AND TRAINING OF HUMAN RESOURCE IN CONSTRUCTION: A REVIEW

Pratiksha Ashitkumar Dhabuwala, Dr. J. R. Pitroda

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Construction Engineering and Management,
Civil Engineering Department, BVM Engineering College, Vallabh Vidyanagar,
Gujarat, India
dhabuwalapratiksha@gmail.com

Abstract

Recruitment and evaluation are one of the tasks that has a significant effect on the organization's success to accomplish its purpose as part of human resources management. The aim of this analysis is to define employee recruiting and selection in the construction industry. The research centered on the analysis, identification and conclusion of current recruiting, selection and training practices implemented by building firms. In comparison, having a career was boring and frustrating early, but it became simple, fascinating and rewarding as technology progressed. The planet has now undergone a radical change in recruiting from newspaper and radio advertising to internet job platforms and media networks. Through the increase in technologies, recruiting is encouraged and strengthened. Because of technical advancements, recruitment has made it simple, cost effective and responsive for a variety of resources, websites and portals to expand. The organization will then implement the latest innovative techniques and methods and introduce technology and enhance the efficiency of its internal recruiting and selection method as preparation program in order to ensure positions are met as quickly as possible as cost-effectively as possible.

Keywords: Construction, Human Resource Management, Recruitment, Selection, Training

I. Introduction

Two separate meanings exist. The first concept of HRM is that it is the manner in which employees in organisations are coordinated and handled in detail. This covers the fields of recruiting (hiring employees), training, compensation and rewards, control of results, transition management and departure management for the organization to complete activities. This is the basic HRM definition that some experts define as a modem variant of the previously used Staff Management function.

The second concept of HRM is the macro management of individuals in organisations, i.e. the control of people in the form of a partnership between management and workers. This reflects on the HRM functions' priorities. Throughout this sense the HR position of contemporary businesses includes the principles of workplace satisfaction, workforce development and the importance put on maintaining the "jobs partnership" between management and workers.

A. Need of Study

The robots cannot do all the work and for every company people are necessary strength. Every organisation will search for the workers that can operate for the company's objectives. The caring partnership between management of sites and their human capital is usually experienced to improve the job partnership in the building project's setting.

B. Objectives of Study

The primary goal of HRM is to supply an organization of trained and professional employees. There are other targets, like that. The aims of the HRM are fourfold: financial, realistic and workers.

C. Scope of HRM

HRM's main roles include HRM growth, work analysis, role planning, workplace and corporate training, workforce participation, administrative control, industrial relations with HRM and opportunities of jobs. HRM is one of the primary functions. The degree to which intellectual resources is treated is:

1) Activities and approaches relevant to people management across any form of company as workers.
2) All aspects related to people and all the dynamics which flow from their employment relationships.

The American Society for Training and Development (ASTD) carried out a relatively comprehensive analysis in this field, describing nine specific areas of HRM 's activities. The following figure 1 Shows scope of HRM.

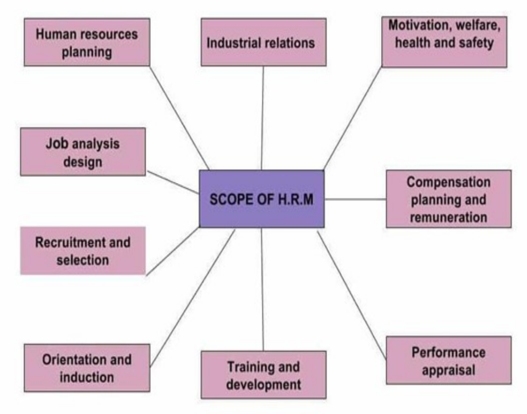

Figure 1: *Scope of HRM*

II. Literature Review

The evaluation text includes the analysis of multiple scholars and the findings of separate study articles. The studied PhD thesis, reviews and books have been released in different national and Foreign journals, and their main findings are described and shown at the end of this article. This improves knowledge of the subject and offers extensive background in the right flow of work.

Othman A. E. A. et al. (2009) analysed the expectations of the value-added contribution of these two large global electronics firms, operated in Malaysia by Japan, to corporate effectiveness. In this study, case studies and questionnaire responses used a mixed-methodological methodology. The two firms evaluated a total of 29 questionnaires. Review of the questionnaire answers and interviews shows that certain modifications and improvements are made in accordance with local circumstances between their approaches and the principles of the mainstream Japanese Management Systems (JMS). The overall findings show that JMS advises recruitment / selection and formation / growth approaches, which facilitate the creation of specific human capital through well

defined, collaborative HRM activities that are aligned with organizational priorities. Although not definite, HRM 's view that greater strategic efficiency correlates positively with organizational performance is supported by the results of this study. The paper presents some observations and realistic perspectives on successful HRM management strategies as a source of competitive advantage for HR practitioners and managers. [8]
According to **Ahmed et al. (2012)** The fields that should be considered for the strong motorway sector and the business as a whole have been revealed in procurement and method management procedures utilized by major road building firms. Recruitment strategies will be improved so employers will make use of their recruiting effort. In fact, there is a major difference in the sum expended on hiring and skilled workers within the organizations. Although certain companies believe that staff in offices are more critical than field personnel, changes may contribute to a behavioral change in the organization. Statistics suggest that companies, in addition to expending more resources to attract applicants for office, would be apparent to these organizations, that an early commitment in the training of an appropriate applicant pool minimizes the recruitment expense of applicants and the procurement of candidates with skills. [1]

Adu-Darkoh et al. (2014) Selection and recruiting is one of the most important processes in the pursuit of an organization's overall objective, as a human resource management tool. For this report, workers for construction in the city of Ashanti are hired and chosen. The research cantered in particular on the understanding of existing recruiting and selection procedures implemented by construction companies, the detection of challenges and findings and feedback based on my tests. The research further analysed recruiting and training literature. For the study a complete list of 62 businessmen from Ghana's Ashanti Construction and Civil Engineering Association division was used. Closed and open-ended questionnaires were used to determine respondents' opinions about specific problems relating to recruiting and job hiring activities. [2]
Kanu A. M. et al. (2015) Qualitative and quantitative methodological methods to research and outcomes of 59 small and medium businesses in interactions between recruiting and selection practices. These conducted in-depth conversations with owners / managers and cross-sectional owner / manager and staff reviews. SPSS used for results analysis. He recommends that the owner / manager employ and choose the best employees, regardless of the number of workers, using more international recruiting platforms, take health and wellness into account prior to recruitment and selection as well as other recruitment and selection approaches. The study was conducted with a lack of time and resources, self-reporting, limited, independent variables, the prevalence of questionnaires, limited semi-circular interviews and, in the end, insufficient sample frameworks. [4]
Manap N. et al. (2017) Higher importance of the building work ended in 2016 in the state of Johor in Malaysia. Malaysia's construction industry has problems with skilled labour, which is why it is important to recruit contractors with international skilled work to satisfy the need. He researched two purposes in order to define requirements for hiring local skilled workers by the construction firm and to research techniques that can draw local skilled workers to the construction industry. Questionnaires were sent to Johor's G7 provider. Reliability data compiled and analysed using SPSS. The outcome of this study indicates that the potential boss wishes to work with him / her and needs young, trained, experienced and competent workers. In addition to improving social services and providing more housing, some strategies are primarily concerned with the provision of revenues such as salary increase, incentives, allowances and overtime compensation. The research will function as a road-map to establish both the skills organization and the contractor in order for the local skills staff to join the industry. [6]

III. Recruitment in Construction

Recruitment is the mechanism by which qualified candidates are sought and drawn for employment. The cycle starts with the invitation for new hires and concludes with the delivery of their applications. The effect is a selection of candidates chosen for new workers. We may therefore conclude that recruiting is the method of finding and motivating prospective workers to apply for employment.

A. Factors Affecting Recruitment

The following figure 2 Shows factors affecting the recruitment.

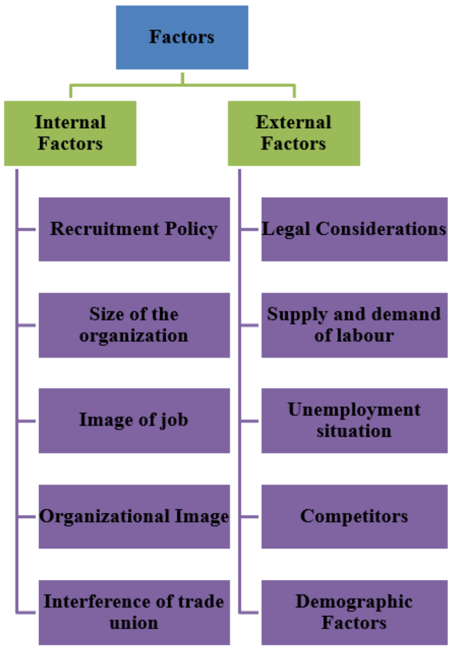

Figure 2: *Factors Affecting Recruitment*

B. Recruitment Process

The following figure 3 Shows recruitment process.

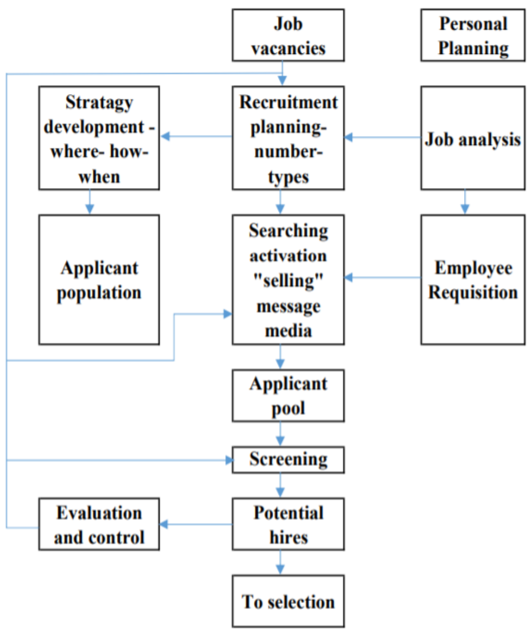

Figure 3: *Recruitment Process*

C. *Source of Recruitment*

1) Internal Source

i. Job posting and bidding
ii. Employee Referrals
iii. Promotions and Transfers
iv. Re-recruiting former Employees & Applicant
v. Internal Recruiting database

a) Advantage:
i. Good capability evaluation
ii. Any work is inexpensive
iii. A motivation for strong results
iv. You just want recruit at the point of entry
v. Causes a number of deals
vi. Promoting principles

b) Disadvantages:
i. Management and Growth Software Require
ii. Nativity
iii. Operation civil resistance
iv. Social problem with the unpromoted

2) External Source
i. Labour union
ii. Media Sources
iii. Employment Agencies
iv. Employment Exchanges
v. School, College & Universities

a) Advantage:
i. Cheaper and faster than college
ii. Trained practitioners
iii. No party community with business backers
iv. Organization Yet
v. Can have fresh insights into the industry.
vi. Young blood provides new opportunities

b) Disadvantage:
i. May cause internal moral problems
ii. Non-selected candidates
iii. Longer time for "adjustment".
iv. Can't choose anyone who fits the job or organization

IV. Selection in Construction

Selection is the method of selecting the most appropriate person for the current position or the future position from among the candidates from within the organization or from outside.

A. Selection Process

The following figure 4 shows the selection process in construction.

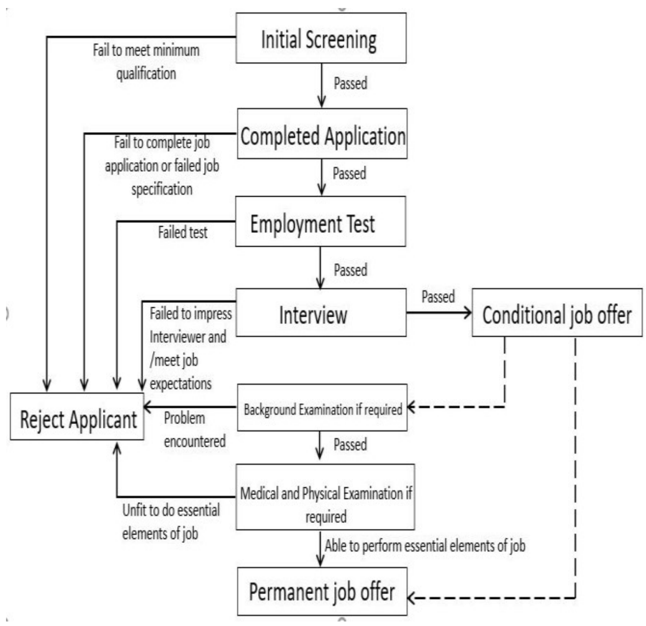

Figure 4: *Selection Process*

1) Preliminary interview: In the first phase of the screening process inappropriate and unqualified candidates are rejected depending on the information in the request forms. Sorting is the reject of malfunctions according to minimal preparation, skill or skills. Appropriate care should be taken to ensure that the sortation procedure cannot lead to the removal of suitable candidates.
2) Application Blanks: After the clearance of the interview, candidates are required to fill in a blank questionnaire to gather pertinent details regarding their age, employment, background, experience, references, motives for leaving their former work. Questionnaire blanks: The applicant shall complete the document and submit it to the company before the stated date with a copy of the certificate and image.
3) Selection Tests: If the candidates obtain filled blanks, they are required to conduct various tasks to identify the best person for the right work. Such tests are carried out by counselors and academics in preparation for candidates in the organization to determine the appropriateness and expertise.
4) Reference Checks: Applicants are required to have two to three people's names and emails. After conclusion of the interview, these people are contacted by structured mail, by telephone or simply with their thoughts on the candidate. The key purpose of the exam is to learn the history of the applicant and to review the information in the application form.
5) Medical Examination: Following the reference check, candidates must receive a wellness examination to guarantee their physical and mental wellbeing, because it improves their effectiveness and decreases the likelihood of absenteeism. Just after passing the diagnostic examination does the candidate submit a work offer.
6) Final Approval: Once the exams and interviews are finished, letters of selection are sent and sought from the applicants specifying the position, position, salaries, certain terms and conditions etc. The candidates are properly set up and activated on the day they join the company.

V. Training in Construction

Education is the incremental shift of actions by schooling, education, development and anticipation. In summary, one may assume that preparation enhances the experience and abilities of an individual to perform a particular work.

A. Need of Training

The number of qualified staff in India has been reported to be very small, so leading businesses need to invest in recruiting. The schooling of workers with different abilities has been important in order to improve their efficiency. Job sense schooling, content knowledge and consistency knowledge will be given to build professional and social competencies, etc. Through the following Chinese proverbs, the importance of preparation is emphasized:

"Give a fish to a man, and you gave meal to him. Teach fishing guy, and life for him.

"Once you prepare seeds for one year, if you decide to grow plant trees for ten years, if you intend to keep them for life time develop men.

So, importance of training for an organization and its employees can be explained as:

1) Better efficiency
2) Optimal human capital use
3) Improved job efficiency
4) Uncontrolled
5) Fewer times of study
6) Less injuries
7) High moral standards
8) Culture & Environment organization

B. Types of Training Methods

Learning approaches are designed to accomplish the intended training outcomes and thus a wide variety of training strategies are used, although not all of them can be implemented by an individual at the same time. This will select the strategies to suit the educational needs and operational criteria.

1) On Job Training Method

The on-the-job preparation is a method from which workers, i.e. employees, are guided to perform their duties on the working floor. The employees can learn the skills required in the current working conditions and become familiar with the working environment. There is also no extra expense for creating a classroom or a simulated structure for delivering guidance to workers apart from the real operating period, as is the case for off-the-job preparation.

Figure 5: *On Job Training Method*

2) Off Job Training Method

The Off-the-Job Training is the training method wherein the workers/employees learn their job roles away from the actual work floor. Simply put, off-the-job training requires a position explicitly reserved for the purpose of training that may be similar to the actual workplace, where employees are expected to practice the skills and be well trained with the equipment and procedures to be used in the actual workplace.

Figure 6: *Off Job Training Method*

VI. Case Study: Recruitment and Selection Process Of Larsen & Toubro, Mysore

Work position: JET (Junior Engineer Trainee, Qualification- Diploma) and GT (Graduate Trainee, Qualification- Engineering) for L & T, C-TEA (Centre for Technology and Engineering Application) 80 resumes were sourced, after the telephonic round, where the candidates interest checks were carried out and the communication skills were evaluated. Fifteen candidates were short-listed based on interest checks communication, relevant work experience and locational constraint (Mysore).
They were called for a face to face interview in L & T's Mysore campus. Document verification was conducted, where the candidates' marks sheets, updated curriculum Vitae (CV), pay slips for the last three months, character certificates from the previous employers were checked.
The candidates had to face another 2 interview rounds, including one inside the administrative team, and if they considered the candidates to be qualified, the candidates were sent into the final interview round performed by L&T – CTEA 's technical council. Two candidates were offered: one fresher and one with relevant professional experience.
The chosen applicants were required to undergo medical examinations in hospitals which are related to L&T, and the applicants obtained a soft copy of the letter of offer after the medical examination was accepted. On the day of joining the hard copy of offer letters were given to the candidates.

Figure 7: *Construction Skills Training Institute*

The above figure 7 shows the Construction Skills The need for skilled labor is paramount for a rapidly increasing and evolving industry such as the construction industry and as a leader, L&T Construction plays a key role in the development of skilled labor through its Construction Skills Training Institutes (CSTIs), which are spread across the world.
The Construction Skills Training Institute (CSTI) has independent, conductive campuses for practical and classroom training at Chennai, Mumbai, Ahmedabad, Bangalore, Hyderabad, Kolkata, Delhi and Cuttack.

VIII. Conclusions

The following conclusion based on literature review and case study:

1) There is no need today for a highly qualified unemployed worker to search for job opportunities. The job is rendered available through career portals and accessibility via one's own door steps.

2) Nevertheless, the planet has witnessed a steady change towards on-line workstations to social networks, towards journal to radio ads. This makes the procurement cycle quicker and easier with the increase in technology.
3) The hunt for jobs was tedious, monotonous and tiresome before, but the introduction of technology in this field rendered things easier, more enjoyable and more satisfying. The recruiting process has also seen the growth of numerous tools, websites, portals that have made this process more complex, faster, more cost-effective and to some degree more efficient as a result of technological innovation. Therefore, the company must utilize the latest technologies and approaches and adopt technology to update the recruiting and selection process more responsively and more efficiently to ensure that vacancies are filled in as little time as possible and in cost-effective ways as possible.
4) DGFASLI seeks to enhance workplace standards and environments in order for factory employees to increase protection, wellbeing and productivity and, broadly speaking, the nature of their working lives. The ILO created the Institute as a Center of Excellence for the Administration of Asian and Pacific Labor.
5) The government of India established the Central Labor Institute, Mumbai, as a center for study, training and consultancy on the various facets of human labor, under the first five-year plan.

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QUALITY MANAGEMENT SYSTEM IN CONSTRUCTION: A REVIEW

Chirag Sumantbhai Patel, Dr. J. R. Pitroda

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Second Year, M.Tech. Construction Engineering & Management, Civil Engineering Department, B.V.M. Engineering College, Vallabh Vidyanagar, Gujarat, India.
patelchirag1298@gmail.com
Associate Professor, PG Co-Ordinator Construction Engineering and Management, Civil Engineering Department, B.V.M. Engineering College, Vallabh Vidyanagar, Gujarat, India.
Jayesh.pitroda@bvmengineering.ac.in

Abstract

Generally, the quality management system is designed to ensure that the organizations make adequate effort to achieve the level of quality required by the customer. Achieving these quality levels will contribute to greater customer satisfaction, which is crucial to maintaining long-term success for construction firms. ISO 9001 Quality Management System is one of the ISO 9000 standards set that includes a collection of instructions on how to set up a quality management system for processes that impact their goods or services. Despite reports that construction organizations enjoyed the great benefits of being an ISO 9000 certification are literally proven, the main goal of Quality management system implementation, namely achieving customer satisfaction in project management, is still broad. Enhanced management & work efficiency of the organization as the most important benefit from system implementation while the most significant issue is lack of knowledge of the system among the employees. To solve these implementation challenges, preparation and audit (internal and external) need to be improved.

Keywords: Construction, Quality, Quality Management System, Quality Assurance, Quality Control, Total Quality Management

I. Introduction

Quality has a functional meaning in industry, engineering, and manufacturing as the non-inferiority or superiority of something; it's also characterized as suitable for its intended purpose (fitness for purpose) while meeting customer expectations. Performance is a perceptual, conditional, and rather subjective attribute and different people can interpret it differently. Consumers should concentrate on a product / service's performance consistency, or how it compares with marketplace competitors. Producers may calculate the quality of the conformance, or the degree to which the product / service was correctly created. Support staff may assess the quality of a product to the degree that it is effective, implementable or sustainable.

In a business sense, there are several levels of quality, but the idea that the company creates something is important, whether it is a tangible product or a specific service. Such products and/or services and how they are made include several types of processes, methods, machinery, staff and investments, all of which come under the umbrella of quality. The idea of quality management has its origins in key aspects of quality and how it is diffused in the sector.

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Although quality management and its concepts are relatively recent trends, the notion of organizational quality is not new. In the early 1900s, pioneers like Frederick Winslow Taylor and Henry Ford noticed the shortcomings of the techniques used at the time of industrial manufacturing and the resulting varying quality of performance, the introduction of quality control, inspection and standardization procedures of their work. Later in the twentieth century, William Edwards Deming and Joseph M. Juran's likes helped to improve quality.

A. The Triple Constraints

The triple project constraints are:

1) Quality
2) Time
3) Cost

Figure 1: Project management triple constraints

One way of thinking about the golden triangle is to imagine a structure of linkages. Scope is in the center and link bars attach to the three standards, time and cost constraints. If the permissible cost is decreased, pressure will be added to one or more of the three other components. For example, schedule must be slipped, quality reduced and/or scope reduced. Project management does not provide free lunch. You can never alter one element of the triangle without changing at least one of the other three.

B. Quality Control (QC)

Quality control (QC) is a mechanism in which the consistency of all variables involved in output is evaluated by organizations. ISO 9000 describes quality control as "a section of quality management which is geared towards meeting quality requirements."

A company must first determine which basic requirements the product or service must follow to implement an effective QC system. Then you have to assess the magnitude of QC behavior — for example, the percentage of units to be checked from each lot.

This approach emphasizes three things (shined in standards like ISO 9001).

1) Elements such as monitors, task management, and procedures identified and well controlled performance and integrity standards, and record identification.
2) Competencies, such as information, expertise, experience and skills.
3) Soft elements such as employees, honesty, confidence, culture of organization, inspiration, team spirit and quality relationships.

Inspection is a significant component of quality assurance, where the actual product is physically inspected (or an examination of the end results of a service). Lists and explanations of inacceptable product defects such as cracks or surface blemishes will be given to quality inspectors.

C. Quality Assurance (QA)

Quality assurance (QA) is a way of eliminating errors and failures in manufacturing goods and of eliminating problems when producing goods or services to customers; which ISO 9000 describes as 'part of quality control based on ensuring that quality standards are met. This quality assurance defect avoidance varies slightly from identification of defects and rejection in quality management, and is described to as a left shift because it focuses on consistency earlier in the cycle (i.e., left to right of a linear process structure attempting to read).

The terms "quality assurance" and "quality control" are generally used interchangeably to respond to objective of ensuring the quality of the service or product. For example, the word "assurance" is often used as follows: Philips Semiconductors explains the introduction of evaluation and systematic inspection as a quality assurance method in a projection screen software system. Furthermore, the term "control" is used to describe the fifth step of the system Defining, Measuring, Analyzing, Improving, Control (DMAIC). DMAIC is a quality approach which is guided by data and used to enhance processes.

Quality assurance involves logistical and operational tasks carried out in a production system to meet the specifications and targets for a product, service or operation. This is the systematic assessment, comparative analysis with a norm, process control and a related feedback loop that confers reduction of errors. This can be correlated with quality control which focuses on the performance of the process.

Quality control comprises two main principles: "fit for purpose" (the result should match the expected intent); and "made for first time" (mistakes should be eliminated). QA covers quality control of raw materials, parts, goods and components, production and management support services, manufacturing processes, and inspection processes. In the history of designing (engineering) a novel technological product, the two concepts often manifest: The task of project management is to make it happen once, while the task of quality assurance is to making it work every time.

D. Total Quality Management (TQM)

William Deming, a professor of management whose work had a significant influence on Japanese industry, developed TQM. Although TQM shares the Six Sigma improvement method much in general, this is not the same as Six Sigma. TQM focuses on ensuring that mistakes are minimized by standards and guidelines and process requirements while Six Sigma seeks to minimize defects.

Total Quality Management (TQM) is the ongoing process of identifying and minimizing or removing production defects, streamlining supply chain operations, improving customer service, and ensuring that staff are trained to pace. Full quality control seeks to keep responsible for the overall quality of the finished product or service to all parties involved in the manufacturing process.

Total Quality Management (TQM) is a holistic approach to optimal management of the organizations. The method focuses on enhancing the quality of the products of an company, including services and products, by continually improving the internal operations. When part of the TQM process, the specifications set will represent both internal expectations and any technical standards currently in place. Industry requirements can be set at different rates and may require adherence to particular laws and regulations governing the company's operation in question. Fig.2. shows the main difference between QC, QA, and TQM.

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Figure 2: Difference between QC, QA and TQM

II. Literature Review

The review paper which contains the work done by various authors and the results of different research paper. Paper published in numerous national and foreign journals, Ph.D. thesis, studies and books have been studied and at the end of this chapter the main findings are described and reported..

The following are the previous research review based on quality management system in construction industry.

Abdul Hakim Muhammad et al. (2006) summarized the definition of the Quality Management System (QMS) and its implementation in the construction sector. A disagreement on the QMS definition among develop players has become the major roadblock for its system execution. Either at company level or at project level, QMS may be applied. They work on the company-based QMS in manufacturing can be described as extensive given the various areas of the project. While several researches on the company-based QMS have been completed, the QMS project-based analysis lags behind. While reports that construction organizations enjoyed the benefits and advantages to become an ISO 9000 certification are literally proven, the prime target of QMS implementation, namely achieving client satisfaction in projects, remains large. At the project stage, QMS as part of the framework needs a Project Quality Plan (PQP). The market players still don't understand PQP well and therefore the implementation of PQP faces a lot of problems. The important information to remember in designing, implementing and managing the PQP is the strategy and goals of the project, the mechanism, the leadership teams and the work methods. PQP may be created separately for each project member, or as an interactive document for all project team members. [2]

A.R. Rezaei et al. (2011) was developed a web-based bureau automation system. Using a web-based automation program for offices, called the performance measurement Support System (PMSS), managers will be immediately supplied with reliable business details. PMSS eliminates paperwork by correct IT usage, eliminates reporting issues through the use of data centers, overcomes connectivity issues through the use of Internet and cell phone facilities, and ultimately allows the organization to achieve Certification as part of its quality management program. PMSS considered only practical OBS and efficiency measurements require three measures for time, cost and price. [4]

Bubshait Abdulaziz et al. (2014) measured the efficiency of 15 building contractors' programs. He claimed that the sophistication of the quality system ranges from an irregular audit program system to a quality system compliant with ISO 9002. Senior management interest in enhancing project efficiency and existing or anticipated demand from clients are the most compelling factors for registration. The most commonly associated with ISO 9000 clauses are: (1) audit and check status; (2) examination and testing; (3) non-compliance quality control; and (4) handling, storage, and protection. Misunderstandings have been found about documentation of the quality program, method of implementation, and the discrepancy between non-conformity behavior and corrective acts. Putting up development goals would be another area that firms are struggling to deliver. [1]

AnupW S et al. (2015) was conducted exploratory work to provide insight into quality processes, methods, strategies and the dedication of management to quality implementation in construction projects. They also discussed the problems facing Quality Control Systems during deployment. They use a qualitative questionnaire approach to collect data, and a case study is performed using content review tool to validate the questionnaire. They concluded by interviewing the professionals through an interview process based on the findings of the review and the case study data and providing reasonable advice on how to solve QMS issues arising. They have established there is a belief that implementation of QMS increases paper work. Certain significant factors experienced during QMS implementation are the staff's inability to follow QMS and poor technological know-how. In the local context, the majority of the quality problems encountered elsewhere are important. In the case of management variables, the association levels are higher for naming members and performing evaluations. Subcontractors operate and there is stronger connection between insufficient professional experiences in QMS implementation issues. [3]

Keng Tan Chin et al. (2016) identified the importance of implementing ISO 9001 Quality Management System in Malaysian construction firms, solving the problem faced by construction firms in adopting ISO 9001 Quality Management System and identifying approaches followed by ISO-certified construction firms to solve or mitigate problems and challenges. They carried out case study and picked approach to collecting data for this research. Five construction companies were chosen to be interviewed for case study purpose. That organization is consulted with one representative form to gain more details from their viewpoint on the advantages, challenges and methods for implementing ISO 9001 QMS. The research findings concluded that the most important benefit from introducing the program is improved management & work quality of the organization while the most serious problem is lack of knowledge on the program among workers. To solve these implementation challenges, preparation and audit (internal and external) needs to be enhanced. [12]

Mohammed ALI Ahmed et al. (2017) established and eliminated barriers to the effective implementation of quality management system in the construction projects created either before or during implementation of such systems. Putting these defined obstacles into seven main categories: managerial, organizational, communicational, financial, cultural, educational, and auditing. CSFs should be defined for more efficient implementation of these systems, taking into account, in particular, the impact of external factors. In this study, 'External Factors' refer to those found in the atmosphere of the construction industry that are produced primarily by external influences that, unlike internal factors, may not be primarily accounted for organizational disruptions such as influences of economic, financial, political, cultural and industrial relations. Using and modeling the final collection of all the current and defined variables (internal and external) should establish a structure for successful QMS implementation in the construction firm. [10]

Pascal Bacoup et al. (2017) they was approach used based on a synergistic synthesis of both ISO (Quality Management System) principles and core Lean Management concepts. Each article begins with a description of a company's performance, and draws some meaningful results. Organizations have the option of gaining certification in conjunction with a Lean Quality Management System: a one-page Quality Guide, just ten documents, no significant non-conformities and no consumer concerns for a period of two years. [11]

Jayden Smith et al. (2018) developed the principle of benchmarking and the philosophy of creating a method that businesses can use to continuously improve their total quality management. They announced survey findings showed that on average, Oil and Gas companies had more mature

QMS than construction and mining firms. The findings also showed that firms operating in wider geographic areas (i.e. internationally) usually had more mature QMS than firms running only regional level (i.e., Perth or Western Australia). Certain findings needing further study include the fact that there was no scientific proof that businesses with higher sales had more advanced QMS. A bigger pool of respondents should be pursued in future iterations of this study so that objective statistical analysis can be used to validate patterns in the survey responses. [7]

Yosep Hernawan et al. (2018) defined the degree to which the implementation of ISO 9001:2015 as a Quality Management System is implemented in a business, what benefits a business can reap by adopting the ISO 9001:2015 Quality Management System, finding challenges and solutions and what steps organizations need to take to incorporate the ISO 9001:2015 Quality Management System. The technique used is a descriptive tool which is qualitative. Outcomes represented in the form of a reinterpretation of the implementation of ISO 9001:2015 in the organization in the context of constraints and barriers, assessment and benefits obtained after the application of ISO 9001:2015 Quality Management System, like the division of authority and obligations in each group which is simpler, quicker contact and response to customers, ongoing. [13]

III. Quality Management System

I. General

A Quality Management System (QMS) is a collection of business processes that are based on fulfilling customer expectations reliably and increasing their fulfillment. It is in line with the intent and strategic direction of an organization (ISO9001:2015). It is described as the organizational objectives and expectations, strategies, procedures, recorded information and resources required for its implementation and maintenance. Early quality control methods, using basic statistics and random sampling, stressed predictable results in a manufacturing product category. Through the 20th century, labor inputs were usually the most complicated and expensive imports in most developed societies, so emphasis shifted to team cooperation and coordination, particularly through a continuous improvement process, early signaling of problems. QMS has continued to align with efficiency and transparency campaigns in the 21st century, as both investor loyalty and c Many QMS, such as Natural Phase, emphasis on environmental concerns and believe other quality problems would be minimized as a result of systemic thought, accountability, reporting, and diagnostic discipline, consumer satisfaction and perceived quality are strongly tied to these factors. Of the QMS regimes, the ISO 9000 standard family is perhaps the most commonly adopted worldwide – both are regulated by the ISO 19011 audit regime, and deals with consistency and consistency and their incorporation.

Many QMS, such as Natural Phase, emphasis on environmental concerns and believe other quality problems would be minimized as a result of systemic thought, accountability, reporting, and diagnostic discipline.

Figure 3: Quality management system

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QMS Guidelines series are:

- ISO 9000 Quality Management Systems-Principles and Vocabulary, applied in all ISO 9000 Standards.
- ISO 9001 Quality Management Systems – Provides criteria that and company must meet in order to be accredited as ISO 9001.
- ISO 9002-Instructions for ISO 9001:2015 use.
- ISO 9004 – Managing an organization's consistent success, offers guidance for maintaining QMS progress through assessment and enhancement of results.
- The latest edition of ISO 9001:2015 is an ISO 9001 standard.

II. Benefits of QMS

Implementing a quality control system has an impact on each and every aspect of the success of an organization. A recorded quality control program has the benefits of:

- Following the expectations of the client, this helps to install confidence in the company, which in turn leads to more clients, more sales and more customer retention.
- Meeting the organization's criteria, this guarantees the most cost-effective and resource-efficient compliance with the regulations and the delivery of products and services, creating space for development, growth and benefit.

Such systems provide more advantages, including:

- Description, development and processes;
- Cutting waste
- Fixing errors
- Rising costs
- Fostering and recognizing opportunities for training
- Recruiting workers
- Setting course through organizations

IV. ISO 9001 Requirements for QMS

I. General

The standard has eight clauses: Scope, Common Attributes, Definitions, Management Accountability, Quality Management Systems, Inventory Control, Product and/or Service Realization, and Measurement, Evaluation and Development. The first three provisions are for details and the last five are conditions that must be fulfilled by an agency. This section follows the numbering scheme used in the normal.

The process approach is referred to as the implementation of a series of processes within an entity, combined with their definition and interactions, and the management of those processes. The method highlights the value of:

1) Comprise and satisfy the criteria
2) The need to consider Value Added Processes
3) Achieving process success and productivity outcomes
4) Continuous process enhancement, based on objective test

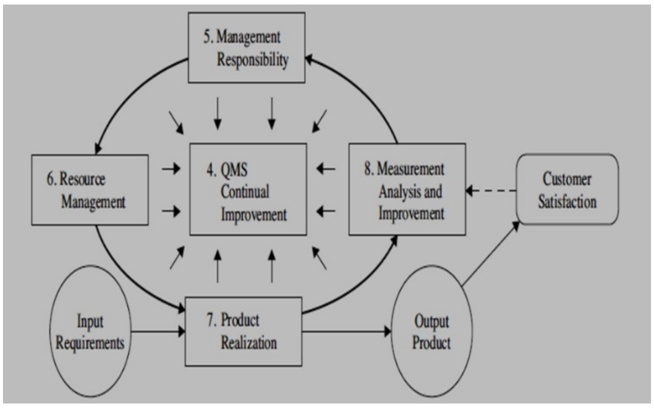

Figure 5: Model of a process-based Quality Management system

II. Eight Clauses of ISO 9001

1. *Scope*

The aim of the standard is to explain the company's ability to produce a product that meets consumer and regulatory requirements, and to increase customer satisfaction. Its aim is achieved by assessment and continuous improvement of the method, rather than the product. The standard's specifications are supposed to extend to all forms and sizes of organizations. It is possible to remove specifications in Clause 7, Product Awareness which are not suitable for the company.

2. *Normative Reference*

ISO 9000:2005 Quality Control Systems — Fundamentals and terminology is a standard guide that offers the principles and meanings which mostly apply.

3. *Terms and Definitions*

The terminology and definitions laid down in ISO 9000:2000 utilize for the objectives of this standard. The word "Good" also means "Service" in the entire text of this standard.

4. *Quality Management System*

The company shall create, log, enforce, and maintain a QMS and enhance its effectiveness continuously. The organization shall (a) evaluate the processes that need for QMS and its implementations within the organization, (b) define their sequencing and interaction, (c) determine requirements and approaches for the successful operation and control of those methods, (d) ensure the provision of resources and knowledge required to support and track these processes, (e) track and evaluate wherever necessary, And (f) introduce steps aimed at achieving expected outcomes and continuous improvement of those processes. Outsourced processes which effect the service quality must be defined that is included in the program.

Documentation:

Common Documentation shall involve (a) explanations of a Quality Policy and Quality Priorities, (b) A quality Report, (c) recorded techniques and records usually needed, (d) documents necessary to ensure efficient process and record preparation, activity, and control. A process or job instruction is needed if its absence may adversely affect the quality of the product. The scope of the reporting would depend on the size and nature of operations of the organization; the sophistication of the procedures and their interactions; and the employees' competencies. For example: a small enterprise may orally inform a manager of an upcoming meeting, whereas a big organization will need a written notice. The standard should meet contractual, legislative, and regulatory criteria as well as the needs and desires of consumers and other stakeholders. Documentation may be in any format or style.

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System document contains:

- The Manual of Quality
- Monitor and control of documents
- Record Control

5. Management Responsibilities

Management Commitment:

Top Organization shall demonstrate its commitment to the success, implementation and continuous improvement of the QMS by (a) discussing the need to satisfy customer, legislative requirements, (b) implementing a quality policy, (c) ensuring that quality targets are set, (d) performing management audit, and (e) maintaining that resources are available. Top management is characterized as the person or group of individuals who direct and regulate an enterprise.

- Focus on Consumers
- Policies of standard
- Arranging:

Objective on standard
Planning of the Quality Control Process

- Competency, Authority and Communication: Responsibility and Power
- Executive Member Inside Cooperation
- Testing the management

6. Resource Management

- Arrangement of Resources
- Human Resources:

General: Upon the basis of adequate schooling, training, expertise and experience, staff conducting work that affect adherence to product requirements shall be qualified. Compliance with quality specifications can be directly or indirectly influenced by staff conducting certain duties within the QMS.

Competence, awareness and training: The company shall

(a) define the required skills for personnel conducting work that affect compliance with product requirements, (b) help in providing instruction or take other steps, where appropriate, to achieve the required skills, (c) assess the efficacy of the actions taken, (d) ensure that its staff are conscious of the significance and value of these actions, and (e) Maintain proper records of schooling, employment, credentials and knowledge. Competence can be defined as the capacity demonstrated to apply knowledge and skills. It may be provided by role, party, or unique place in the job description. Effectiveness of training can be measured by assessments, results, or turnover before and after.11 ISO 10015 Training Guidelines can help companies achieve this requirement.

1) Infrastructure:

The company shall define, provide and maintain the infrastructure required to comply with the specifications of the goods. Infrastructure includes (a) offices, office, and related facilities as appropriate, (b) production equipment (both hardware and software), and (c) support services (such as transportation connectivity or operations management).

2) Work Atmosphere:

The company shall establish and maintain the work environment needed to meet the specifications of the product. Creation of an acceptable work environment can have a positive impact on morale, happiness and success of the employees. The word "work climate" refers to working environments, including physical, climate and other factors (such as noise, temperature, humidity, visibility, and weather).

7. Product Realization
   - Market realization preparation
   - Processes related to customers: Determination of Product Specifications
     Revision of Material Specifications Customer care
   - Development and Evolution:
     Project and Development Planning Input in the design and production of
     Excellence in design and production Technology and technology analysis
     Verification of concept and development; Validation of design and development
     Command over changes in design and development
   - For tend to purchase:
     Phase Purchase Buying Data
     Verification of the Goods Purchased
   - Manufacture and service provision: Sales and Service Inspection
     Validation of the production and service delivery processes
     Traceability and Identification Customer Ownership
     Product preservation
   - Testing and testing devices

8. Measurement, Evaluation and Improvements
   - General:

The company shall prepare and execute the processes of tracking, testing, evaluating and enhancing required (a) to demonstrate conformity to product specifications (b) to ensure QMS compliance, and (c) to continually enhance the QMS effectiveness. This shall include the determination and scope of their use of relevant tools, including statistical techniques.

   - Management and computation of: Service quality
     Inside Compliance
     Monitoring and process assessment
     Surveillance and product and service assessment
   - Material nonconformity test
   - Information Analysis
   - enhancements:
     Improvements
     Corrective and preventative measures

V. Conclusion

Following conclusions are made based on literature. There are many advantages of registering with ISO 9000. These specifications are also used as the fundamental structure for ISO 9000 criteria. The rule is common in nature and can be customized to fit the needs of any organization.

The general aims of ISO 9001:2015 based on literature are:

- To be standardized enough, but still applicable to all forms and sizes of organizations, regardless of their industry or field.
- Considering improvements in practice and technology in TQM.
- The implementation of the standard framework, core texts and meanings set out in the annex to the ISO Directive.
- To simplify operational performance and efficient compliance checks.

From literature benefits of ISO registration and implementation of QMS are:

- Increased management and job efficiency: Both organizations accepted that the introduction of ISO 9001 QMS in their organization would make work management more systematic.
- Improved communication: As job management has become more formal, companies A, C, D and E have found that contact between workers has improved considerably.
- Improved documentation control: Companies B, C, D and E submitted that the structured filing system was one of the significant advantages of implementing ISO.
- Increase customer trust and satisfaction, and thus improve the brand image of the organization.
- Heightened number of projects undertaken.
- Increased efficiency of the on-site jobs.

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RISK ANALYSIS AND MITIGATION TECHNIQUE IN INDIAN TRANSPORTATION INDUSTRIES: A REVIEW

Jyotin Shaileshbhai Rana, Dr. J. R. Pitroda

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Construction Engineering and Management,
BVM Engineering College, Vallabh Vidyanagar, Gujarat, India
Jyotinrana97@gmail.com

Abstract

During the past decade, risk management has been implying into a parent business practice in government and industry. The objective of risk mitigation in the transport industry has been to strength increases and intensity. Hazardous material shipments are involved, this leads to prevention tearing down and minimizing the consequences when a release develops. Managing the transport network along with the management of the business, the creation of programs, and the implementation of projects is extremely complex and fraught with doubt. Administrators, planners, and engineers collaborate as well as provide technical support to improve the quality of the transit system. The approach to transportation risk management assumed that when man-made disasters occurred, they were accidental in nature and not due to spiteful intent. Risk management in the construction industry is not at all and simple process. Because risk creates different problems in cost, quality and time. If risks are not managed properly, order of works will get influenced in construction sites. There are six types of risks, their causes and serious issues faced by Contractors, Project managers and engineers. Therefore, questionnaire has been prepared to find out the root causes of risks and its origin. Here I shared some reviews and some ideas to reduce the risks. Thus, risks are determined, quantified, and suggestions have been given to reduce or control the risks.

Keywords: Risk Management, Risk Assessment, Risk Mitigation, Transportation Industries

I. Introduction

Being an owner of some small building or contracting company be a dream for everyone. Design of some high-risk systems. The job of management authorities are not so straightforward to finish the project on schedule and quicker. Most building programs fail to implement the time, expense and intent of the project. The founders, companies, contractors, banks and economic agencies, sellers & suppliers, every have their risks in carry out their business. By the point the sum of threats becomes unknown. Building schemes are often special and threats derive from a variety of different sources. Some behaviors or event that can impact project task performance is considered danger. Every initiative that has a danger that cannot be prevented so that we can retain the danger and monitor. For the last two years, the business owner has chosen a contractor depending on their bid because of the extremely dynamic contractor environment and has been preferred by the contractor to reduce their prices with fewer expertise, efficiency, protection and creativity. Hence, it causes the project to exceed expenditure expense and timeline.

The construction cycle has several uncertainties and risks which increase project size and complexity. PMI defines project risk as an indefinite event or condition and has both positive and negative effects on the objective of the project, such as time, cost, scope or quality. As we know, construction industries are more at risk than any other industry. The explanation for this is because of the difficult complexity of the building, operation, climate and organization activities. The risk in road project will lead to disability to achieve the required project goals. Delays, expense, and time overruns, and decreased capital supply are detrimental consequences of intimate highway project threats. There, the value of risk estimation, risk sharing, and risk control in successfully planning any highway construction project. Risk assessment will be brought up, and issues reported.

II. Literature Review

Following are the literature review based on risk management and their mitigation strategies in construction of transportation infrastructure.

Perera et al. (2009) conducted work on Sri Lankan road projects aimed at defining contracting parties risk liabilities with a view to strengthening their risk management strategies. Their study followed the Multiple Case Studies method and concentrated on close completion of two major foreign-funded road ventures. The research started with 26 risk factors that were identified by literature analysis and interview transcripts and it was observed that the two case studies were appropriate to only 23 sources of risk. The results showed that road building ventures in Sri Lanka are exposed to multiple sources of danger while the bulk of threats are faced by parties who have been allocated risk by contractual clauses. Parties, however, that were not assigned with the defined threats, still had the consequences of the risks. Ultimately, it was decided that there is no right approach to react to a challenge, and that various risk reduction approaches can be followed to comply with threats effectively. [4]

Anmol Okate et al. (2014) was developed Road building works which carry a great deal of risk due to their scope across a wide geographical area and the danger of underground conditions. Risk can be described as a known uncertainty situation and this uncertainty is calculated in terms of its probability of occurrence. Risk has a direct impact on all of the aspects of a project, including project expense, time or scope. Understanding risks at the initial phases of a project will assist the project management to reduce its own effect and produce the job in a continued to improve and more efficient way. [2]

G. Bhagavatulya et al. (2014) gives information on risk management in India 's transport programs. Because Indian infrastructure is a big part of Indian GDP, the significance of transport industries affecting our country is clearly described here. Researcher will take some questioner survey with several well-known transport project experts. Several methodological approaches implemented after survey data collection to assess association between variables and Relative Significant Index. As a consequence of statistical system researcher, several big factors are discovered that often influence the project. Some statistical techniques are used here to measure precision of results, mathematical formulae quantify correlation between variables and relative index. [5]

Serpella et al. (2014) addressed risk management challenges in building projects utilizing a knowledge-based framework and suggested a three-fold structure technique that involves risk management role analysis, feature assessment and the development of best practices model. Researcher was stated that most of the time risk is mitigated by adding contingencies (money) or floats time and that in certain situations it is simply inadequate to cover the implications of the risks

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that arise during the realization of a project. Thus, projects finish with expense overrun and late in most cases. Therefore, it is necessary to provide a good and systematic methodology and, most specifically, awareness and practice of different styles to create accurate and efficient risk management. [11]

Nguyen et al. (2014) done an analysis undertaken to classify 140 risk factors involved in Indian transport projects by literature review, which was reduced to 30 aspects for the survey questionnaire. Therefore, these threats were grouped into 4 specific categories, namely Contractor-Associated Threats, Owner-Associated Risks, Designer-Associated Risks and Project Manager-Associated Risks. The threats were rated using mathematical measures such as Cronbach Alpha, association between factors, and RII. Results revealed that the most important danger is project framework adjustment in the context of alteration to a current design or introduction of new elements to the program. Ultimately, the report concluded that building risk reduction would be of greater value to ensure that programs are finished on schedule and under budget. Despite various influences affecting the smooth execution of transport programs, there is ample room for developing a better approach for risk reduction. Study results indicated that all of the identified risks had a major effect whereas the risk of prevalence is low, including the bankruptcy of a contractor. [8]

Mahmoud H. Mansour et al. (2015) conducted in the UAE and 33 risk factors were identified for the highway construction industry. A test was developed to gain the opinions of construction experts. Further experiment was done out using RII (Relative Importance Index) to determine the danger ranking used to assign danger for more predictive assessment or reaction preparation the findings showed that the most significant risk in the UAE highway construction industry is the inefficient planning. This also provides suggested distribution of threats. In comparison, the rank correlation coefficient of the Spear man was used to research the frequency of relationships between the contractors' and consultants’ opinions. [7]

R. R. Singh et al. (2016) identified and established variables impacting the organization of the construction facilities at the concept production and review stages. The top five aspects include the project's size and scope, the construction team's level of expertise, the consistency of the building project's preliminary / conceptual design, Clarity of the owner's expectations and goals, committed project expenditure and organizational capabilities of management team leaders. [9]

Agarwal et al. (2016) provided no such detailed methodology is available to prioritize the management of low-volume road network activities. Most portion requirements evaluation approaches are sophisticated, expensive and involve specialist equipment and man power. While it is basically useless to use such technique on remote networks. There is also an important need to implement practical approaches that focus on rural road networks that are cost-effective, reliable and convenient to operate. [1]

Mane et al. (2017) has presented Pavement Maintenance and Management System (PMMS) methodology was introduced using AHP for rural roads in India, where historical traffic congestion pressure data was difficult to obtain. The work finding has been valuable to field engineers and decision-makers for successful distribution of the fund for surface repair. This research can be extended extensively to rural roads in different regions of India, which would be helpful in establishing a universal distress ranking guideline for rural roads, as environment and traffic characteristics in different regions directly influence the cycle of pavement deterioration. [6]

III. Introduction to Indian Transportation

Risk assessment as a central business strategy between policy and industry has grown over the past decade. In the transport sector, the main risk reduction strategy has been to increase the possibility and type of harm. Where imports of toxic products are concerned, this task applies to the mitigation of leaks and mitigates the effects when a leak happens. Before recently, the transportation risk assessment strategy believed that they were accidental in nature when manmade accidents happened, and not attributable to specific intent. Terrorist actions. In fact, we also found that transportation risk evaluation has to be carried out with a more extensive scope to handle terrorism situations that historically may have been thought too impossible that they would not merit exposure to risk management. Similarly, in terms of the number of incidents, the allocation of recovery services and the collaboration of departments, first personnel will be able to handle impacts well beyond what was previously feasible.

Some vulnerability to potential failure may be described as a construction risk. Since each building project is special, there are a number of legal threats to it. A contractor that works on a building project must be able to recognize and evaluate the threats to ensure the success of a project. So, then the provider needs to be worthy of managing such threats. In financial terms, risk is defined as the possibility that the actual outcomes from an occurrence or investment may differ from the planned effect or gain. Benefit needs a potential risk of an initial investment, or more.

A. Introduction to Indian transportation Economy

Risk is a part of every business. India's building companies continue to face difficulties relating to manpower shortages, rising material and labor expenses, and socio-economic shifts. Construction is on the rise due to large-scale expansion plans and infrastructure programs like transport, electricity and natural resources. Fig. 1. shows contribution of infrastructure to GDP of India in last decade.

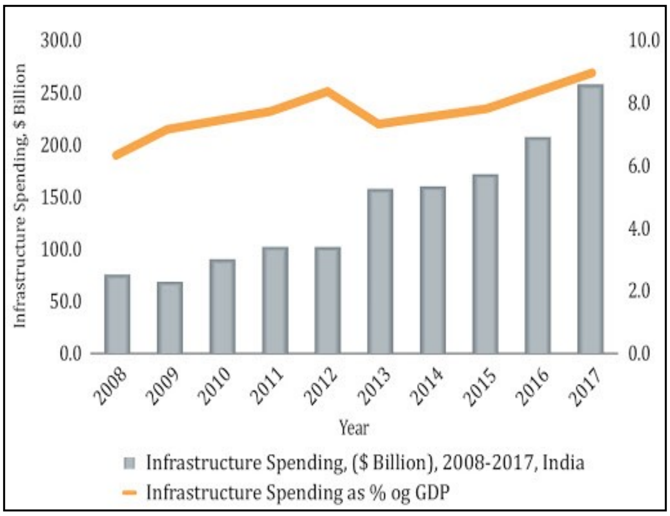

Figure 1: *Contribution of infrastructure in GDP*

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IV. Introduction to Risk Management

Danger is described as an incident that is expected to arise, but if that risk happens, it may have either a positive or negative impact on a project. A risk will have one or more reasons and one or more impacts if it really does arise. For example, a reason can need an environmental permit to do research, or have limited personnel assigned to plan the project. The danger case is that the authorizing agency will take longer than expected to grant a permit, or the necessary and allocated staff might not be sufficient for the operation. When one of these uncertain things occurs, the expense of the project may be impacted.

A danger is a possible future risk that may occur from some current action, such as a project interruption or an increase of costs. The cost is mostly calculated in terms of actual financial harm, but in terms of success, potential profit, and property or life harm, it may often be a disaster. The overall aim of risk management was to improve the frequency and extent of accidents in the transport industry. In the case of imports of dangerous materials, this function applies to the prevention of leakage and mitigates the impact when breaches arise.

A risk is a possible future damage that could arise from an existing action; such as a delay in the timetable or a cost overrun. The failure is sometimes known as a simple financial loss, although it may often be a loss in terms of reputation, possible company and property or life loss. Two other essential things are to be discussed as part of implementing risk reduction, Firstly, the preventive measures that should be implemented to minimize the risk of an incident happening, secondly, the action method or a set of actions that will come into effect during or at the moment of the incidence. Mitigation acts also come at a premium. The expense of mitigating the risk can sometimes exceed the cost of taking on the risk and incurring the effects Until agreeing on executing a contingency plan, it is necessary to determine the likelihood and effect of increasing danger against the expense of the mitigation strategy. Pre-risk mitigation strategies adopted are pre-emptive measures intended to will the effects or minimize the danger as a whole. In addition, contingency plans introduced after a risk occurs can only lessen the impact.

A. Project Risk Management

Project Risk Assessment includes the mechanisms of preparing, defining, assessing, organizing solutions, executing responses and monitoring danger on a project. The project risk management objective is to increase the chance and effects of identified risks, and to decrease the chances and/or impact of negative risks to improve the project's probability of success. Fig.2. shown some major variables of project risk management.

Figure 2: *Project Risk Management*

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Risk reduction is a large factor that affects a variety of business fields, but it is also a factor that any human being on earth will tackle with regard to their way of living because if ignored human life is left in the path of damage and susceptible to illness, disease and hunger.

Building owners, project managers and contractors often identify and execute risk-management activities on a project differently. Owners can use informal methods or methods that they view as risk management operations, such as process gate approval, Contractors may describe risk control as monitoring future change orders and project managers may claim that 'all we do is manage risk.' Although all of these practices help define and handle specific elements of project harm, they don't explain clearly a thorough risk assessment approach to project.

B. Risk management Process

Figure 3: *Risk Management Process*

Here, Fig.3. shown the process chart of risk management.

1) Risk Management Planning: Since undertaking risk management practices are assessed in the proposed model (scope, timetable, and cost) to assess their risk potential. This evaluation (or risk screening) tests all activities against a range of traditional screening categories in the areas of building, system management, health, regulatory and environmental, infrastructure, architecture, capital, spatial migration etc. This can monitor activities that are known as project threats.
2) Risk Identification: Identify risks that may impact the successful completion of the project. Risks are identified for the entire life cycle of the project. Risk associated with context, expense, and schedule of project work is defined by systematically examining the project's assumptions, logic, and complexity, and by examining the identified uncertainties associated with each project stage.
3) Risk Assessment: Assess the risks to determine their likelihood and impact on the project's cost, schedule, and/or work scope. This provides both a qualitative and quantitative assessment of the consequences (impact) of the risks and the probability.
4) Risk Handling: Determine the strategy for risk-handling, whether to reduce, transfer, prevent, minimize or assume.
5) Risk Management Impact and Control Actions: Assesses the risk impact on the project and the effect of the risk handling strategies. Risk handling strategies will be reflected in the project's baseline, whereas residual risks will be reflected in the project contingency.
6) Risk Reporting and Tracking: Risk reporting and tracking is the documentation of the risk management process.

V. Risk Mitigation

A. Introduction to Risk mitigation

Risk mitigation implies a reduction to a reasonable level of the probability and/or effect of an adverse risk occurrence. Early intervention to minimize the probability and/or effects of a danger arising on the project is always more successful than trying to minimize the harm after the risk arises.

The possibility of price inflation of building materials such as steel, cement, bitumen etc. in the airport ventures. It seems that the proper planning of available resources and management of waste during transportation and development has maintained and mitigated what represents the project expense considerably.

The possibility of the subcontractors' financial loss has been mitigated by checking the subcontractors' previous records and experiences, as well as from the clients' list of licensed subcontractors. Contract was only awarded if it meets all political, technological and other commercial requirements. The groups who have good relations with the contractor in the past have been given mainly subcontracts.

Labor related problems at one of the airport projects sites have been mitigated by supplying accommodation for school or their children near the facility, pharmacy, grocery store, and transportation from the accommodations to the location. Previously having labor has been a very big challenge, as there are many builders in and around various metros where they get a decent pay closer to their home but comparatively the danger has been reduced after offering the above listed facilities.

In one of the airport locations, which is an extension area, theft and fire damage to land, material and equipment has been mitigated and protection is of high concern in any regard. Highly complex safety standards are being implemented such that only licensed and permitted labor and workers may access the field of operation. Building industries are also a main economic sector in India, accounting for 15 per cent of the GDP. So, it is important to control building threats in India.

B. Risk Categorization

1) Site Risk: The danger associated with the land acquisition can be mitigated with the project beginning only after the government procures and hands over the necessary property. Even, by giving pre-notice for the purchase to the property owner, so that the sale process can be quickly completed. The Regular Project Report (DPR) program should be fully implemented for effective site inspection and the DPR format should provide site photos, regular resource use, daily manpower working, and volume of work completed etc.
2) Material Risk: The Regular Project Report (DPR) program should be fully implemented for effective site inspection and the DPR format should provide site photos, regular resource use, daily manpower working, and volume of work completed etc. We will also have the standard certificate for through material, such as ballast, sleepers, ties, etc., often used in railway line laying. Also, the agency will have many choices i.e. several number of products dealers. And if one struggles unless the correct content is shipped on schedule, another may produce the specific element on site on time to reduce the risk associated with delay.
3) Design Risk: As the key period needed to complete the railway project is the Design and Survey process, Ideal Design is necessary in railway projects, as millions of kilograms of load must be moved in that direction. Therefore, the railway department spends more time writing papers on construction and survey. In this scenario, the tender winery, which prepares the design and survey reports of this enterprise, has six months to detailed complete reports including GADs (General sheet arrangements), hydrology of each major and minor bridge, railway curves, Track descriptions with differing chain length. But it can be mitigated by providing proper concept documentation and by owner and contractor before beginning the project. Yet again, such a danger may be mitigated by recruiting seasoned surveyors yet planners or by providing the fresher employee adequate training under the supervision of experts.

4) Contractual risk & Exposures: The forms of danger of contractual responsibility have had a rather serious effect on the project, in this case, for the design process, one private consulting company has refused to carry out the whole survey of a specific road, so breach of contract happens, in order to complete such incomplete work, the railway ministry needs to offer another tender again, So after all the boring tendering process every other consulting company would carry over the task of doing the balance of the job, which would trigger a lot of misunderstanding so repetitive work. To mitigate such a possibility, the railway ministry should be strictly informed in the initial tendering phase of contract violation.
5) Financial Risk: This is also important to look at the strategies for analyzing project cash flow, which is a major feature of risk management mechanism, since recognizing the danger involved in a Railway project. The essential methodology in cash flow control notes that, In the first two stages and in the last two stages of the development process, the project cost will be between 8% and 10% of the overall budget and, in the remaining period, it differs with the rise at the center, the lowest at the middle and the reduction towards the end arising from the 'bell curve.'
6) Site Safety: Such a possibility was found to be very popular not only in rail projects but in the building industry as well. And steps to minimize such a risk, include wearing safety equipment including helmets, hand glows, gloves, goggles, etc., are often very common. Many government undertakings and commercial companies will not obey such a policy as would be understood. Apart from this, for starters, there are other actions for the benefit of people examples,
   a. The Workmen’s compensation act, 1923
   b. The Employees Compensation act, 1923
   c. The Trade Unions Act, 1926
   d. The Payment of Wages Act, 1936
   e. The Employers Liability Act, 1938 and many more.
7) Management Risk: Management danger in such a project which is working with public agencies is considered to be very critical risk. Here the railway ministry outsources the tender to private entities and private entities work in their comfort according to the capital available. Often supplies are not accessible on time and they would have alternate supplier solutions available to alleviate such a danger, so the project does not stop due to resource unavailability.
8) Organizational Risks: This form of danger exists with private consultancies that are going to operate for the Railway Ministry, the subcontracted products and other construction reports such as GADs, hydrological reports etc. do not meet the head office or corresponding site locations on time, which often helps to prolong the procurement of permissions and postpone the implementation of research. Then the private consultancies will handle proper transport networks to resolve such a risk. The products held on site will also be well secured against heat, wind and other unnecessary items such as robbery, waste etc.
9) Human resource risk: Such a problem arises again primarily for private consultancies, as some trained employees employed on these massive contracts exit the positions, and the firms have to find any new staff and have to train them first, which takes so much time that indirectly affects the project delay.
10) Construction risk: Those threats are more prevalent in the building sector, and typically such a danger arises during the project implementation process. Due to confusion, the requirements provided in the sketches and design reports are becoming different at the location. The site engineer will first review the proposal in depth with senior engineer to address such a possibility. The implementation process should also be carried out correctly, since millions of kilograms of weight would be transported through that path. Instead of

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traditional ethical practices, new equipment can be used by the State for cheap and convenient building.

11) Legal Risk: Many of the government agencies / civic bodies etc. that are influenced by the development of this Railway line in one or the other, had to give separate permissions for the project, which would be a complicated and time-consuming procedure throughout the construction period. However, with a project of this size the government would have a single window clearance.

C. Mitigation Techniques

1) Increase Responsiveness: Increasing responsiveness related to faster deliveries, which accounts for a 20% increase in production rates. The faster one gets the item into consumers hands the better.
2) Reducing Cost risks: Many of the specific expense challenges encountered when a project has to be done immediately include the consistency of expense forecasts, incomplete or missing adequate problems with timeline compression financing. Risks in cost forecasts are reduced by way of adequate preliminary planning and preparation via the fast-track project execution. If the team may recognize project problems early in the planning phase, expense projections are more far-reaching, mitigating future risks, unexpected surprises.
3) Mitigating schedule risks: When modularizing equipment, it is vigorous for the project team to include merchants early and to introduce an expediting equipment measure to avoid potential scheduling barricades caused by deliverers of equipment or harm during transport.
4) Mitigating safety and quality risks: Quick track ventures can mitigate issues created by delays in the construction environment by creating a schedule of an hour to an hour that recognizes places of activity that overlap and enables the project manager to create contingency arrangements to avoid that overlap.
5) Rapid prototyping and test feedback: This are an integral component research analysis appropriate might not be accessible on the market or inside the enterprise. This may, therefore, be part of the market's quality control mechanism, even inside the organization / project. The sample suggestions should be carefully examined and discussed, and appropriate recommendations should be accompanied throughout the duration of the project for improvements. Upon crucial review of such projects, the danger such as grid contact, delays in start-up, or maintenance problems could be gone.
6) Political, policy and regulatory risks: Similar financial, legislative and economic threats. Continuous inconclusiveness on prospective government assistance or regulatory conditions related to the criteria for solvency resources. Thanks to ongoing activities providing an evaluation of potential prospective policy reforms, such as through defining indices of political danger.
7) Staff training: This approach involves the creation and promotion of organizational building and soft skills training in teamwork, collaboration, facilitating, service leadership, analytical thinking strategies and strategic analysis, as well as technological competence. Proper staff preparation becomes necessary because the recruited team may not have experience operating in the individual area and managing the different equipment.
8) Efficient Communication: The life-blood of a project is productive and reliable coordination with all main actors over the lifespan of a project. No project is expected to function without successful and secure coordination system through the web. The value rises much further in such as creative ventures, as the absence of proper and timely coordination between the project management and all stakeholders will generate uncertainty that can serve as a baseline for significant project setback.
9) Counterparty risk: Financial security of activity and repair facilities for the vendors or contractors is important. The counterparty danger for the significant problem of major

suppliers or contractors for offshore wind parks, where financial strength concerns contractors with existing credit evaluation and performance track record, especially important for offshore wind parks, as well as long-term contracting.

VI. Case Study

This case study is on Risk Management in infrastructure project of pune metro construction.[3]
Location: Pune, India.

Researcher states the risk involve during project life cycle are varies extensively having uncertainties and too much complex and that directly affect the cost to institution to the national wealth. They establish analytical method for recognizing, analyzing and controlling risk as part of a contract is not enforced. Risk assessment, statistical data generation of ongoing programs, review and conclusion of project-specific decisions and project implementation recommendations. They create their own methodology for managing risk and privations methods. Here, in fig. 4. describe the methodology that they were created to manage risk is shown.

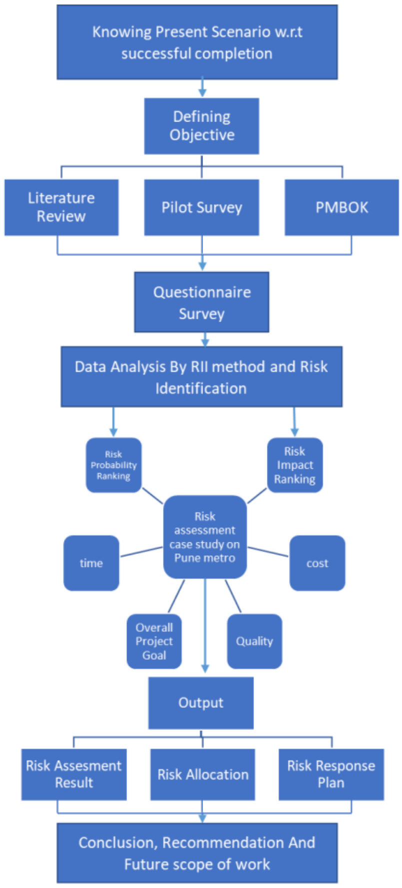

Figure 4: *Methodology for Pune metro risk management*

VIII. Conclusions

From the extensive literature review and the case study on the importance of Risk analysis and mitigation in construction of Indian transportation industries.

1) Due to an overview of the protective process, it is inferred that danger is usually passed to certain parties or that they apply to prior and current related programs.
2) Many threats may be easily minimized from the parties involved, such as risks resulting

from the Acts of Christ, from service companies, from local interactions, from matters of public health and protection, from legislation and from the difficulties of receiving permits. Employer interference, which serves the government, is especially critical in solving community, public safety concerns.

3) Risk transfer is also an essential risk management tool because it may serve as a buffer against such losses and to attain each party's organizational goals. However, vendors were hesitant to submit requests for damages to prevent damaging the employer's good partnership. The presence of insurers in this instance is important.
4) The prevention approaches introduced in terms of both proactive and corrective interventions are primarily tailored to policy-making and strategic decisions to reduce the risk and extent of various forms of ship disturbances.
5) The current focus of the analysis was limited to the detection during the construction phase of essential risk factors. This can also extend to all building projects in the legal and functional stages.
6) Political risk can play an important role in complex projects such Large International Airport Projects, where agreements, agreement and contract issues are an important part of the project management process. As always, in the case of the current research, there was no presence of international danger and geological / climate risk. Some conclusions can be drawn from the extensive study of literature and case studies on various practical solutions and methods to human resources.

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AUDIO ASSISTED ELECTRONIC GLASSES FOR BLIND & VISUALLY IMPAIRED PEOPLE USING DEEP LEARNING

[1]Khilan Pandya and [2]Dr. Bhargav C. Goradiya
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[1]Research Analyst at Numerator
khilanpandya@gmail.com
[2]Professor – BVM Engineering College, V.V.Nagar
bhargav.goradiya@bvmengineering.ac.in

Abstract

Encroachment of technology has replaced individuals in almost every field with machines. By introducing machines, automation system has reduced human workload, with specially focused on visually impaired person or completely blind person find difficulties in reading a printing or handwritten text from real world or distinguishing people in front of them. So, they cannot perform particular tasks without someone's assistance or help. Hence looking at this challenge, it is necessary to make the reading device for blind people which is capable of recognizing text, human objects and, differentiate the bank currencies across the world. Obviously, Output will be in the form of audio, which will help the blind user to read the texture like a normal person. To overcome this difficulty for the visually weakened group, this paper presents a device which will help blind people for giving them guidance efficiently and safely to read book, recognize faces of their near and dear ones as well recognize different bank currencies. In this paper, we propose a deep neural network algorithm like CNN integrating with OCR model achieves a recognition accuracy of 95% for human detection and 90% for disgusting bank currencies.

Keywords: Deep Learning, CNN, Electronic Glasses, Visually Impaired, OCR.

I. Introduction

Blindness has been a malady which has been prevalent for centuries, there are a plethora of people suffering from this condition. We cannot even imagine the problems they are going through. They face many challenges in their life as the gift of eyesight is denuded from them. Following are the causes for blindness: 1) Glaucoma 2) Diabetic Retinopathy 3) Cataract 4) Age-Related Macular Degeneration 5) Refractive Errors 6) Amblyopia and 7) Strabismus etc.
With modern advancement we as engineers strive to facilitate them in any mean possible. These are some facts released by WHO (World Health Organization): 1) An estimated 253 million people have vision impairment: 36 million are blind and 217 million have moderate to severe vision impairment. Out of these over 15 million blind people are in India. 2) 81% of people who have blindness or have moderate or severe vision impairment are aged 50 years and above.
Furthermore, visually weakened people face many encounters in their every-day life, and a number of these could be relieved to some degree via the use of an aiding device based on artificial vision systems [1]. One particular problem is such that determining the denomination of a bank currencies,

difficulties in reading a printing or handwritten text from real environment and distinguishing people in front of them as an object. This is very useful for a blind person that is on their own because recognizing the any real-world running objects which are useful in daily life for blind people is quite challenging. Devices like a glass openly considered to perform this task already exist on the market but the current trend in technological development is to take advantage of cameras found in smartphones, portable computing devices (tablet-like devices), and wearable devices that offer a number of complementing solutions for the user [1]. Today, in the digital world mobile applications are being developed technocrats and some have already been released into the market to help social. However, but it is found that there is a lack of advancement in the current technology is possible and necessary.

In this paper we present a simple and robust method for the identification of real-world objects, which is part of a wearable glasses for helping the blind. The scope of this glasses is that it guides the visually impaired person in reading independently in an efficient manner. These days if they must read anything, firstly it needs be written in braille script for them to feel and understand it. Whereas this glass will help them interpret anything just with help of a click. The functionalities of this device are:

- It detects the human face which is standing in front of it. We first need to scan and load it into the database.
- It also detects the currency in the same way.
- It can convert written text into phonetic text.

Fig. 1 shows basic Aiding system for the blind and its use for object recognition. In that A) camera mounted on a wearable frame B) Object C) Headphone and D) Cable connecting the wearable system to the processing unit.

Figure 1: Aiding System for Visually Impaired People [1]

The rest of the paper is divided as follow. Section 2 presents the related work. The State-of-Art of proposed system discussed in Section 3. The methodology which includes the CNN technique and OCR model is presented in Section 4. Section 5 consists of various simulation results. The paper is concluded in Section 6.

II. Related Work

In this section, first we present a systematic survey of the state-of-the-art electronics glass architectures and its working. In [1], authors propose a novel method for automated identification of banknotes' denominations based on image processing is presented. This method is part of a wearable aiding system for the visually impaired, and it uses a standard video camera as the image collecting device. The method first extracts points of interest from the denomination region of a banknote and then performs an analysis of the geometrical patterns so defined, which allows the identification of the banknote denomination. Experiments were performed with a test-subject in order to simulate real-world operating conditions. A high average identification rate was achieved by this method [1].

Advancement of Technology has replaced humans in almost every field with machines was the first point of the authors [2]. By introducing machines, banking automation has enormously reduced human workload very proficiently. It is imperative to take care while handling currency, which is reduced by automation of banking. The identification of the currency value is hard when currency notes are blurry or damaged or withered. Convoluted designs are included to improve and increase security of currency. This certainly makes the task of currency recognition very difficult. To correctly recognize a currency, it is very imminent to choose the proper features and suitable algorithm. In this particular method [2], Canny Edge Detector is used for segmentation and for classification, NN pattern recognition tool is used which gives 95.6% accuracy.

In [3], authors describe the development of a human face recognition system (HFRS) using Multilayer Perceptron Artificial Neural Networks (MLP-NN). It is trained with a set of face images until it is in a "learned" state. The network is able of classifying the face input into its class [3]. In the case of the subject face is not one of those trained, the network will register it as anon. This system takes the face image as input from video camera, is also developed to notice the presence of an object in front of the camera and to search for the human face area automatically. The identified face area will then be used as the inputs to the neural network to perform recognition [3].

The paper [4] presents a more hardware-based solution to the problem of the visually weakened people in which an android system integrated with camera and USB laser is attached to the chest of the user. Device detects the classified image and it distance from the user providing with it a voice output.

Authors in [5] present a novel technique where visually impaired people are able to capture image in their android phone and through an application which is running on the deep learning principles. They have used VGG16 Model and used Flickr8k dataset [5] to train the model in generating output. So, system takes an image runs through a CNN module which encodes the image in different aspect and then using RNN and LTSM it generates a caption for the image. RNN is for the generating the highest probability of a word and LTSM for the complete caption.

In [6], authors make an effort to prepare a complete solution which helps blind or visually impaired people to navigate through an area which has obstacles. They have included an RGB-Depth camera which is used at 30 degrees to get the location of the obstacles using the floor segmentation method. Here they had an issue with transparent objects like glass or french door. So, to remove this issue they have also included ultraviolet sensors which transmit 8 cycles of ultrasonic burst at 40 KHz and wait for the reflected burst. It also has AR gear so that people who have not completely lost their vision can be helped. It uses audio for guiding the user. It also has feature of tactile feedback. Moreover, this paper has provided very good comparison on various data acquisition techniques.

In [7], authors have not prepared any hardware. It is more of a software-based paper. They have used Alexnet for training and testing. They have used two approaches 1) Transfer Learning and 2) Feature Extraction. Their major purpose was to make a hospitals and clinic for blind or visually impaired people friendly. So, authors have created their own database by taking real time pictures of a hospital doors, signs etc. They created the labels and gaussian noise images themselves. In this regard a pre-trained Alexnet model has been fine-tuned using the database they generated. Majority of the images were taken for training and remaining were taken for test set. Learning rate was kept 0.0001, epoch of 20 and minimum batch-size of 128. They have made comparison between TL and FEX. They are able to get good precision of almost up to 98%.

In [8], It has used 6-axis MEM (micro-electromechanical sensor module). Infrared transceiver has been used to detect object. It also has Wi-Fi and Bluetooth connectivity in the proposed solution. With the help of MEM, it detects an object and in case the blind person collides with an object then a message will be sent to guardian or caretaker for the same, and that location will be marked. For messaging and location purpose authors have also generated an application.

Object detection performance, as measured on the canonical PASCAL VOC [9] dataset, has improved tremendously in the recent years. The better performing techniques are complex ensemble systems that typically combine numerous low-level image features with high-level context. In [9], authors propose a simple and scalable object detection algorithm that helps to refit mean average precision (mAP) by more than 30% relative to the previous best result on VOC 2012—achieving a mAP of 53.3%. Their approach combines two insights: first of all, one can apply high-capacity CNN to bottom-up region proposals in order to localize and segment objects and secondly when labeled training data is very less, supervised pre-training for an auxiliary task, followed by domain-specific fine-tuning, yields a significant performance increase. Since they combine region proposals with CNNs, they call their method R-CNN [9]: Regions with CNN features.

III. State-of-Art Proposed System

Single Board PC: NVIDIA Jetson TK1 Developer Kit:

This hardware is much useful as it is very handy when it comes to training and running CNN models. It is also lightweight, easy to wear and portable. It also supports CUDA which will help in training the model more efficiently and quickly. The NVIDIA Jetson TK1 development kit is a full-featured platform for Tegra K1 embedded applications. With the power of 192 CUDA cores, it will use to develop cutting-edge solutions in Computer Vision, robotics, medicine, security, and automotive. Fig. 2 Shows wearable NVDIA Jetson developer kit.

Figure 2: NVIDIA Jetson TK1 Development Kit

Camera: SainSmart IMX219 AI Camera

This camera module is designed for NVIDIA Jetson Nano Board. It is with 8-megapixel IMX219 sensor and features the 85-degree field of view and supports 1080p at 30 fps, 720p at 60 fps and 640 x480p 60/90 video recording. With the power interface, it also supports 3.3V output power supply. Fig. 3 shows lightweight high-resolution camera which works very great in real-time.

Figure 3: SainSmart IMX219 AI Camera

System Block Diagram and System Flow Chart

Fig. 4 shows block diagram explains the basic view of the hardware connection in the simplest manner. Flow chart of system gives a brief understanding of the process which is followed shown in fig. 5.

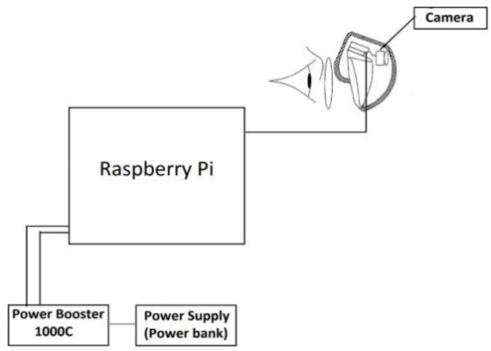

Figure 4: System Block Diagram

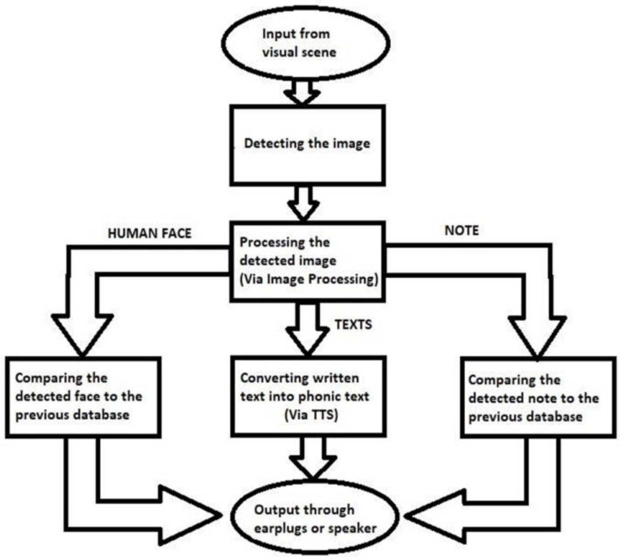

Figure 5: Working Process of System Flow Chart

IV. CNN Model and OCR

CNN stands for Convolutional Neural Network; it is one of the easiest yet a very powerful neural network which can be used for object detection or classification process. The term "deep" is used as there are many hidden layers in the neural network. It can contain up to 150 layers. These layers are trained using a large labelled dataset. One of the easiest ways of tagging the database is to save the different images which are to be classified or detected in different folders. This process makes them different classes. This way the model learns features directly from the data and it does not require manual feature extraction. A CNN convolves features with input and uses 2-dimensional layers; making this architecture well suited for 2-dimensional data such as images. It has the automatic feature extraction which is learned when the model is fed a collection of images. The working of CNN shown in fig. 6.
Tesseract is on the most powerful and advanced OCR software can be used easily and provides almost error-free results. It is one the most efficient way to convert image to text. It can also be

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executed from command line interface.

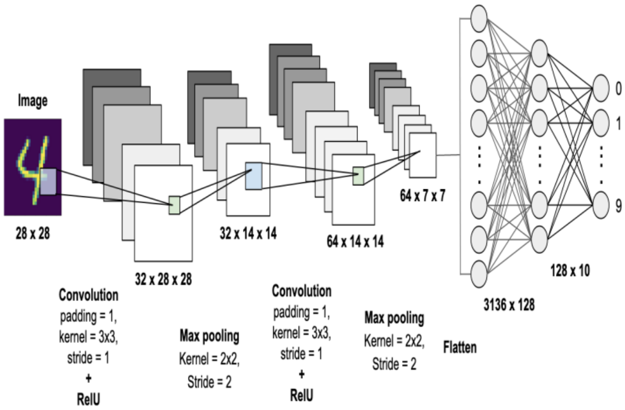

Figure 6: CNN Model

Dataset

First, to train neural network model, it needs to make a dataset. There are ways to make a database, it can even download a whole database or even download weights of a pre-trained model for the prediction purpose, here we have made a data base using images from the source IMAGE-NET. For that we have captured the images using the camera for face recognition part. For the currency recognition we have used the online database.

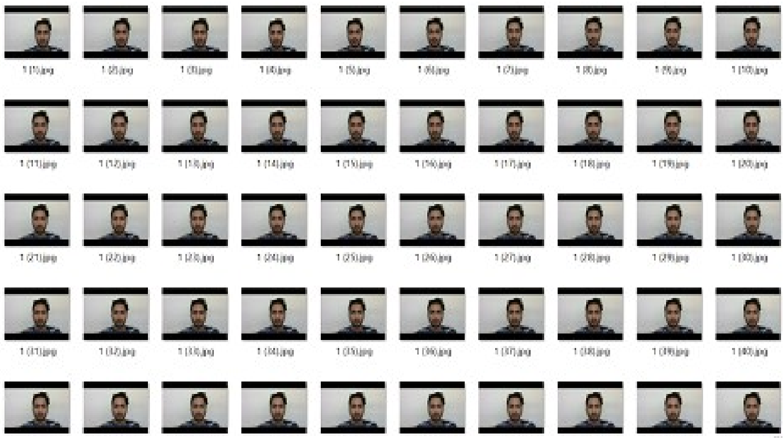

Figure 7: Database

Loading a Dataset and Information of the Model

Loading a Dataset: We are able to make a dataset of 2000 images which has 500 of both the categories. (Here we have used only 500 per category otherwise it can be made of even more images.)

Model: Now will move forward towards building a convolutional neural network. Input of my model is 3x100x100. (3 as RGB and 100x100 is the size of my image). We have used 4 layers for both the face and currency recognition. Given image gives more information regarding the model. Max pool layer helps in making the feature detection independent of noise and trivial changes like image rotation or tilting, shown in fig. 8. It is based on the sliding window concept, in which it applies a statistcial funciton over the values which are specified as window also known as kernel. Max pooling takes the maximum value within the filter of convolution. ReLU is short for REctified Linear Unit and is a type of activation function shown in fig. 9. Mathematically, it is defined as y = max(0, x).

Figure 8: Maxpooling Method in CNN

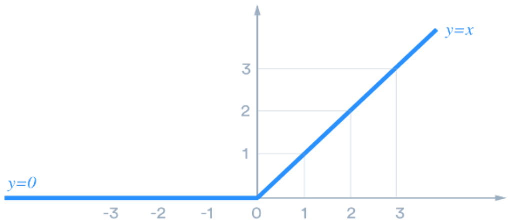

Figure 9: RELU Activation Function

Linear layer is used to convert the data into linear function which then makes it much easier for classification.

V. Simulation Results

To implement this model, we have used following simulation tool shown in table 1.

Table I. Simulation Tools

Model	**Simulation Tools**
CNN	Pytorch
Computer Vision	OpenCV
OCR	Tesseract

We have defined various parameters such as learning rate, momentum of that learning rate, type of optimizer, type of loss function etc. Training the model is the most important step. Here we have trained the model twice in the same epoch that is in one iteration of loop with the training dataset and cross-validation dataset. Adding further we found the accuracy and loss curve to fine tune our model.

Once the model is trained, we can use it to predict the different faces and currency. We have used the same model for the both the purpose as it works perfectly in both the instances. For currency we have used dataset of 10, 20, 50, 100 rupees notes (Indian Currency). Here, 25-epoch, Adam optimizer with 0.001 learning rate and Cross Entropy Loss used for face and currency recognition model. Accuracy of face detection and currency recognition is around 95% and 90%, respectively shown in fig. 10 and fig.11.

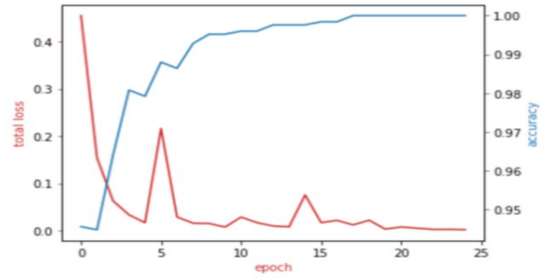

Figure 10: Face Recognition

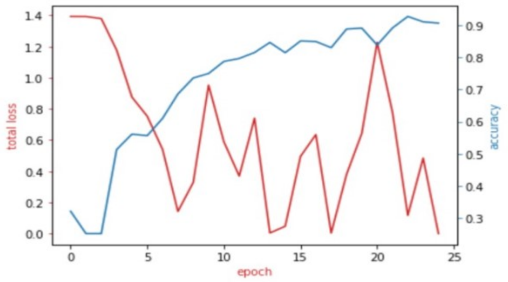

Figure 11: Currency Recognition

VI. Conclusion and Future work

This paper shows a novel methodology, CNN with OCR for recognition of face and currency denominations via image processing. The proposed method is fast, efficient and robust with respect to the way in which the object is presented to the system. Simulation is conducted over 500 images. Here, database is trained using CNN, which gives 95% and 90% classification accuracy for face detection and currency recognition respectively. In the future we have planned to design improvements with the objective of making it even more efficient and robust by currencies of different countries can be added which makes it applicable globally and instead of using OCR a model, RNN and NLP engine can be made to complete the task of image to text.

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RISK ANALYSIS AND MITIGATION TECHNIQUES IN HIGH RISE BUILDINGS: A REVIEW

Umesh Ishvarbhai Patel, Dr. J. R. Pitroda

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Construction Engineering and Management Department,
BVM Engineering College, Vallabh Vidyanagar, Gujarat, India
up5322739@gmail.com

Abstract

Risk is an integral aspect of any significant project. Risk is present in every project, whatever its size or industry. No project is entirely risk-free. If threats are not adequately assessed and plans for coping with them are not established, the project will likely lead to failures. One of the greatest building projects which Plays an important part in growth of the country. It is projected that the high- rise (or) multi-story buildings are the most significant part of the architecture for the greater development. The greater part of the building goes up to high towers. Therefore, the risk involved in this section of the construction industry also scores lower. Risks in building projects are considered one of the most common problems with a range of negative effects on building projects. And when the triggers are known can the risks of the building be significantly reduced. This work aimed to analyses the risk evaluation when constructing high-rise buildings.

Keywords: Analysis, Building, Construction, Mitigation, Monitoring and Control, Risk Identification

I. Introduction

Risk management theory has become very common in a lot of enterprises. Many organizations also establish risk management procedures for improving performance, minimizing losses and increasing profits in their projects [1]. Risk incidence on another project is different from that on another project. Similarly, in each The extent of occurrence and effects of a project often vary from project to project. The board finds it difficult to tackle new projects with risks. There is a lack of risk management, sometimes inadequate risk analysis, that can place projects under construction.

Risk: Danger is described as an explanation of the consequences of uncertainty. Danger is typically referred to as an unwanted event which can be described and quantified by its effect and occurrence possibility. The classical risk definition states that, Risk = Probability x Impact; A probability of occurrence of that event.

Risk Assessment: Risk Assessment is the process by which the identified risks are assessed and eligible for those risks. Increasing risk will be assessed for its probability of occurrence and its effect on scheduling, expense, scope and performance / quality. This will combine probability and affect the overall magnitude of the risk is determined.

A. Need of Study

There are very different standard storied buildings and high-rise buildings. Thus, the tasks involved starting from the planning stage will have an impact on project execution. It will include sustainable infrastructure development around the building. Detailed planning for the building services and facilities at all construction phase will be required. The safety standards increase drastically, the management requirement all.

Other factors that favor this are:

1. Exponentially rising urban population, raising demand for high-rise housing.
2. The human factors are neglected, at the expense of quality of life.
3. Fixing new research goals in this specific field.
4. The new information about high-rise buildings must be accessible to the professionals. Above points justify considering the management of high-rise buildings as different from ordinary.

B. Objectives of Study

Following are the objectives of conducting this study.

Determine the most effective methodology for high-rise development by analyzing, evaluating, and determining the best way to manage the project along with cost efficiency.

Only when their cause is identified can the construction risks be mitigated.

This study was aimed at research the risk assessment when constructing high-rise buildings. About the equipment used only to fight the fire.

II. Literature Review

Following are the literature review based on Risk management and mitigation strategies in high rise buildings and its effects.

According to **V.Sakthinivedithaet al. (2003)** concluded that Building projects are one of the most important projects which play a vital role in the country's development. It is estimated that for the greater development, the high-rise (or) multi-story buildings are the most essential part of the construction.The larger part of the building leads to high-rise towers. Hence the risk involved in this part of the construction industry also ranks higher. Risks in construction projects are considered one of the most common issues that cause a number of negative effects on the construction projects.Building risks can only be minimized when the cause is known. The aim of this study was to research the risk assessment when constructing high-rise buildings. This study was conducted based on a review of the literature and a questionnaire.The data for this research will be gathered through a detailed survey of questionnaires. The questionnaire consists of two sections and the first section consists of general questions, the second section contains the list of major risks and the sub-risks involved. This work focuses on identifying and assessing the risks in high-rise buildings, and enhancing the risks that occur during building construction. [10]

Ming-chunLuobet al. (2014) found that High-rise building risk analysis is of critical importance as there is still a lack of a systematically efficient extinguishing Method to ensure safe evacuation. A case study for a super-highrise building is being conducted to expatiate the procedure and methodology for fire risk assessment of super-high-rise buildings. This paper quantifies both the likelihood of the fires and their effect.[8]

R Kathiravan et al. (2014) managed risks in Building projects have been recognized as a very important management process for achieving Timing, cost , efficiency, safety and environmental sustainability goals for the project. Project Risk Control in the past few years has been the topic of intense discussion. The goal of this paper is to identify and analyse the risks from project participants and life cycle perspectives and their impact on time and cost associated with the development of construction projects in terms of human safety. This can be done by calculating the lab productivity rate and by analysing the work force's company's objectives. [9]

E.R. Gokul Surjith (2014) integrated thatBridge construction projects are initiated with complex and competitive problems resulting in high complexity and risk circumstances intensified by time- and cost constraints.Their work aims to identify and evaluate the risk factors that influence bridge project performance as a whole through use of appropriate methods and techniques, and to develop a risk management process.[4]

AratiChougule (2015) identified theTechnological risks, building risks, socio-political risk, risk to the community, risk to the management. Risk is an important part of any single project. Risk is present in every project regardless of its size or industry.No project is completely risk-free. The project is likely to lead to failures if threats are not adequately assessed and plans are not built to deal with them. The data were gathered with sufficient knowledge from seasoned staff In the construction sector. The object of this review is to identify critical factors affecting the construction projects and their correlation. This paper presents the factors with the highest likelihood and/or effect that statistics on any project and correlation between them. [2]

Hanish Verma et al.(2017) concluded thatHigh-rise structures, which have the potential to ease congestion urban sprawl, are also called 'vertical cities.'Indian cities experience massive growth in population as a result of population growth from nearby villages, resulting in urban sprawl, demand for housing, rise in land costs.Housing grew into a sector-generating economy. Construction projects are one of the most important which plays a vital role in the country's growth. It is projected that for the greater growth, the high-rise (or) multi-storey buildings are the most important part of the design.Given this demand, although high-rise residential structures in the metropolitan cities have become a solution, they remain eluded in India's Tier II cities. High density dwelling styles in these cities have grown to be low-rise or mid-rise. Only when their triggers are established will the building hazards be minimised.The aim of this study was to research the risk assessment when constructing high-rise buildings. This study was conducted based on a analysis of the literature and a questionnaire. The bulk of high-rise buildings always exist as plans.In this case study, an investigation shows The high elevation buildings are not preferred because of the consumer's perception of fire danger and high construction costs. The techniques used in this study will help to identify risks. [5]

ImayantiBasari (2017) Increasing space and limited land requirements are causing numerous high-rise construction projects in Indonesia, particularly in big cities. Building projects and high-rise construction projects are situated in large and varied environments contributing to high rates of complexity and danger. Building project uncertainties are often present and also contribute to delays or cost failures. In a number of companies, the concept of risk management is becoming very popular. Most organizations also develop risk management processes for enhancing efficiency, reducing losses and growing profitability in their ventures. Danger occurrence on another project is different from that on another project. [6]

Leenu Paul (2018) Risk management is an instrument for defining and managing certain risks in a project And with adequate care. This study's methodology depends on the questionnaire survey that was gathered from the local high-rise construction contractors. pilot study and interviews are conducted to identify the risk factors which affect the construction industry 's efficiency. A total of 24 risk affecting factors in three divisions are identified through pilot study and from expert advice. The risk management and assessment can be improved by combining qualitative and quantitative methodologies to analyse the risks.[7]

Ahsan Nawazet al. (2019)conclude that Building is an extremely dangerous business that lacks a good reputation for risk management. But as a result of increased rivalry and construction activities This gradually gives it more meaning. The research indicates that, in the sense of locality Low- level risk control was applied. The findings also indicate that there is a greater degree of correlation between positive risk management and project efficiency. The results demonstrate the importance of risk management techniques, their use, involvement and effect on the performance of the contractor's construction projects point of view, thus encouraging the main project participants to use risk management. [1]

Pitroda et al. (2019) given Information on Identification of risk factors and expectations of Indian construction professionals, i.e. contractors, owners, project managers and engineers, on the importance of different construction risks and how the risks should be shared among contracting parties. Risk management is the approach that covers evaluation risk analysis with the aid of responding qualitatively and quantitatively with the appropriate management and control technique. The term has acquired prominence in various industries. The system is also used in different companies for improving their output in their ventures to reduce their losses and improve their profits.The questionnaire sample is evaluated with the use of the Relative Importance Index (RII) tool for customers, contractors, engineers and architects.We concentrated on understanding Risk management system for construction projects and offering in-depth information on the use of risk management in high-rise building projects. [3]

III. Risk Management

A. Risk Management Processes

Risk management is the structured mechanism by which possible project threats are identified, evaluated and reacted. It involves optimizing The probability and impact of positive events, and the risk and effects of negative events on project goals are that. Each section defines the project risk management process. Risk management will be discussed in two ways as follows:

Creating a General risk perception within the project organization such that it is taken into account in All Teamwork areas.

Defining, assessing and mitigating risks, considering contingency plans and reporting the risk to the project using an active risk management protocol.

The Processes for Risk Management include:

1) Risk recognition – define and assess which risks may affect the goals of the project and record the characteristics thereof;
2) Qualitative risk assessment-perform a qualitative risk assessment to determine its effect on project objectives;
3) Quantitative risk assessment — Measure the likelihood and effect of risks and calculate their impact on project goals;
4) Risk Management Preparation — Designing strategies and methods to reduce risks to project goals;
5) Hazard management and control — Surveillance of residual risks, identifying possible hazards, taking measures to minimize the probability of occurrence and impact of each danger, and assessing the effectiveness of the hazards interventions over the lifecycle of a project.

The Risk Management process should be conducted to track and manage the probability and effect of project risks.

a. Risk Identification

Based on previous experience (implant training), expert opinion (literature review) and expert assessment, the risk recognition strategies are as follows:

a) Technical Risks
b) Environmental risk
c) Financial risk
d) Socio-political risk
e) Construction Risks
f) Management risks

b. Risk identification Techniques

Risk Identification can be done by the following methods:

1) Brain storming: It is one of the most sought-after methods. It's usually used for producing ideas; it's also very useful for detecting threats. All relevant project-related persons meet at a single location. There is one facilitator who briefs with the participants on different issues and then takes note of the variables. The facilitator checks the variables before closing it exclude the unwanted ones.
2) Delphi technique: Strategically thinking about HRM allows a company to look beyond the here and to understand the external and long-term factors that are likely to impact its business over the coming years. There are six main characteristics of a strategic HRM strategy that include a structure of SHRM formulation criteria and we're addressing them in relation to the construction below.
3) Interview /expert opinion: Experts or workers with ample project expertise may be of great help in consistently avoiding / resolving similar problems. All project participants or related individuals may be interviewed for the identification of risk-influencing factors.
4) Past experience: The analogy for the identification of the factors can be built from previous experience with the same kind of project. When comparing project characteristics, insight will be provided on the common factors. Check lists: These are predetermined basic yet very useful lists of variables that are possible for the project. The checklist, which includes a list of the risks found in previous projects and the responses to those risks, offers a head start in the identification of risks.
5) Check lists: These are basic yet quite useful, predetermined list of possible factors for the project. The checklist, which includes a list of the risks found in previous projects and the responses to those risks, offers a head start in the identification of risks.

c. Risk Assessment Procedure

1) Identify the hazards
    a. Walk around the workplace;
    b. Look at the work habits, location, equipment used, substance exposure;
    c. Speak to staff, administrators and students;
    d. Consider recent accidents/incidents.
2) Including board of directors, staff, teachers, young people, guests, vendors, cleaners, new mothers and expectants.
3) Evaluate the risks

When managing risks, a systemic approach should be used to determine which control measure to enforce, taking into account the general control hierarchy as follows

a. Elimination: The danger is built or mechanized.
b. Substitution: Use the less hazardous material / substance.
c. Engineering controls: Install ventilation systems, fixed guarding systems, sound fittings.
d. Signs, Warnings and administrative controls: Install detectors, safety protocols, barriers, checks, access controls.
e. Personal Protective Equipment: Hearing security, protective glasses, face masks, gloves.

4) Report and enforce your findings:

a. Document evaluation on the College risk assessment form.
b. Archive Reports on Connected.
c. Ensure that any further steps needed are completed and the assessment is updated accordingly.
d. Communicate reports to employees and any other person(s) influenced by the work activities.

5). Review Assessment

Assessments should be assessed every 2 years, or sooner, if the assessment is suspected of no longer being accurate.

d. Risk Analysis

Risk analysis, the next step in the risk management process, explores the causes and consequences of risk management the accidents that cause harm.

The purpose behind such an analysis is a precise and unbiased assessment of the risk. Risk analysis seeks to try and capture all possible options and to determine the various consequences of each decision.

Based on the answers obtained from different respondents to the questionnaire, the study was carried out using the Social Science Statistical Kit to assess the percentage of each risk.

B. Benefits of Risk Management

1. Risk management leads to a deeper understanding of and prevention of potential effects resulting from unmanaged risks.
2. The benefit of collaborating with risk management is greater control of the entire project and more efficient methods of problem solving.
3. There’s better quality data for decision making
4. It’s easier to spot projects in trouble

IV. Risk Mitigation

Mitigation: The purpose of mitigation is to reduce the risk and/or effect of a danger to below an acceptable level. Early intervention to avoid a danger is more successful than attempting to rectify the aftermath after it occurs. Considering the possible effect and likelihood of the risk, mitigation costs should be reasonable.

It is the last method of risk management which includes the application of risk response to the risk. To ensure they are successful, all responses to risks have to be monitored and reviewed.

Risk responses should also be reported thoroughly for future reference and appropriate updating of project plans. Because of the possibility all necessary changes in schedule, budget etc. should be reported and modified in the project plans. Risk management should be a continuous process where the risk impact is calculated and assessed again.

Risk Monitoring & Control: Risk monitoring and control tracks known threats, measures residual risks and detects new risks – ensuring that risk strategies are followed and measuring their efficacy in risk mitigation.

Risk monitoring and control is a process that continues for the life of the project. Following on from Fig.1. And Ill.2. Displayed criticality of work at such heights and its protective steps for staff.

Fig. 1. Working at heights

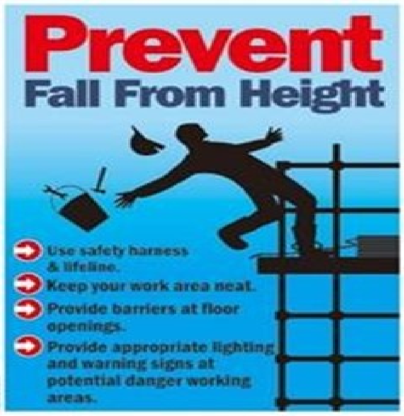

Fig. 2. Prevent fall from height

V. Case Study

Case Study 1

This case study is on occurrences of Risk management of ventures at high-rise buildings in Saudi Arabia.

Locaion: SAUDI ARABIA

General: Risk management preparation is the method of deciding how a project will be handled and risk management activities planned. Planning for the resulting risk management processes is necessary to ensure that risk management level, type, and visibility are proportionate to Risk as well as value of every project.

The main risk management goals as described by a risk strategy are:

a. Identifying a baseline risk level in a project;

b. Use of common risk management practices throughout a project;

c. Determining, evaluating and determining a project's risk with respect to its probability of occurrence and impact, e.g. time, expense, scope and quality / performance.

Data Analysis by Relative Important Index (RII) Method

Data collected from the survey questionnaire were analysed with use of the Relative Importance Index method to rank each factor from an engineer, architect, contractor and owner perspective.Table 1 shows the ranking of overall response by RII method for risk factors.

TABLE 1. RANKING OF OVERALL RESPONSE BY RII METHOD FOR RISK FACTORS

ID	Factors	RII	Rank
A	**Design**		
A1	Defective Design	0.705	6
A2	Awarding the Design to Inexperience Designer	0.675	11
A3	Inaccurate Quantities	0.657	15
A4	Design Changes	0.673	12
B	**Physical**		
B1	Occurrence of Accidents Because Of Poor Safety Procedures	0.649	18
B2	Supplies of Defective Materials	0.625	22
B3	Security of Material and Equipment	0.596	29
B4	Varied Labour and Equipment Productivity	0.652	16
C	**Logistics**		
C1	Improper Site Investigation	0.636	21
C2	High Competition in Bids	0.712	5
C3	Poor Communications Between the Site and Head Offices	0.689	9
D	**Legal**		
D1	Ambiguity of Work Legislations	0.327	35
D2	Difficulty to Get Permits	0.586	31
D3	Disputes Among the Parties of Contract	0.625	22
E	**Environmental**		
E1	Adverse Weather Conditions	0.622	25
E2	Difficulty to Access the Site	0.689	10
E3	Natural Calamities (Floods, Earthquakes, Fire, etc.)	0.723	4
F	**Management**		
F1	Poor Communication Between Involved Parties	0.689	8
F2	Improper Planning	0.692	7
F3	Changes in Management Ways	0.651	17

F4	Information Unavailability	0.617	26
F5	Material Management	0.746	3
F6	Equipment Management	0.668	13
G	**Cultural**		
G1	Religion	0.222	38
H	**Financial**		
H1	Delayed Payments on Contract	0.779	2
H2	Unmanaged Cash Flow	0.591	30
H3	Inflation	0.485	33
H4	Financial Failure of the Contractor	0.791	1
I	**Construction**		
I1	Gaps Between the Implementation and the Specifications.	0.638	20
I2	Actual Quantities Differ from the Contract Quantities	0.361	34
I3	Lower Work Quality in Presence of Time Constraints	0.604	28
I4	Undocumented Change Work Orders	0.662	14

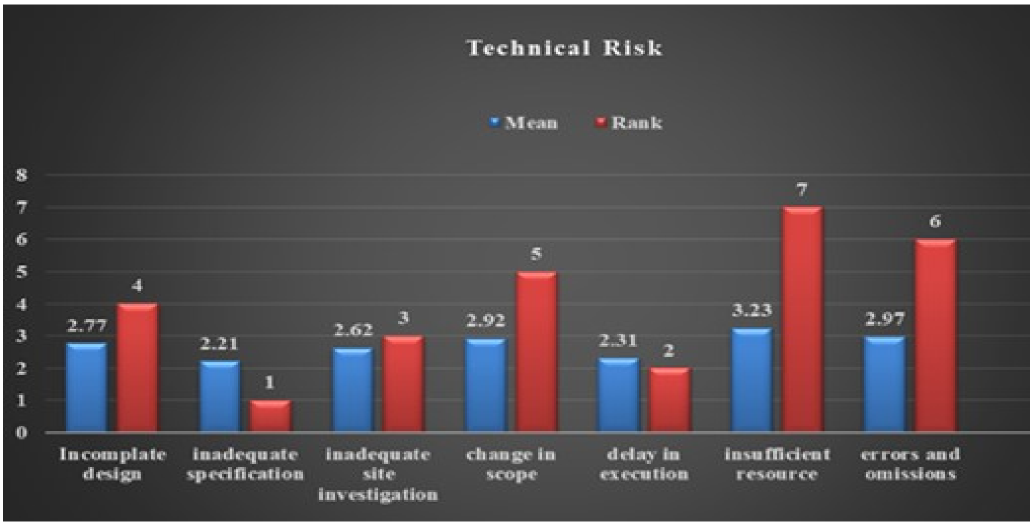

Fig. 3. Technical risk factors

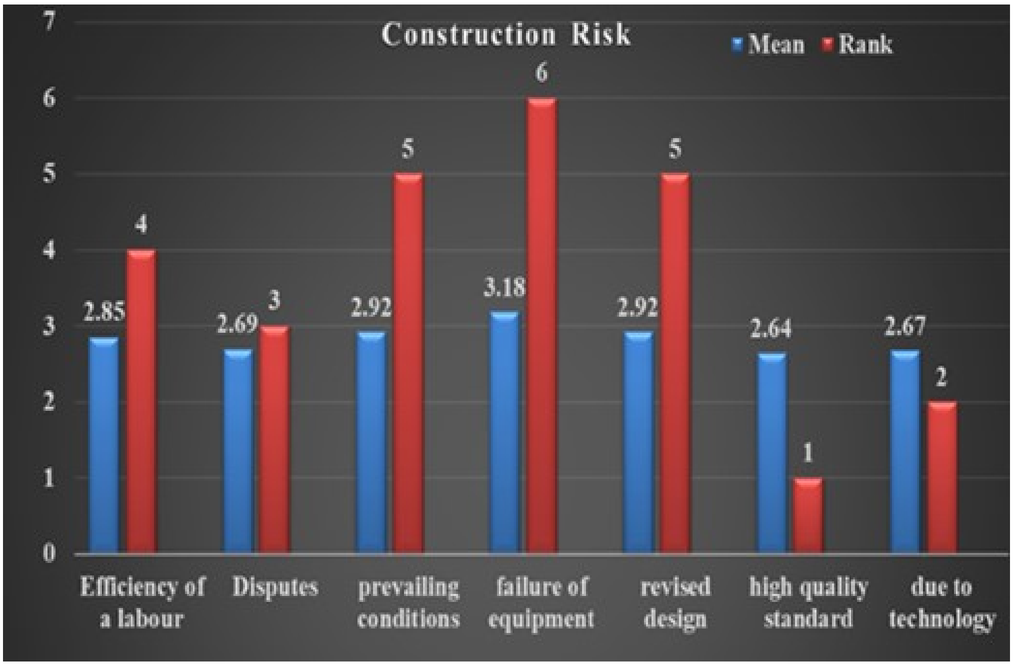

Fig. 4. Construction risk factors

Fig. 5. Management risk factors

As above fig. 3,4,5 is shown risk factors of technical, construction and management field respectively with their mean and rank as per surveyor's survey.

Result: The top five risk factors affecting high-rise construction projects are described below, taking into account all responses.,

1) The contractor 's financial loss to the interest of RII = 0.791

2) RII-value material management = 0.746;

3) Natural calamities have a RII value = 0.723

4) High bidding competition with the value 'RII = 0.712

Case Study 2

This Case Study on Risk Inentification and Assessment In Construction of High rise Building in kerala

Location: kerala, india

Factors Influencing Risk

Risks associated with the construction industry can be broadly categorized into:

Table- 1: List of risk influencing factors

External Risks	Project Risks	Internal Risks
Union issues	Obsolete technology & Tools	Type of contract
Bribery & Corruption	Knowledge on equipment	Delay in license and permits
Fluctuation of raw material prices	Designing errors	Cost overruns
Scarcity of materials	Non availability of resources	Environmental regulations procedure
Shortage of labors	Labor accidents	Differing site conditions
Unpredicted weather conditions	Defective work/Rework	Late changes in design

Results And Discussions

Risk factors on the construction projects are divided into three groups: External, Project and Internal. The following graphs show the impact of risks in high-rise building construction.

Chart-1: Impact of external risk factors

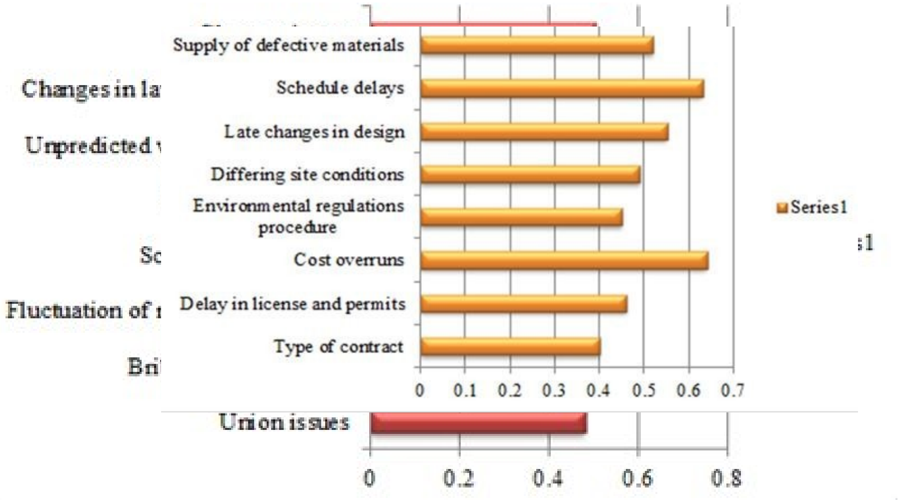

Chart-2: Impact of project risk factor

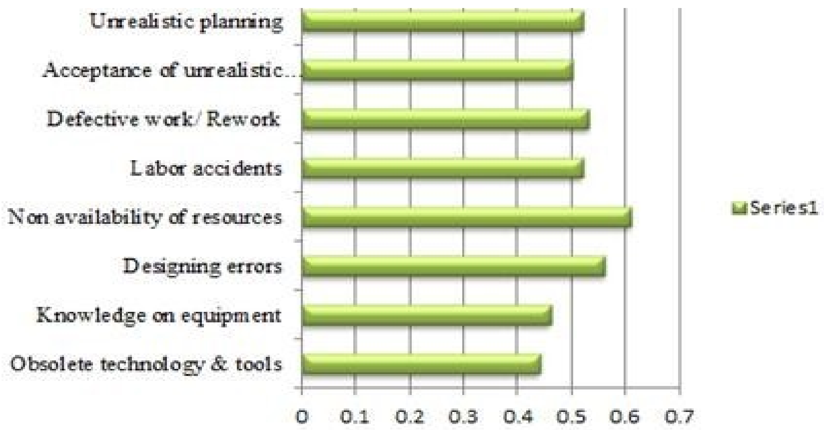

Chart-3: Impact of internal risk factors

Scarcity of materials, Non availability of materials and cost overrun are the high impact risk factors in external, project and internal risks respectively whereas bribery and corruption, obsolete technology and tools, Type of contract are the factors having less impact in external, project and internal risks respectively.

Risk Mitigation

The Project Manager determine appropriate metrics for the project,ensuring they are not burdensome and do not affect behaviour. Results of the analysis need to be communicated and adjustment made through a change management . Comparable to risk reduction, risk mitigation takes steps to reduce the negative effects of threats and disasters on business continuity (BC).

VI. Conclusions

1) In order to reduce their effect on Highrise construction projects, engineers should pay special attention to issues related to material handling, inadequate preparation and coordination between the parties involved.
2) Specific consideration should be paid to the issues of faulty construction and coordination between the parties involved by the developers, contractors, in order to reduce the effects on the effect of high-rise building projects.
3) Risk management is an integral part in the process of construction. The correct identification and assessment of risk factors are the critical procedure for the success of the project. A total of 24 risk affecting factors in three divisions are identified through pilot study and from expert advice.
4) Engineers and contractors are urged to pay careful attention to resource control, proper preparation and coordination between the parties concerned.
5) Particular attention should be paid by the owner on issues related to outstanding payments, awarding the design to the inexperience designer, awarding contract to the financially incapable contractor, contact between the parties concerned.

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CONSTRUCTION FINANCE AND ACCOUNTING: A REVIEW

Rahul Nitinbhai Bhadeshiya, Dr. J. R. Pitroda
•

BVM Engineering College, Vallabh Vidyanagar, Gujarat, India
rahulbhadeshiya@gmail.com

Abstract

Finance is one of the major part of construction industry. Because without finance on project cannot be start. It is also essential that from where the finance come from and how to manage the available finance and have a track on it. To track them cash flow is used and to manage accounting is foremost. In which earned value and break-even point is comes handy. Earned-value analysis helps to identify the project status depending on the cost and schedule variance and performance index. Delays in construction projects are a common phenomenon and a costly issue. The underlying triggers and discusses effective preventive measures for disruptions in the financial phase. Four main reasons have been identified: late payment, weak cash flow control, insufficient financial capital, and financial market volatility. In which weak cash flow control is the most important factor contributing to a pause in the project, accompanied by late payment, scarce financial capital, and financial sector volatility.

Keywords: Construction finance, Construction accounting, Cash flow, Break-even point, Earned-value analysis

I. Introduction

Finance is defined as money management which involves spending, borrowing, lending, budgeting, saving, and forecasting practices. Where Construction Finance is the solution that provides immediate and ongoing working capital across various stages of a contract for a construction sector.

In the construction sector, domestics, macroeconomics, product prices and a variety of other variables under control of the industry are heavily affected. These factors make lending money to construction firms relatively risky for mainstream institutions like banks. The major, inevitable reality is that the financing for a construction project is not cheap. An apartment block cannot be bootstrapped. Materials, manpower, insurance, conflict settlement and the very fact that projects beginning now would be at the whims of the economy in two or three years ' time, which will create a very different market climate, which means that for every big construction project to get off the ground, the companies involved need liquidity and resources.

In a world where contracting and subcontracting are normal, construction companies are often forced to wait for work to be paid for. You can have to wait 30, 60 or even 120 days in certain serious cases. And this is in addition to having to pay for supplies, hires of equipment and salaries.

Factoring payment systems have been developed to ease cash flow for construction companies by allowing cash payments protected against the company's payment applications. This is a form of factoring that enables companies to obtain an advance on much of the payment for completed work. It can be used to help finance the next new venture, to provide cash for new machinery or supplies, to help pay suppliers early and benefit from economies of scale discounts that could have been previously out of reach.

A. Sources

There are number of sources for finance came. These can be from private to government, each source has its own benefits and drawbacks.

These are some examples of financial sources for construction industry:

1) Firm Investment
2) External Stakeholders
3) Foreign Direct Investment
4) End User
5) Owner
6) Government Sector
7) Loan
8) Bank Syndicates

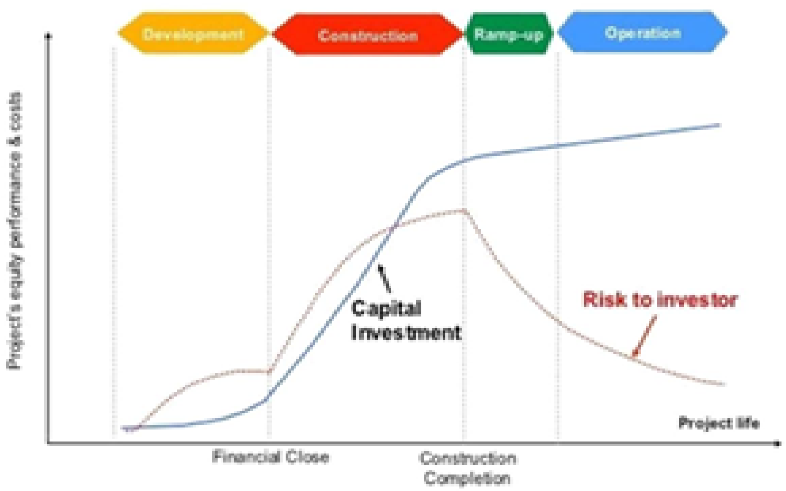

Figure 1: *Financial requirement as per phase [6]*

B. Financial Requirement

1) Development:
In development phase, requirement of finance is low due to in this phase planning is going for the infrastructure, so risk of investors high compared to investment.

2) Construction:

During construction phase use of finance increased rapidly because of bills of materials, labors, machines, and other essential things. With finance risk of investor is also increased because their money is used in ongoing project and this project will decide the future of their money.

3) Ramp-up / Closing:
Up to this phase approx. 80% - 90% of finance is utilized in the project. This phase is especially important for investors because risk involves in project drastically decreased over time.

4) Operation:
It is usage phase of infrastructure, in this phase finance is utilized for the maintaining of structure. This phase is for long time with less finance and lowest risk.

II. Time Value of Money

Time value of money is one of the most fundamental principles in finance. Time value of money (TVM) is the concept that money you have now is worth more than the same amount in the future because of its potential earning power. The central theory of finance is that the money given will generate interest, every sum of money is worth more the faster it is earned. TVM is often referred to as the present discounted value.

A. Equations

$$\text{Future Value (FV)} = \text{Present Value (PV)} \times [1 + \frac{i}{n}]^{(n \times t)} \quad (1)$$

$$\text{Present Value (PV)} = \frac{Future\ Value\ (FV)}{[1+\left(\frac{i}{n}\right)]^{(n \times t)}} \quad (2)$$

FV= Future Value of Money

PV = Present Value of Money

i = Interest Rate

n = Number of compounding periods per year

t = Number of years

B. Example
If you won ₹ 10,00,000 and you have two payment options:

A) Receive ₹ 10,00,000 in one year with 2% interest,
B) Receive ₹ 10,00,000 now.

For, option A:
₹ 10,00,000 with 2% interest for 1 year

$FV = 10,00,000 \times [1 + (\frac{2\%}{1})]^{(1 \times 1)}$
FV = ₹ 10,20,000

For, option B:
₹ 10,00,000 at a time

In this option idea is to take money and put it for same time but with different amount of interest.

₹ 10,00,00 with 5% interest for 1 year

$$FV = 10,00,000 \times [1 + (\frac{5\%}{1})]^{(1 \times 1)}$$

FV = ₹ 10,50,000

From this example its visible that having money now is much better than later. It can be applied to construction industry.

C. Compound Interest

There is no point in investing money unless it rises faster than inflation. It is easier to invest money now because it's worth more. A regular bond returns a flat percentage of the principal value each year, which is basic interest. In that case, if you had a 5 % annual interest rate on a ₹1,000 face value bond, you would get ₹50

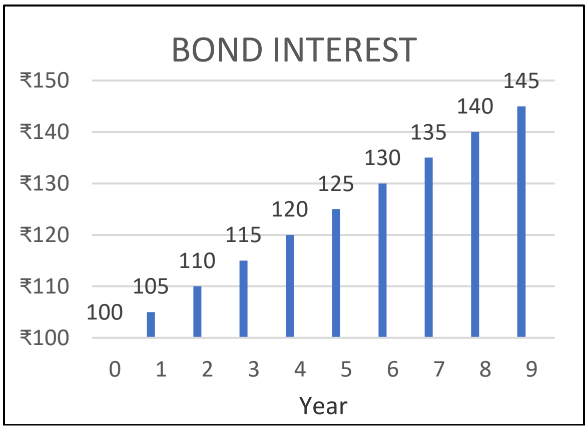

Figure 2: *Bond interest*

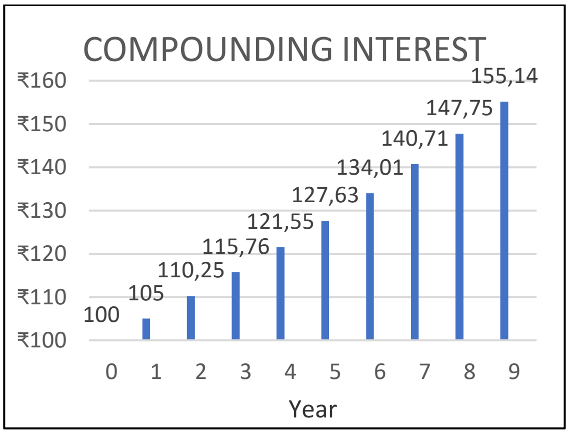

Figure 3: *Compounding interest*

If you look at investment as a share, you expect the average percentage rate to be 5% a year, or 7% if you consider the dividends. When you have a stock of ₹100 that has risen by 5 per cent by the end of the year, you have $105 in the compounding era. By the end of year two, another 5% has risen and is worth ₹110.25. Although that is just an additional 25 cents, in this case for a long period of time and with huge dollar amounts, it might end up being a lot of money.

III. Managing Finance

After receiving finance from different sectors for project it's essential to manage that amount utilized it with care and having log of that. The financial manager is responsible for making sure that the organization's financial resource is handled wisely.

Financial manager's responsibilities:

1) Making sure that project and general overhead costs are accurately tracked through the accounting system.
2) Ensure that a proper accounting system has been developed and that it works properly.
3) Projecting the unbilled committed cost — costs that the organization has agreed to paying but has not provided a bill for — are included in these estimates.
4) Determine whether the project is over or underbalanced.
5) Ensure that the correct financial statements have been prepared.
6) Reviewing the financial statement to ensure that the company's financial structure is in line with the rest of the industry and trying to identify potential financial problems before they become a crisis.

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B. Ways to manage finance

There are several ways to manage available finance:

1) Make a payment schedule:
By managing payments from clients and ensuring an agreement occurs, so you have certainty of payment will certainly make finance run in the right flow. Having good sales records and regular billing makes it easier to manage finances and monitor the revenue you receive each month.

2) Pay in advance:
Avoid using company funds for each project that is run. Try the billing contract agreement at the outset, so that more financial risk is borne by the client, not the contractor. This kind of agreement takes you away from bad financial risks. The payments you receive in advance can be used to do more structured and efficient work planning.

3) Manage material effectively:
Ensuring that materials are properly managed and regulating their use effectively and efficiently will reduce the excessive costs that must be incurred by the contractor. The management of these materials would be simpler by using program which can track the availability and usage of materials in different projects. Using the Inventory System makes it easy for you to manage material so that you can manage the material outflow that will be used to run the project you are holding. Also manage well the use, so as not to waste the budget for the purchase of excess basic materials, or unnecessary.

4) Oversee worker's activities:
Monitoring the activities of workers so that the project can be completed properly and efficiently is not an easy job. How much work time is needed by workers to complete a project, or how many workers are needed to work on one part of the project is certainly a very useful observation as an evaluation material for the company. By knowing the data about the activities of these workers, managers can do good budgeting in each project that will run in the future.

IV. Construction Accounting

Accounting history has been around for about as long as money itself. Accounting history goes back to antiquity in Mesopotamia, Egypt, and Babylon. For example, the government had extensive records of its finances during the Roman Empire. However, since the early 19th century modern accounting as a discipline has existed.

Accounting is the method of reporting a business-related financial transaction. Accounting requires the summary, analysis and reporting to supervisory agencies, regulators, and tax collectors of these expenditures. The financial statements used in accounting are a descriptive description of financial activities during the accounting period, summarizing the results of the company, its financial status, and its cash flows.

Construction accounting is described as monitoring how the financial resources of the company are used, including general operating costs, project determinations over or underbilled, preparing financial statements and reviewing financial statements to ensure that the financial structure of the business is compatible with the rest of the industry.

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A. Types

1) Financial Accounting:

Financial accounting refers to the methods used to produce interim and annual reports. The details of all financial operations during the accounting period are listed inside the balance sheet, the revenue statement, and the cash flow report. For certain businesses, such as publicly traded firms, audits are a legal necessity. Nevertheless, borrowers often usually request the results of external audits on an annual basis as part of their debt agreements. As a result, most businesses should have annual audits for one cause or another.

2) Managerial Accounting:

Managerial accounting uses many of the same documentation as financial accounting but organizes and incorporates information in a number of ways. Namely, in management accounting, the accounting department provides monthly or quarterly reports that the executive team of the business can use to make decisions on how the business operates. Managerial accounting also covers many other facets of accounting, including budgeting, forecasting and various methods for financial analysis. Essentially, any details that may be of interest to management falls under this umbrella.

3) Cost Accounting:

Just as managerial accounting helps companies make financial decisions, cost accounting allows businesses to make cost decisions. Essentially, cost accounting calculates all costs related to the development of a good. Analysts, executives, owners of companies and accountants use this knowledge to assess the cost of their goods. In cost accounting, money is used as an economic factor in production, while in financial accounting, money is considered to be a measure of the economic performance of a company.

B. Difference

There is major key difference in construction accounting and regular accounting many aspects some of them are mention bellow:

1) Sales:

Regular businesses account for sales and usually offer 1-5 categories of products and services. Construction businesses offer a greater range of service categories – service work, consulting, engineering, labour costs, design, physical products, and materials, and more. With all of these service categories, it can be more difficult to keep track of every expense or profit coming from each category. Revenue recognition can be tricky as well due to the many categories and each cost associated with each.

2) Cost of Goods Sold:

Regular businesses usually record the cost of the product sold. It's never that easy in building accounting. Through work incurs both direct and indirect costs, which fall into hundreds of categories. Keeping track of these direct and indirect costs can be difficult, particularly if they come from all categories. Implementing a software platform that can keep track of these costs for you can save you time and money.

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3) Expenses / Overhead:
For normal companies, the difference between the cost of products sold and the cost of overhead is obvious, but this is not the case for construction. Some of the products that grocery stores may call "Overhead" fall under the category "Cost of Goods Sold" in production as they are directly related to the customer's project. It is important to know the distinction between the two when it comes to building accounting, since it can be difficult.

4) Break Even:
In regular businesses, the direct relationship between income and expenses makes breakeven points extremely easy to calculate. In construction, however, there are far too many categories of items to easily understand how to break even on a project.

Additionally, most projects are one-of-a-kind custom jobs, with intricate requirements and a variety of associated costs. Since the relationship between income and expenses can be intricate, it can be helpful to have a software to keep track of income and expenses for you.

V. Cash Flow

In very general terms, 'cash flow' is the movement of income into and expenditure out of a business (or other entity) over time. When more money comes into the company than comes out of it, the cash flow is considered to be 'positive.' When more money goes out, it is a negative cash flow. In construction however, the term 'cash flow' generally refers to an estimation of when costs will be incurred and how much they will be incurred over the life of the project. Predicting cash flow is essential in order to ensure that an adequate level of funding is in place and that adequate withdrawal facilities are available.

Positive cash flow means that the net assets of a company are growing, allowing it to repay debts, reinvest in its business, return capital to shareholders, pay out expenses, and provide a buffer against potential challenges. Companies with strong financial flexibility can take advantage of profitable investment. They are even well off in downturns, reducing the risk of financial hardship. Even profitable companies can fail if they do not generate enough cash to remain liquid. This can occur if the income is associated with the accounts due and the inventory or if the company spends too much on capital. Investors and shareholders would also want to know that the company has enough capital and assets to cover short-term liabilities. Analysts analyze debt service coverage ratios to see how a corporation can meet its current commitments by bringing cash out of its transactions.

A. Types
Now that we understand the importance of cash flows, let’s see the types of cash flows in that are in use:

1) Operating Cash Flow:

Cash flow produced from operating activities is referred to as operating cash flow. Operating activities include the day-to-day activities of a company, such as the purchase of raw materials or the sale of goods. Cash inflows are the product of cash sales and accumulation of accounts receivable. This is basically the collection of profits from major business operations, for instance XYZ's income is generated from its electronics sales. To

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order to obtain these revenues, businesses must conduct operations such as the procurement of raw materials, the manufacture of inventories, the paying of workers, etc. As a result, revenue outflows arising from cash outflows for raw materials, wages, royalties, etc.

Operating Cash Flow = Cash inflow from operating activities – Cash outflow from operating activities (3)

2) Investing Cash Flow:

The cash flow generated from investing activities is termed as investing cash flow. Investment activities include the purchase and disposal of long-term properties and other investments. Cash outflows are created from investments in long-term assets and other investments including land, plant, and equipment; intangible assets; long-term and short-term investments in equity and debt provided by other organizations; etc. Cash flow provided by the purchase of shares or investments exclusively for the purpose of investing or the main business activity of the company shall not be included in the cash flow spending. For example, if an Indian exporter hedges US dollar in order to reduce the impact of USD-INR price volatility on his current orders, the cash flow from this hedging would go to operating cash flows and not to investing cash flows.

Investing Cash Flow = Cash inflow from investing activities – Cash outflow from investing activities (4)

3) Financing Cash Flow:

Financing cash flow comes from doing business financing operations. In other terms, cash flow funding requires the purchase or redemption of capital, be it equity or long-term debt. Cash inflows in this group include cash receipts from shares issued or bonds lent by long-term loans. Cash outflows include repurchase and interest payments of debt and other borrowings.

Financing Cash Flow = Cash inflow from financing activities – Cash outflow from financing activities (5)

A. Net cash flow

Net cash flow refers to the difference between cash inflows and outflows of a company in each period. In the strictest sense, the net cash flow refers to the shift in the cash balance of a company as defined. On the cash flow analysis. You can estimate the net cash flow of a company by looking at the period-over-period shift in cash on the balance sheet. However, the cash flow analysis is a more informative document to look at. Net cash flow is the amount of cash flow from financing (CFF), cash flow from operations (CFO).

Net cash flow is a fuel that helps companies to grow, produce new goods, repurchase stocks, pay dividends or reduce debt. This is basically what makes it possible for businesses to conduct their day-to-day operations. Some people therefore value net cash flow more than any other financial measure, including earnings per share. Revenues and expenses are also important because they are major drivers of net cash flow.

Table 1: *Equation table for NCF*

Year	Cash-Out	Cash-In	NCF
0	C_0	B_0	$NCF_0 = B_0 - C_0$
1	C_1	B_1	$NCF_1 = B_1 - C_1$
2	C_2	B_2	$NCF_2 = B_2 - C_2$
:	:	:	:
:	:	:	:
n	C_n	B_n	$NCF_n = B_n - C_n$

Table 2: *Example of NCF*

Category	Jan	Feb	Mar
Beginning Balance	₹ 550,000	₹726,000	₹746,000
Operating Activities			
Project Income	₹100,000	₹150,000	₹75,000
Supplier Payment	₹14,000	₹20,000	₹10,000
Subcontractor Payment	₹25,000	₹50,000	₹25,000
Payroll Expenses	₹10,000	₹10,000	₹10,000
Investing Action			
Truck Purchase	₹35,000	-	₹35,000
Bulldozer sale	₹10,000	-	
Financing Activities			
Sale of Stock	₹200,000	-	-
Building Lease Payment	₹50,000	₹50,000	₹50,000
Net Cash Flow	**₹176,000**	**₹20,000**	**₹55,000**
Project Balance	₹726,000	₹746,000	₹691,000

VI. Earned Value Analysis

Earned value analysis (EVA) appears to be a compelling technique to use on projects to better understand and manage performance. Companies that have won interest plan procedures and can have some basic training. Project managers are then advised to start using the money they have won, and management expects the performance of the project to improve quickly. Typically, reality sets in around a year later.

Earned Value (EV):

It is the percent of the total budget actually completed at a point in time. This is known as “budgeted cost of work performed” (BCWP).

EV = % complete x budget (6)

Planed Value (PV):

It is the budgeted cost for the work scheduled to be done. This is the portion of the project budget that is supposed to be allocated at any particular period. This is known as “budgeted cost of work scheduled” (BCWS).

Actual Cost (AC):

It is simply the money spent for the work accomplished. This is known as “actual cost of work performed” (ACWP).

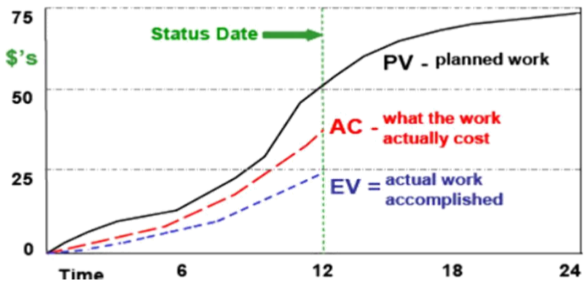

Figure 4: *Earned value graph [5]*

A. Cost variance and Cost performance index

The cost variance is defined as "the difference between the value earned and the actual cost (CV = EV – AC)." Often this calculation is expressed as the difference between the budgeted cost of the work performed and the real cost of the work performed. If the variance is equal to 0, the project is budgeted. When a negative variance is calculated, the project is over budget and the project is under budget if the variance is positive.

The CPI is defined as a "project cost-effectiveness measure." This is the ratio of earned value (EV) to actual costs (AC). The CPI is proportional to the received value divided by the actual costs, CPI = EV – AC. A CPI equal to or greater than one indicates a favorable condition and a value less than one indicates an unfavorable condition. For example, the calculation will display a CPI of ₹0.90, which translates to a project that recognizes ₹0.90 for every ₹1.00 spent to date on the project. Assuming that your CPI output stays the same for the rest of your work; your project will be over budget

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B. Schedule variance and Schedule performance index

Schedule Variance status shows the dollar value discrepancy between the job ahead of or behind the schedule and represents the calculation tool used. Schedule The status of the variance does not address the impact of the work sequence, address the importance of the

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work, reflect the critical path assessment, indicate the amount of time it will be slipped, identify the source (labor & material) of the difference, indicate the time before / behind (or recover) the schedule, or indicate the cost needed to recover the schedule. The calculation used for the express schedule variance is the value of the project obtained minus the project's expected value as of the date of the analysis. (SV = EV – PV) If the variance is equal to 0, the project is scheduled. If a negative variance is determined, the project is behind schedule and the project is ahead of schedule if the variance is positive.

The SPI is described as "a measure of the efficiency of the project schedule. This is the ratio of obtained value (EV) to expected value (PV). The SPI is equal to the value obtained divided by the expected value, SPI = EV / PV. An SPI equal to or greater than one indicates a favourable condition and a value of less than one indicates an unfavourable condition." For example, if your calculation shows an SPI of ₹1.1, which translates into a project that acknowledges ₹1.10 for every ₹1.00 spent to date on your project. Assuming that the SPI output is preserved during the job reminder; the project will be finished ahead of time.

B. Example

If a Work Package is the delivering of 500 cement begs at project site, and 350 are delivered, the Work Package progress is 70% complete (350/500). If the budget for this Work Package is ₹ 200,000, the earned value is ₹ 140,000 (0.70 x ₹ 200,000).

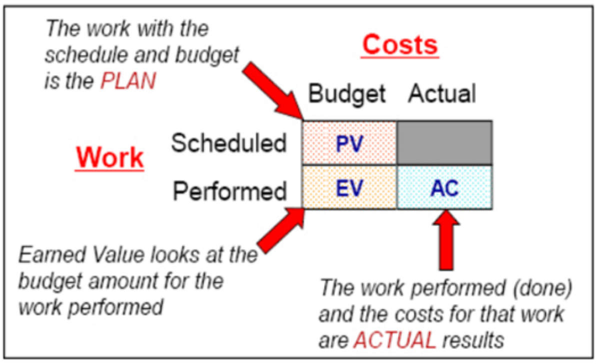

Figure 5: *Relationship of earned value terms [5]*

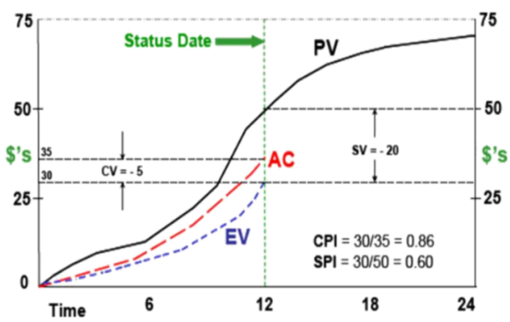

Figure 6: *Earned value analysis [5]*

Fig. 6 shows the Planned Value, Actual Cost, and Earned Value for a project. Please note that as compared to the actual amount spent, the planned spending curve shows a difference of $15. An outsider would probably assume that the project team does the job and does it for less money.

However, an analysis of the project using earned value gives a different picture. The graph shows a cost variance of-US$5 and a plan variance of-US$20. The project team has made $30 ("earned"). At this point in time, however, the scheduling plan was to carry out US$ 50 of work. The project team is now 20 dollars behind schedule work. In addition, the actual cost of the work performed was US$ 35 and the budget for the work performed was only US$ 30.

It means that the project manager has invested so much on the research that has been completed. The bottom line Earned Value Analysis clearly reveals that this project is in trouble!

C. Key parameters, performance measure and forecasting

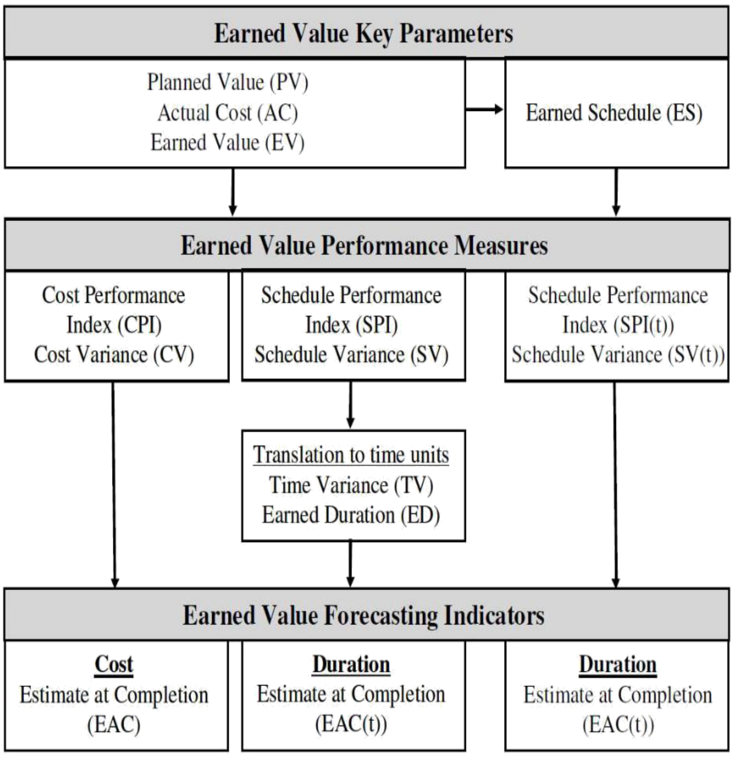

Figure 7: *Earned value method flowchart [7]*

VII. Break Even Point

By definition, the Break-Even point is the point where costs or expenditures are equal to revenues. Simply put, this is the inflection point where a corporation does not make money or lose money. For accounting purposes, the formula for a break-even point is calculated by dividing the total fixed costs involved in manufacturing by sales per product minus the operating costs per company. In this scenario, the fixed costs are those which do not adjust on the basis of the number of units produced. In other terms, the breakeven point is the amount of output at which the net income for the business is equivalent to the total expense.

$$\text{Break Even} = \frac{Fixed\ Costs}{Gross\ Profit\ Margin} \tag{7}$$

$$\text{Total Revenue (TR)} = \text{Direct Cost} + \text{Cost of administering} + \text{Cost of marketing} + \text{Profit} \tag{8}$$

Total Cost (TC) = Variable Cost (VC) + Fixed Cost (FC) (9)

VC includes cost of direct material, labour, equipment, fuel, etc. Cost varies with the volume.

FC is constant and is regardless of the volume. It includes rent, salary, taxes, etc.

A. Example

A construction material company makes and sells windows panels. The selling price per panel is ₹900. The variable cost for making the window panel is ₹500 per unit. The fixed cost is ₹8,000,000. Company has capacity of 25,000 panels. Find the break-even point (BEP).

P = selling price per unit = ₹900
V = variable cost per unit = ₹500
FC = Fixed Cost = ₹8,000,000

Table 3: *Solution of break-even point*

Volume	x = 18,000	x = 20,000	x = 22,000
TR (Total Revenues)	₹900 × 18,000 = ₹1,62,00,000	₹900 × 20,000 = ₹1,80,00,000	₹900 × 22,000 = ₹1,98,00,000
VC (Variable Cost)	₹500 × 18,000 = ₹90,00,000	₹500 × 20,000 = ₹1,00,00,000	₹500 × 22,000 = ₹1,10,00,000
FC (Fixed Cost)	₹80,00,000	₹80,00,000	₹80,00,000
TC (Total Cost)	₹1,70,00,000	₹1,80,00,000	₹1,90,00,000
Net Income	₹ 8,00,000 Loss	0 BEP	₹8,00,000 Profit

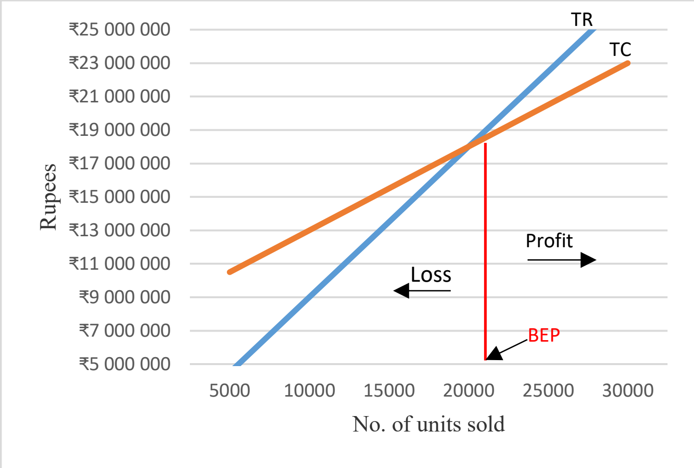

Figure 8: *Graphical presentation*

Mathematical presentation

TR = (p)(x)
TC = (v)(x) + FC
At BEP, TR = TC
(p)(x) = (v)(x) +FC
BEP = x = ${FC}/{p-v}$
BEP = x = ${8{,}000{,}000}/{900-500}$ = **20,000 units**

% capacity at BEP = $\frac{FC}{(p-v)(Total\ capacity\ in\ units)} \times 100\%$
% capacity at BEP = $\frac{8{,}000{,}000}{(900-500)(25{,}000)} \times 100\%$
% capacity at BEP = **0.8 / 80%**

VIII. Conclusions

6) In conclusion finance is the core of the construction project, it is an essential part of every construction ventures, no matter how big or how complex it is.
7) A construction company is a risky venture. Each year, many construction companies go out of business. Operating a successful construction company requires a specialized set of financial management skills, because of the unique nature of the construction industry.
8) The construction industry faces a number of challenges including:

    a. constantly building unique, one-of-a-kind projects,
    b. building a project at a different location each time,
    c. dealing with retention and progress payments,
    d. relying heavily on the use of subcontractors to complete the projects

4) After having capital, management of that is as critical as the project, where accounting plays a major role in it.
5) During project knowing how and where stakeholder's money is spent cash flow and net cash flow is important.
6) If scope or duration changes is directly or indirectly affecting the cost of the project.

7) Delay is a serious issue in construction industry because it affects the time and expense of the project. Delays in construction projects will results in increased costs and losses in the financial return or other benefits of the project. Thus, delay is costly for both owner and contractor.
8) Financial delays are root causes for weak cash flow control, followed by late payment, insufficient financial resources, and uncertainty of financial market.

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PREDICTION OF COMPRESSIVE AND TENSILE STRENGTHS OF ZEOLITE BLENDED CONCRETE IN RIGID PAVEMENT USING ARTIFICIAL NEURAL NETWORK

Sushant Waghmare, Dr. A. D. Katdare,Dr. N. K. Patil

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Sanjay Ghodawat University, Kolhapur
sush4396@gmail.com

Abstract

Tremendous amount of CO2 emission is carried out due numerous human events. It is projected that construction sector is alone accountable for release of nearly 50% of Greenhouse gases. Cement production itself produces about 7% Carbon Dioxide. Zeolite is one of the few Supplementary Cementitious Materials (SCM's) which can be used as a partial substitution of Cement in concrete without hampering the properties of Concrete. One of the major benefits of blending zeolite in Concrete is its tendency to adsorb CO2. This study tries to blend Natural Zeolite in Concrete and to be used in rigid pavement which was not tried earlier. In this study, Neural Network tool of MATLAB is used to predict the mechanical properties (Compressive Strength and Split Tensile Strength) of Zeolite Blended concrete and to validate the results with the actual test results. Economic Analysis of Rigid Pavement blended with zeolite is also carried out to compute the effect of this blending on the economy of pavement.

Keywords: Rigid Pavement; Zeolite; Neural Network; Concrete; MatLab

I. Introduction

Concrete which is one of the most widely adopted Construction material due to its various properties like strength, Durability etc. The role of Cement in Concrete plays very important role with regard to the characteristics properties of Concrete. In order to accomplish Economical, Environmental and social profits, it is advisable to add mineral additives in concrete.

Per year about 4000 MT of cement is produced, that may upto 6000 MT per year in next 40 years. Manufacture of one ton of cement emits 900 kg of CO2. [Kami 2019] To reduce the impact on environment, various SCM have been tried to substitute cement in concrete manufacture. Some of well-known mineral additives with pozzolanic properties are industrial waste (Fuel Slag, ashes) and natural pozzolanas (Pumice, Diatomite and Zeolite). Zeolite can be extensively used due to their abundant availability and excellent pozzolanic activity despite of the crystalline structure. [1].

According to Greenhouse gas emission statistics of IEA (International Energy Agency), 25% of global CO2 emission is produced by transport industry network. It appeared that construction of

1km of Expressway produced 9729 tonne of CO_2 emission per lane.

Use of mineral admixture in concrete has many advantages in economic, ecological and technological aspects. [4].

The word Zeolite is derived from Greek words: Zeo (to boil) and lithos (Stone) which means 'Boiling Stone'. Zeolites are crystalline alumina silicates with even pores, channels, and hollows. They hold special properties, such as ion exchange, molecular sieves, a big surface area, and catalytic activity, which make them a desirable material for various industrial applications. Numerous researches have been carried out related to addition of Zeolite in order to adsorb harmful gaseous substances and to improve water quality. Zeolite is having very high adsorption capacity (≈ 40% of its own weight) so it can act as an internal water curing agent. [13]

Zeolite containing SiO_2 and Al_2O_3 reacts with CH in presence of water to create cementitious products ($3CaO.2SiO_2.3H_2O$ and $3CaO.Al_2O_3.6H_2O$) [13]

$$2SiO_2 + 3Ca(OH)_2 \rightarrow 3CaO.2SiO_2.3H_2O$$

$$Al_2O_3 + 3Ca(OH)_2 + 3H_2O \rightarrow 3CaO.Al_2O_3.6H_2O$$

Addition of Zeolite in concrete densifies the Microstructure of cement paste which also reduces porosity and permeability. [13].

Usually it is not advisable to expose RCC to CO_2 as it neutralizes the concrete hence reducing the strength so concrete with Zeolite can be used in Pavement. [11]

In this study, it is proposed to examine the effect of blending of Natural Zeolite in Concrete. Neural Network tool of MATLAB is used to predict the Strength properties of Zeolite blended concrete. This result is validated with the test results conducted in Laboratory. Economic Comparison between Concrete with and without Zeolite is carried for One Kilometer stretch of National Highway designed for Heavy Traffic..

II. Material Characterization

To study the effect of Zeolite on Concrete, Chemical Composition of both Cement and Natural Zeolite is compared. Following table 1 shows the Chemical Compositions.

Table 1: *Chemical Composition*

Parameter	Cement	Zeolite
pH	12.2	7.34
Fe_2O_3	3.36%	8.86%
SiO_2	21.26%	71.76%
CaO	61.68%	0.08%
MgO	2.04%	0.04%
Na_2O	0.08%	6.68%
Al_2O_3	5.56%	6.20%
K_2O	0.00%	4.36%
Bulk Density	2.81 gm/cm3	0.81 gm/cm3

Table 2: *Chemical Properties of Zeolite as per ASTM C618*

Chemical requirements	Class N, ASTM C618	Zeolite
$SiO_2 + Al_2O_3 + Fe_2O_3$ (%)	Min, 70.0	86.82%
Sulphur trioxide (SO_3) (%)	Max, 4.0	0.00%

Ordinary Portland cement (OPC 53 Grade) available in local market is used in the research. Locally available well-graded, clean, M- Sand having fineness modulus of 2.6 following to IS 383-1970 [9] is used as fine aggregate. Crushed angular granite aggregate of size 20 mm obtained from local market is used as Coarse Aggregate.

IIa. Design of Rigid Pavement

Laboratory Experiments need to be carried out to find the various Mechanical Properties of Concrete. Mix Design of M30 Grade concrete using IS 10262 (2009) [8] is performed. The Mix Proportion obtained for M30 Grade concrete is 1:1.45:2.79 with Water to Cementitious Material ratio as 0.420.

In this research, a rigid pavement is designed as per IRC SP 62 (2014) [6]. The Details of Rigid Pavement design with reinforcement details is shown in Fig. 1

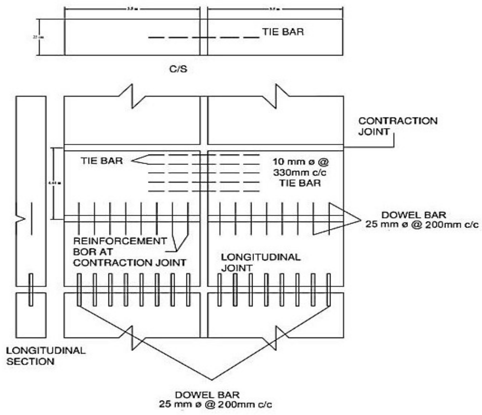

Figure 1: *Pavement Design*

III. Testing of Concrete

To Study the effect of Zeolite on Concrete, the dosages of Zeolite ranged from 0% to 20% of mass of cement.

Sample ID's are generated according to Zeolite Percentage (i.e. NZ05 represents Natural Zeolite 5% by mass of Cement).

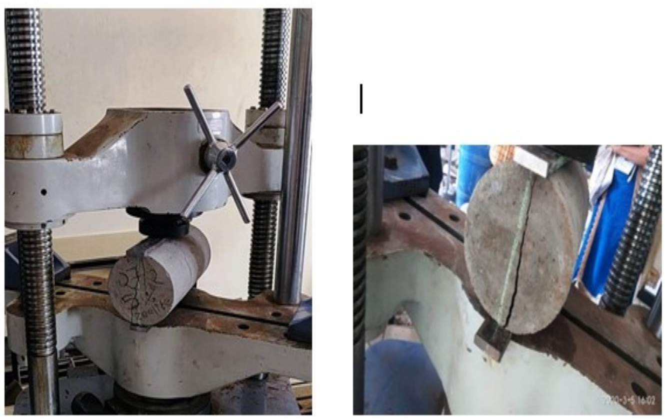

Figure 2: *Compression Testing Machine* **Figure 3:** *(a) Split Tensile Test on Cylinder (b) Failure Pattern*

The tests carried out to identify Mechanical Properties are Compressive Strength Test and Spilt Tensile Strength. Assembly and Testing of Concrete Samples can be seen in Fig. 2 and 3.

The results obtained in Compressive Strength Test and Split Tensile Strength is tabulated in Table 3.

Table 3: *Laboratory Test Results*

Sample ID	Compressive Strength in N/mm2		Split Tensile Strength in N/mm2	
	7 Days	**28 Days**	**7 Days**	**28 Days**
NZ00	20.39	30.89	1.59	2.79
NZ05	20.18	31.07	1.71	2.54
NZ10	**24.93**	**35.90**	**2.14**	**3.26**
NZ15	23.38	34.83	1.47	2.96
NZ20	18.31	32.65	1.29	2.92

From the above the test results, it can be concluded that with 10% replacement of Cement by Zeolite give satisfactory results in terms of Concrete Properties. The same is adopted in later chapter for economic analysis.

IV. Artificial Neural Network

Artificial Neural Networks (ANNs) are algorithms simulating the human neurons. They are forms of artificial intelligence, which attempts to simulate the networks of the nerve cell (neurons) of the biological central nervous system. [5].

An artificial neuron, also called a unit or a node, takes several input connections which are assigned certain weights. The unit then computes the sum of the weighted inputs and applies an activation function. The result of the unit is then passed on using the output connection. [12]

In recent years, Artificial Neural Network has been applied successfully in various fields of Science and Engineering. It has been proved that ANN based models can be successfully used in prediction of various parameters.

Artificial Neural Networks has capabilities to model nonlinear relations among the sets of input and their corresponding outputs. The information used to prepare the ANN models are categorized into different subsets (i.e., training set, testing set, and validation set). This research paper analyses the prediction of the compressive strength, Split Tensile Strength of concrete using ANN.

In this research, ANN is designed with 5 inputs and 1 output for Compressive Strength as same for Tensile Test. It Contains 10 hidden Layers of neurons and 1 output layer. Feed Forward backdrop type train with “Gradient Descent with Momentum and adaptive LR” (traingdx) train function and transfer function “logsig” is adopted in Neural Network Training as shown in Fig. 4. 70% of data is used for training, 15% data is used for testing and 15% data is used for validation.

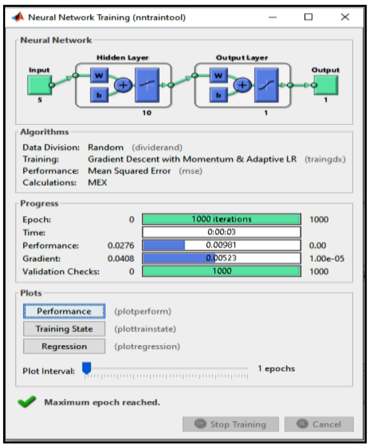

Figure 4: *Neural Network Tool*

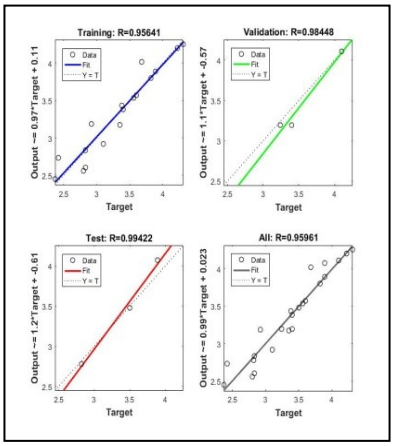

Figure 5: *Regression Values after Training*

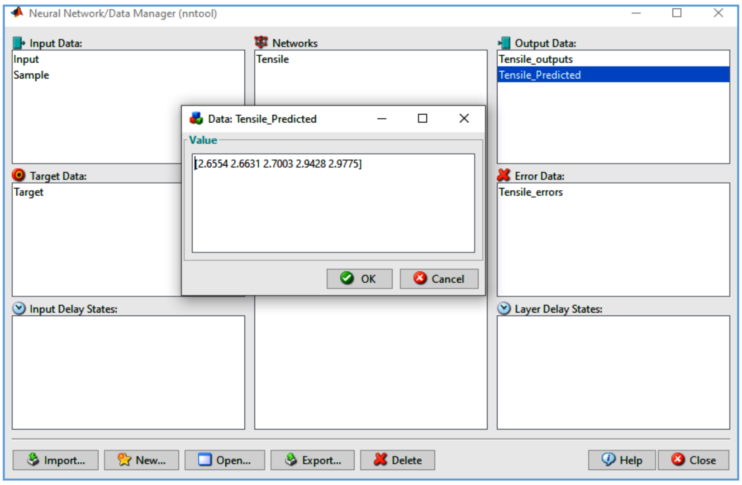

Figure 6: *Predicted Values after Simulation*

Separate Training of ANN is carried out for both tests to predict the Values. Two different data sets have been prepared for training of Neural Network. The data consists of five inputs (Weight of Cement, Coarse Aggregate, Fine Aggregate, Water and Zeolite per cubic meter of concrete) and one output as either Compressive Strength or Split Tensile Strength. The input data set has been referred from previous literature for training purpose.

Once a Neural Network is successfully trained (with value of regression ≈ 1) then that network is simulated with the sample data. The Sample data consists of weights of different constituents of Concrete derived from Mix Design of M30 Concrete as elaborated earlier. After simulation is carried out successfully, Neural Network provides "Predicted values" of Compressive Strength or Split Tensile Strength for the provided Sample Data. These predicted values are compared with actual values obtained from laboratory Tests carried out.

The Predicted and Actual Test result have been tabulated in table 4.

Table 4: *Comparison between actual and Predicted Values*

Sample ID	NZ0	NZ05	NZ10	NZ15	NZ20
	Split Tensile Test				
Predicted Result	2.6554	2.6631	2.7003	2.9428	2.9775
Actual result	2.79	2.54	3.26	2.96	2.92
	Compressive Strength Test				
Predicted Result	35.09666	34.9765	34.7301	34.2254	33.2808
Actual result	30.89	31.07	35.90	34.83	32.65

V. Economic Analysis

As stated earlier that use of mineral additives has economic significance too. During Concrete Testing, it was found that optimum blending percentage of Zeolite in Concrete is 10% so for economic comparison, so this substitution is adopted for further calculations. Material Rates in calculation are referred from District Schedule of Rates (DSR) of Pune Region for year 2019.

For the calculation, one Kilometer Stretch of Highway with a designed thickness of 0.25m and width of 14m is considered.

Table 5: *Material Cost of Rigid Pavement per Kilometer*

	Without Zeolite	With Zeolite	Cost Reduction	% Reduction
Total Material Cost (in Rs.)	1,81,77,724	1,78,60,926	3,16,798	**1.743%**

V. Conclusion

In this research, testing and validation of Zeolite blended concrete is carried out using ANN and Laboratory Test. ANN tool is a supplementary tool used for data validation. ANN itself is a modelling tool so relation between input and output of trained model need not to be elaborated.

Reasonable accuracy can be seen between Predicted results from trained ANN and the actual results. So it can be said that cost and efforts of experimentation can be reduced.

Zeolite which is one of the Supplementary Cementitious Materials (SCM's) can be used in Concrete without hampering its properties. It also shows economic advantages. Various environmental benefits can also be achieved with procurement and application of Zeolite in concrete it's properties. It also shows economic advantages. Various environmental benefits can also be achieved with procurement and application of Zeolite in Concrete.

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PERFORMANCE EVALUATION USING FRAGILITY ANALYSIS OF RC FRAME - WALL STRUCTURES

Khushali Desai, Dr. Rutvik Sheth, Keyur Patel

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Dharmsinh Desai University, Nadiad
kyd.cl@ddu.ac.in

Abstract

A frame-wall structure provides resistance to lateral loading by a combination of shear walls and rigid frames. Due to the difficulties in predicting earthquakes and its random nature, probabilistic analysis is proposed in analyzing structural seismic responses. Fragility curve represents a continuous relationship between a seismic intensity measure and the probability that the structure will reach or exceed a predefined damage state. The fragility analysis is carried out using lognormal distribution of clouds of responses obtained using Incremental Dynamic Analysis (IDA). In the present paper, 15, 18, 22 and 26 storeys RC moment resisting frame-wall structure are analysed for seismic zone IV. The structures are assumed to be resting on hard soil and are analysed using ETABS-2016 and designed as per IS code provisions. Geometrical configuration of the structure is considered as per IS 16700:2017. The performance evaluation of above frames is done using SeismoStruct software for set of 11 recorded ground motions of past Indian earthquake varying in range of magnitude from 5.6 to 7.8. For this study, limit states Immediate Occupancy (IO), Life Safety (LS) and Collapse Prevention (CP) are considered as the performance criteria referred from FEMA 356. From the fragility curves, it is observed that there is negligible probability of collapse for spectral acceleration corresponding to Design Basis Earthquake. Also, probability of exceedance increases as the number of storey increases at given level of spectral acceleration. This is due to reduction in median collapse capacity of building.

Keywords: Frame-Wall Structure, IS 16700, Incremental Dynamic Analysis, Fragility Analysis, Performance Evaluation.

I. Introduction

One of the most prevailing system in medium to high rise structure is wall-frame system. Shear walls are used in high-rise buildings to resist lateral loads. Often they supplement frames, which if unassisted, could possibly not efficiently withstand the lateral loads. Majority of the buildings, therefore, are frame-shear wall. The distributing lateral loads is based on the interaction behaviour of the frame-shear wall system.

As the independent behaviour of frame and shear wall under seismic action are diverse, the combined effect is beneficial in context to deformation limits and economy. When these two are held together by floor slabs or beams, the cumulative pattern of deformation is different. Likewise, the interacting forces vary in magnitude and direction along the height of the structure as shown in Fig. 1.

The shear wall primarily responds by flexure as a cantilever, whereas, the frame deflects in a shear mode. Compatibility of the two, assuming that the beams or floor slabs have sufficient in-plane stiffness to produce equal lateral displacements at the floor level, generates interaction between the wall and frame. The parabolic sway of the shear walls and the linear drift of the moment frame, leads to enhanced stiffness because the walls are restrained by the frames at the upper levels while at the lower levels the frames are restrained by the walls. However, a closely spaced frame with deep beams tends respond predominantly in a flexure mode. Correspondingly, a shear wall weakened by large openings acts more like a frame by deflecting in a shear mode. Hence, the combined structural action depends on the relative stringency of the two, and their modes of deformation. [11]

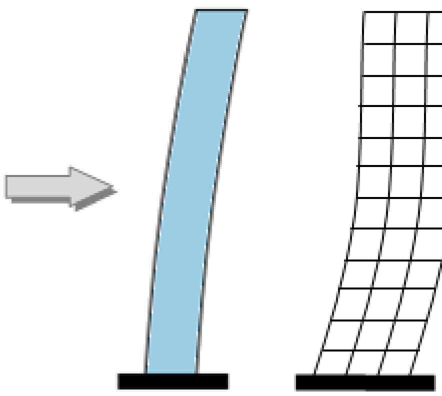

Figure 1: *ShearWall and Frame Deformation Shape under Lateral Load*

The behaviour of reinforced concrete structures under the effect of ground motions has always been a subject of investigation, especially in seismic region. Meanwhile, the damage to buildings from recent earthquakes has emphasized the need for risk assessment of existing building standard to estimate the potential damage from future earthquakes. Seismic actions are challenging to predict and hence, probabilistic analysis is offered for vulnerability assessment of building responses. In order to accurately capture the nonlinear seismic response of a structure, complex analysis methods and material models are required. Incremental Dynamic Analysis (IDA), an extension of nonlinear time history analysis, is a parametric method of analysis which predicts complete structural responses and performances. A structural model is subjected to a suite of ground motion records and the intensity of these ground motions are monotonically scaled. Plotting of Intensity Measurement (IM) of the scaled ground motions and Damage Measurement (DM) is termed IDA Curve.

Vulnerability evaluations of buildings are normally carried out for judging the requirement for consolidation of vital members against later earthquakes. The best way to achieve such assessments is by Fragility curves. It demonstrates the conditional probability of response of a structure that it may exceed the performance limit at a given ground motion intensity. This approach is beneficial for damage and loss estimation, and disaster response planning. Out of many existing approaches, here fragility analysis is carried out using clouds of responses obtained from IDA using lognormal distribution of median and dispersion parameters.

Using IS code [4], [7] provisions, analysis and design of RC Frame-Wall Structure with 15, 18, 22 and 26 Storey is carried out. The frames are assumed to be resting on hard soil and lying in seismic Zone IV. IDA with monotonic scaling till numerical non-convergence of above frames is done using SeismoStruct software for set of 11 recorded ground motions of past Indian earthquake. Using IDA results, considering performance criteria as per FEMA 356[3], fragility curves are obtained for probabilistic assessment of vulnerability.

I. Fragility Analysis

In IDA, the structural model is subjected to set of seismic ground motion records whose intensity are increased monotonically using scale factors. It continues to proliferate, ranging the structural responses to go from elastic to the nonlinear till collapse. Moreover, if both Capacity (C) and Demand (D) of a structure are subjected to time variation, it is difficult to predict safety of structure. At certain time t, Safety (S) can be expressed as St = Ct - Dt where if demand exceeds capacity, it indicates a hazardous state. Probability distribution for C and D can be thus carried out for better estimate of safety. Fragility curves are a crucial component of probabilistic seismic risk assessment. Fragility curve (F) defines continuous relationships between a ground motion intensity measure (IM) and the total probability that the specified structure will reach or exceed predefined engineering demand parameter (EDP); they can be expressed as:

$$F = P\,[D > C \mid IM] \tag{1}$$

Where, D is the demand of the asset class being assessed and C is a specific predefined state of damage. Fragility may be evaluated using either EDP or IM ordinates versus their associated capacities EDPC and IMC, respectively. An IM is a scalar representative of the earthquake damage potential with respect to the specific structure.

Procedure of Developing Fragility Curve Using Incremental Dynamic Analysis:

- Computer model of building is analysed and designed.
- Ground motion records to perform dynamic response history analysis are selected.
- Solve equation of motion at each time step and record the response parameters.
- Use scaling to increase the IM level of the ground motion record, and repeat the process until all the limit states are reached.
- Above steps are repeated for each selected ground motion.
- Cloud of structural response results is plotted.
- Fragility curves are constructed from the set of IM and EDP pairs through an appropriate statistical curve fitting approach.

II. Regression Analysis Using Least Square Formulation:

As the Monte Carlo simulation (MCS) mostly relates to its high computational cost, for such cases, seismic fragility can be computed based on data from cloud. For cloud analysis, regression is required to achieve a continuous representation of the distribution of EDP∣IM for all IM levels of interest, which is generally performed using the power-law approximation:

$$EDP(IM) = aIM^{b}\,\varepsilon \tag{2}$$

ε = lognormal random variable, a and b = constants from trend line.

Probability of exceeding a certain damage state given the value the earthquake intensity measure can be expressed as:

$$P(D > C|IM) = \Phi\left(\frac{\ln\left(aIM^{b}\right) - \ln EDP_{C,50\%}}{\beta_{EDP(IM),tot}}\right) \tag{3}$$

$$= \Phi\left(\frac{\ln a + b\ln IM - \ln EDP_{C,50\%}}{\beta_{EDP(IM),tot}}\right) \tag{4}$$

$$= \Phi\left(\frac{\ln IM - \ln\left[\left(\frac{EDP_{C,50\%}}{a}\right)^{1/b}\right]}{\beta_{EDP(IM),tot}/b}\right) \tag{5}$$

$$= \Phi\left(\frac{\ln IM - \ln IM_{C,50\%}}{\beta_{IM,tot}}\right) \tag{6}$$

Where,

$IM_{C,50\%}$ = Median ground motion intensity (IM)

$\beta_{IM,tot}$ = Associated dispersion of intensity measure (IM) on the EDP capacity

= $\frac{STDEV\ [\ln(\varepsilon)]}{b}$

Φ = Standard normal cumulative distribution function

In this study, $\beta_{EDP(IM)}$ uncertainty of ground motion only is taken into consideration in order to understand the behaviour of structures subject to ground acceleration variations considering material uncertainty as null.

II. Analysis and Design of Structure

All buildings of 15, 18, 22, 26 storey are analysed using ETABS 2016 software and designed as per provisions of IS codes. Geometrical configuration of RC moment resisting frame with shear wall is considered as per IS 16700:2017 [5]. For all the cases, maximum plan aspect ratio (L/B) does not exceed 5.0. Further, the maximum building height does not exceed 100 m as per criteria of structures located in Zone IV. The slenderness ratio of height (H) to minimum base width (B) does not exceed 8. For design purpose, concrete grade of M40 with reinforcement steel of Fe500 grade are used. Response reduction factor of 5 with importance factor of 1.2 are assumed with structure lying on hard soil. Typical storey height was taken as 3.40 m. Dead load including self-weight of beams, columns, wall and slabs are considered and the imposed load taken as 4.00 kN/m^2. Effective moment of inertia for the design of beam and column/shear wall considered is 0.35 Ig_0 and 0.70 Ig_0 respectively, while that for drift for beam and column/shear wall considered are 0.70 Ig_0 and 0.90 Ig_0 respectively. Typical plan of all structures under study is of 18 m x 36 m as shown in Fig.2.

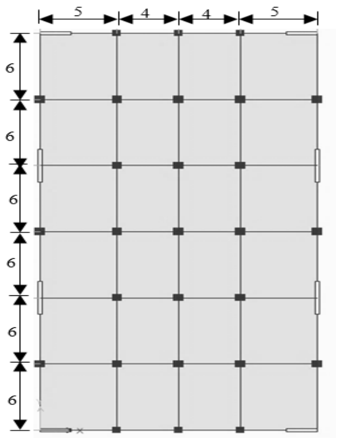

Figure 2: *Typical Geometric Configuration in Plan*

As per IS 16700:2017, when design lateral forces are applied on the building, the maximum inter-storey elastic lateral drift ratio (Δmax/hi) under wind load, shall be curbed to H/500. For earthquake load combinations the drift shall be limited to hi/250.

RC Moment Resisting Frame-Wall Structure with 15, 18, 22 and 26 storey are analyzed and designed for load combinations as per Indian Standards. The design base shear, and modal time period is shown in Table 1.

Table 8 : *Modal Time Period and Design Base Shear*

Storey	Time Period of First Mode (s)	Base Shear, Vbx (kN)
15	3.63	3806.45
18	4.26	3847.24
22	4.64	3897.34
26	5.49	4113.04

Dimensions of beam is computed such that steel reinforcement designed for both moments range from maximum 1.10% to minimum criteria. For column, design steel reinforcement is computed for axial force and bi-axial moments. Dimensions are selected so as to keep maximum percentage of steel up to 3.37%. Shear Wall is designed with boundary elements with maximum 2.54% of steel reinforcement. SAFE 2016 software is used for design of footing as per provisions of IS code. Buildings are considered to be resting on hard soil and safe bearing capacity (SBC) of soil assumed is 350 kN/m^2. Sections of each member are reduced with elevation for optimized reinforcements as per Indian Standards.

I. Nonlinear Modelling

SeismoStruct software is used for performing nonlinear analysis. The concrete model used was proposed by Mandar et al (1988) with both confined and unconfined section properties. Reinforcement steel used is a uniaxial bilinear stress strain model. This simple model is also characterized by its computational efficiency.

Distributed plasticity is chosen for elements idealized to fibre sections with multiple integrating points using Inelastic Force-Based Plastic Hinge Frame type giving forced based formulation. It concentrates such inelasticity within a fixed length of the element. The advantages of such formulation are a reduced analysis time, and full control of the spread of inelasticity. The number of section fibres used in equilibrium computations needs to be defined. In addition, the plastic hinge length needs also to be demarcated. Reinforced concrete rectangular wall section is used to model shear walls with edge sections.

In this research, P-delta effect was considered on the RC columns and shear walls when gravity loads introduce compression axial force and lateral loads perpendicularly applied to the columns and shear walls. Fixed support was adopted for the foundations. Top of the building is free to move both translationally and rotationally having the maximum deformation.

II. Past Earthquake Records

Out of the available ground motion records from database, the following criteria were selected:

Chosen ground motions have a magnitude greater than 5.5. The site condition is classified as rock. The recording is made in the far field at a distance greater than 10 km. Considered earthquakes has Peak Ground Acceleration (PGA) more than 0.10g and Peak Ground Velocity (PGV) more than 10 cm/s.

Ground motion records were recorded in different locations pan India. Response spectrum of such 11 recorded ground motions of past Indian earthquake along with design response spectrum are shown in Fig.3

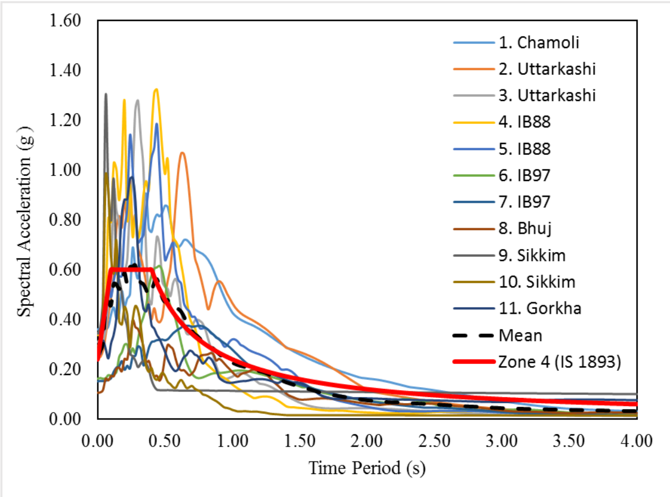

Figure 3: *Ground Motion Response Spectra and Design Spectra*

III. Results and Discussions

After designing the structures under study, nonlinear dynamic analysis is performed using IDA. The results of IDA response are then further used to plot fragility curves to indicate the probability of exceedance of various limit states considered as per FEMA356. Fragility curves are plotted using regression analysis of clouds of response and its lognormal distribution.

I. Clouds of Response

For the purpose of illustration, clouds of response of 15 Storey Frame-Wall structure has been represented. Fig. 4 shows the IDR (%) v/s Sa(g) plot from IDA. Fig. 5(a), 5(b), 5(c) are the logarithmic plots for IO, LS and CP limit states respectively for computation of median and standard deviation parameters for fragility analysis.

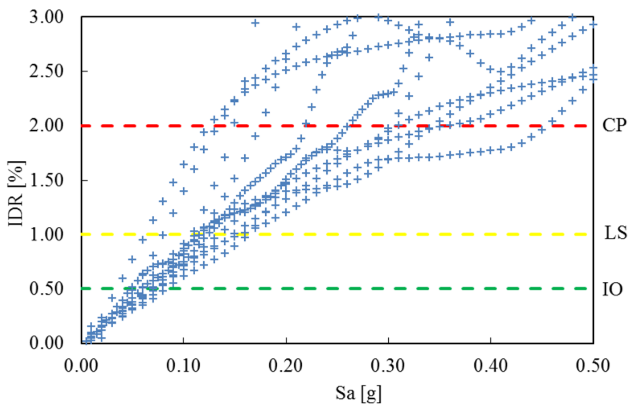

Figure 4: *Plot of IDR(%) v/s Sa(g) from IDA*

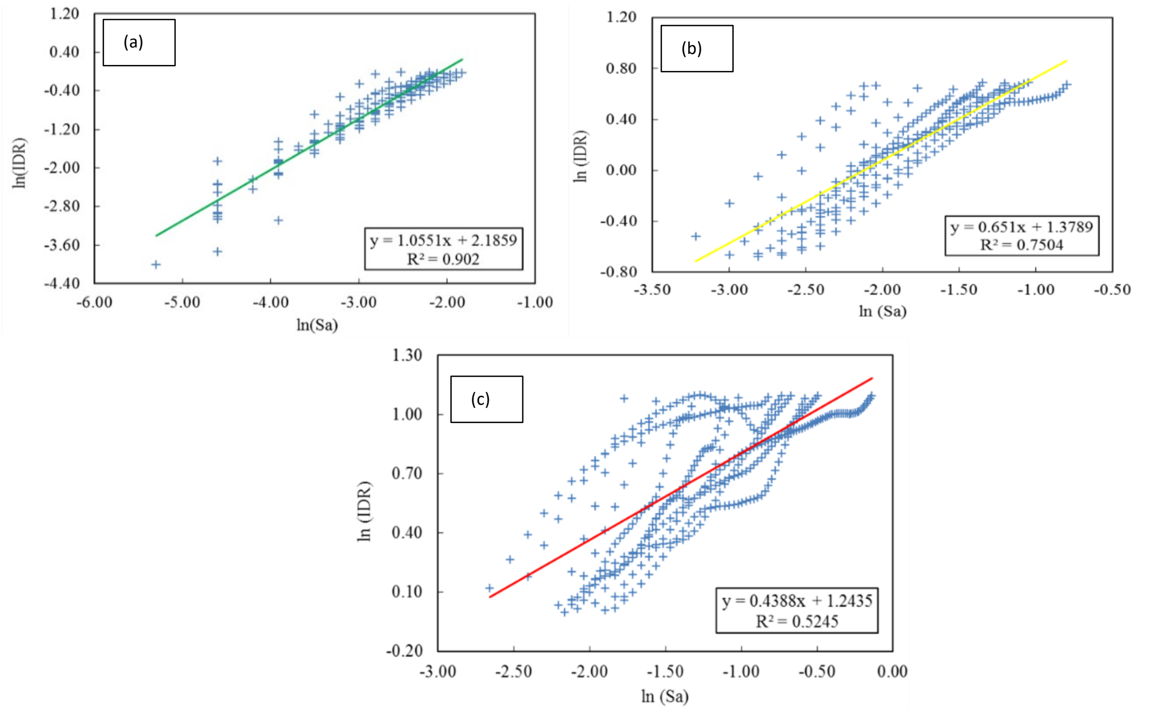

Figure 5: *Clouds of Response of 15 Storey Building at (a) IO (b) LS (c) CP limit states*

II. Fragility Parameters

Using least-square regression procedure, the clouds of response are summarized in form of fragility parameters of median and dispersion. These are as indicated in Table 2.

Table 2: *Fragility Parameters*

Performance Levels	Fragility Functions	Storey			
		15	18	22	26
IO	Median	0.065	0.055	0.051	0.045
	Dispersion	0.246	0.273	0.217	0.202
LS	Median	0.120	0.105	0.091	0.083
	Dispersion	0.292	0.309	0.326	0.350
CP	Median	0.285	0.267	0.247	0.241
	Dispersion	0.483	0.346	0.443	0.474

III. Fragility Curves

After obtaining responses from IDA method, they are arranged in ascending order and as per FEMA356 criteria, they are bifurcated in category of IO, LS, and CP. Using computed parameters of median and dispersion, the fragility curves are plotted applying lognormal distribution. The fragility curves obtained are as shown in Fig.6(a), (b), (c), (d) for 15, 18, 22, 26 stories frame-shear wall structure respectively.

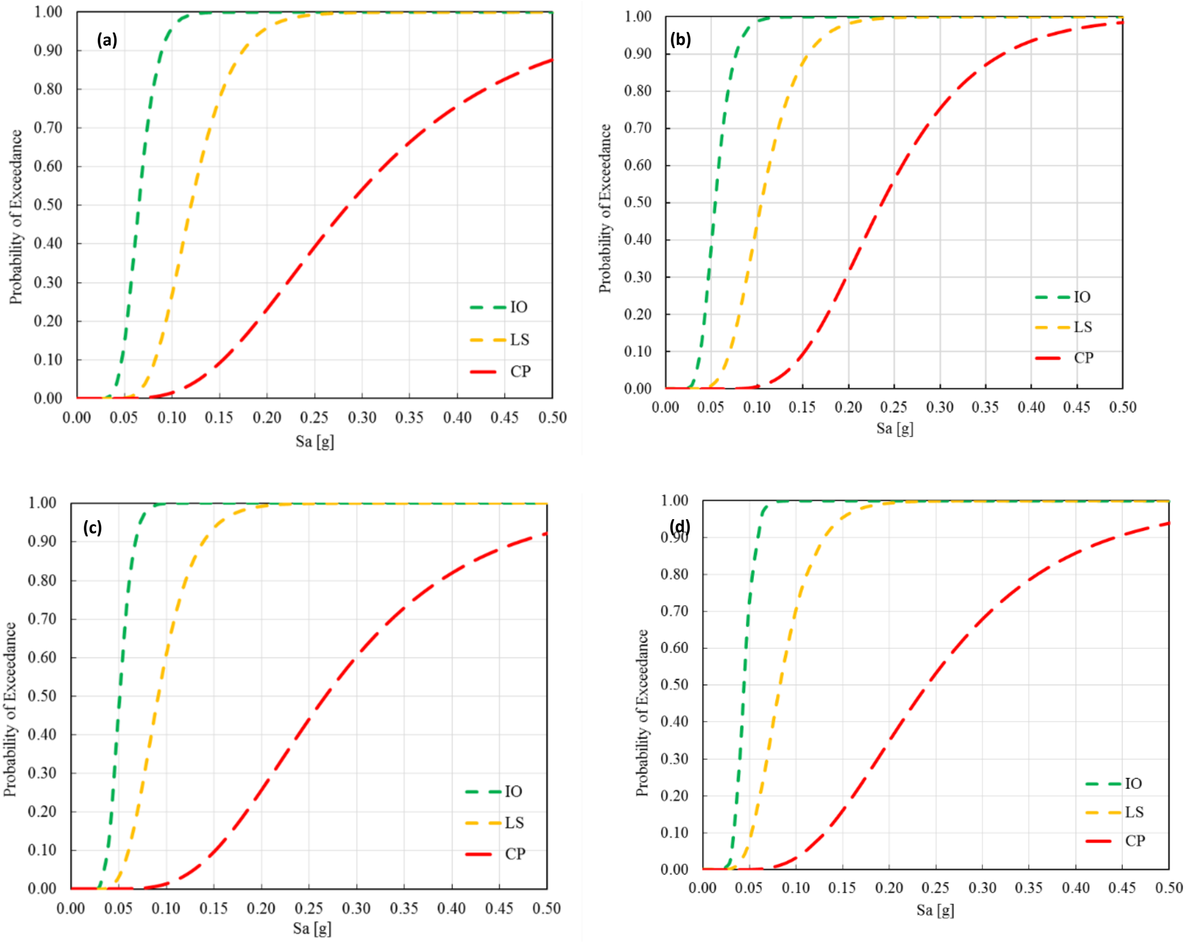

Figure 6: *Fragility Curves for (a) 15, (b) 18, (c) 22, (d) 26 storey buildings*

IV. Summary

It is seen that for spectral acceleration corresponding to Design Basis Earthquake (DBE), all the frame has less than 50% probability of exceedance of Life safety limit state. It is observed that probability of exceedance of Collapse limit state for spectral acceleration corresponding to DBE is negligible.

Spectral acceleration at DBE and Maximum Considered Earthquake (MCE) for each designed building is shown in Table 3.

Table 3: *Spectral Acceleration for DBE and MCE*

Storey	DBE, Sa (g)	MCE, Sa (g)
15	0.111	0.222
18	0.092	0.185
22	0.076	0.151
26	0.064	0.128

Probability of exceedance of DBE and MCE obtained from fragility curve results using nonlinear dynamic analysis is shown in Table 4.

Table 4: *Probability of Exceedance*

Performance Levels	Probability of Exceedance	Storey 15	18	22	26
IO	DBE	98%	97%	97%	96%
	MCE	100%	100%	100%	100%
LS	DBE	39%	31%	28%	23%
	MCE	98%	98%	94%	89%
CP	DBE	3%	0%	0%	0%
	MCE	30%	24%	10%	9%

IV. Conclusion

It is observed from the fragility curves that probability of exceedance decreases as the number of storey increases for spectral acceleration corresponding to respective DBE and MCE. This is due to increase in height of buildings resulting in a higher time period and lower spectral acceleration.

From the fragility curves, it is indicated that there is less than 40% probability of exceedance of Life safety limit state and has negligible probability of exceedance at Collapse limit state for spectral acceleration corresponding to respective DBE. Hence, it indicates satisfactory behaviour, though the probability of exceeding IO limit state is above 95%.

It is also observed that probability of exceedance increases as the number of storey increases at given level of spectral acceleration. This is due to reduction in median collapse capacity of building.

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COMPARISON OF CRASH PREDICTION MODELS USING MLR AND ANN

Aanal Desai, Dr. L. B. Zala, Amit A. Amin

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Birla Vishvakarma Mahavidyalaya
Vallabh Vidyanagar, Gujarat, India
aanaldesai735@gmail.com

Abstract

Recently, in crash analysis statistical tools greatly helped in predicting future consequences based on recent data by studying the influence factors in the form of independent variables which can have significant consequences on the dependent variable. Hence, the forecasting of crash prediction models has to be developed. In this study, the stretch of National Expressway-1 has been selected from Ahmedabad to Vadodara because around 1058 crashes and 50 deaths occurred every year. Traffic volume, Speed, and Road characteristics were used to develop the models. Two approaches were chosen for the prediction model namely, the Multiple Linear Regression (MLR) model and Artificial Neural Network (ANN) model. Both methods are used to determine the relationship between the influencing factors of crashes and the frequency of crash occurrence, compared and discovered that the ANN model gives much better results for the prediction of road crash than the MLR model in this study.

Keywords: Crash Prediction Model, Multiple Linear Regression, Artificial Neural Network

I. Introduction

It is estimated that in the World, approximately 1.35 million people died in 2016 and 55 million injured every year due to road crashes [1]. Road traffic injuries cause considerable economic losses to people, their families, and nations as a whole. The safety scenario related to road crashes in India is poor because of the mixed traffic condition. Around 0.15 million of people were killed annually in India due to road crashes [2]. So, road safety is a major concern in the current situation and becomes an issue of national concern. Generally, the crash prediction model was developed by using different statistical techniques in both developed and developing countries. In general, the model development the process is iterative because in this process many models are derived, tested, and built upon until a model fitted in the desired criteria. Also, this process involved several tasks: structural model definition (e.g. linear, exponential, etc.), order (power) evaluation, and parameter estimation. Here, the crash prediction models were developed by using Multiple Linear Regression (MLR) and Artificial Neural Network (ANN). The prediction performance of both models presented in this study by comparing the predicted crashes versus observed crashes for each model.

II. Background

Ahmad, Erwan Sanik [3], studied accident prediction models comparison. The locations were selected in a rural area in Malaysia. Traffic volume, speed, number of access points and gaps data were used to develop the models. These parameters were then used to develop an accident prediction model by using the Artificial Neural Network (ANN) and Multiple Linear Regression (MLR) models. It was found that the MLR gave the best of R2 which was 99.92% validation for the model. Meanwhile, the ANN gave 82.40% which was lower than MLR. So, this was proved that the MLR model was the better model than ANN for this study. Jadaan, Fayyad [4], developed a traffic accident prediction model that was developed using the novel Artificial Neural Network (ANN) simulation to identify its suitability for prediction of traffic crashes under Jordanian conditions. Training, validation and, testing of the network were performed using MATLAB. Four alternative models, with a different number of hidden layers, were considered and Model 4 was found to be the best model with the highest coefficient of determination (R2 =0.992). The model was validated and found to produce good results under Jordanian traffic conditions thus can be used with confidence to predict future traffic crashes on the national road network. Nivea John, Archana [5], in their study, ANN were developed in Python with Keras library. The factors considered in the model are crash data, speed, volume, landuse type, pavement width and condition, shoulder width, number of horizontal curves, vertical curves, intersections, and bus stops. Results show that estimated traffic crashes, based on the input data are close enough to actual road crashes hence it is reliable to predict future crashes in two-lane undivided state highways. The performance of ANN is found to be better than other statistical methods. R.R. Dinu, A. Veeraragavn [6], developed accident prediction models were developed for day-time and night-time crashes over a three-year accident history of nearly 200 km of two-lane undivided highway segment around the city of Chennai in India. The explanatory variables considered for modeling included hourly traffic volume, length of highway segment, the proportion of buses, cars, motorized two-wheeler and trucks in the traffic, driveway density, shoulder width, and horizontal and vertical curvatures. The model coefficient was assumed to be normally distributed and a simulation-based maximum likelihood method was used for parameter estimation. This model helps to safety engineers in computing more realistic ranges of safety benefits of remedial measures. Williams Ackaah, Mohammed [7], Salifu Statistical models have been developed to predict crashes on rural highways in the Ashanti Region of Ghana. Generalized Linear Model (GLM) with Negative Binomial (NB) error structure was used to estimate the model parameters. Two types of models, the 'core' model which included key traffic exposure variables only, and the 'full' model which included a wider range of variables were developed. From the model developed, traffic flow, segment length, junction density, terrain type and presence of village settlement within road links are significant explanatory variables that influence the prediction of injury crashes on the rural highways in the Ashanti Region of Ghana. The study proved that passing a highway through settlement areas, traffic volume, provision of a long straight and flat sections and increasing number of junctions per unit road length tend to worsen road traffic safety. B. Rejoice, L. B. Zala, Amit Amin [8], in this paper they developed the accident prediction model by considering the generalized linear modeling technique. The data used for model development were speed, traffic flow, and road characteristics data and also, they used association rule mining techniques for the identification of accident spots as it can deal with the heterogeneous nature of crashes and help to improve road safety on rural highways.

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III. Objective and Scope of the Study

With the help of recent data and statistical tools for analysis of crashes, road crashes analyzed, and predicted. With proper engineering measures, similar crashes can be reduced from happening in the future. In this study two approaches MLR and ANN were chosen for the crash prediction model development. The objective of study is comparison of these two statistical approaches and to determine which is more effective approach for crash prediction in this study.

IV. Study Area and Data Collection

The selected study stretch was Mahatma Gandhi Expressway (NE-1) connecting the cities of Ahmedabad and Vadodara in the state of Gujarat, India. The total length 93.1 km. was selected which is a four-lane divided expressway. For model development variables considered were: Traffic Volume in terms of Hourly Traffic Volume (HTV), Average Speed, Road Condition in terms of straight-section and curve-section and, Carriageway Width as independent variables, and Number of road crashes per hour (average of 3 years i.e., 2016-2018) as a dependent variable. Table 1 shows the descriptive statistics of variables.

Table 1: *Descriptive Statistics*

Variable Code	Variable Description (per hour data)	Minimum	Maximum
HTV	Hourly Traffic Volume (HTV) [in Log Natural (ln) form]	7.27	**8.17**
S	Speed (kmph)	60	**80**
CW	Carriageway Width (m)	11	**11**
R	Road Condition*	1	**2**
Rc	**Road Crash (per hour in a year)**	**28**	**62**

*Subjective rating: 1-Straight section, 2-Curve section

The models developed by considering hourly crashes to find out how traffic volume, average speed and carriageway width will affect road crashes. Generally, the research work carried out as a road crash per km but in this study does not give meaningful image because expressway has limited access points therefore classified volume count and speed for segments are the same. Hence in this research work crashes are considered as per hour based because traffic volume and vehicle speed considerably vary with per hour basis rather than per km based. So, all the variables are converted into hourly basis which is shown in Table 2.

Table 2: *Input Data for Model Development and Validation*

Time (hr)	Ln(HTV)	Speed (kmph)	Carriageway Width (m)	RC*	Road Crash in Hours
0-1	7.493	75	11	1	**40**
1-2	7.311	69	11	1	**44**
2-3	7.394	70	11	1	**42**
3-4	7.277	69	11	2	**39**
4-5	7.422	70	11	1	**41**

5-6	7.585	70	11	1	**39**
6-7	7.729	80	11	2	**62**
7-8	7.953	75	11	1	**51**
8-9	8.040	72	11	2	**52**
9-10	8.176	80	11	1	**60**
10-11	8.090	70	11	2	**51**
11-12	7.936	60	11	1	**42**
12-13	7.969	62	11	1	**38**
13-14	7.996	70	11	1	**39**
14-15	7.990	65	11	1	**47**
15-16	8.054	80	11	2	**56**
16-17	7.963	77	11	1	**54**
17-18	7.967	72	11	1	**43**
18-19	8.116	70	11	1	**42**
19-20	8.092	65	11	1	**34**
20-21	7.974	70	11	1	**30**
21-22	7.841	70	11	1	**33**
22-23	7.726	60	11	2	**28**
23-24	**7.698**	**75**	**11**	**1**	**40**

V. Multiple Linear Regression Analysis

Early models of crash prediction are based on the simple multiple linear regression approach which has more than one explanatory variable X and a scalar dependent variable denoted as Y. The model must be linear and the general form of the linear crash prediction model can be expressed as equation (1).

$$Y/\Theta \sim \text{Dist}(\Theta) \text{ with } \Theta = f(X, \beta, \varepsilon) \quad (1)$$

Where,

Y: the dependent variable (i.e. crash frequency),

θ: the crash dataset,

Dist(θ): the model distribution,

X: a vector representing different independent variables (i.e. risk factors),

β: a vector of regression coefficients,

f(.): link function that relates X and Y together,

A similar linear relationship was adopted as per equation (2).

$$R_C = \beta 0 + \beta 1 (\ln(HTV)) + \beta 2 (S) + \beta 3 (R) + \beta 4 (CW) \quad (2)$$

Where,

R_C = Road Crashes,

HTV = Hourly Traffic Volume,

S =Average Speed,

R = Road Condition,

CW = Carriageway Width

The linear regression model developed in Microsoft Excel and the result shown below in Table 3 and The R square value for the model sounds good. It explains that outputs are close to the linear trend line.

Rc (per hour in a year) = 6.954 ln(HTV)+1.036 (Speed) - 8.104 (CW) + 4.125 (RC) (3)

R^2 = 0.984

Table 3: *Regression coefficient of the developed model*

	Coefficients	t	P-value
Intercept	0.000	-	-
Volume	6.954	1.500	0.149
Speed	1.036	4.577	0.002
Carriageway width	-8.104	-2.306	0.032
Road Condition	4.125	1.427	0.169

F-test was performed to find out that there is any variance within samples. It is the ratio of the variance of the two samples. The result is shown in Table 4. F-value is less than F-critical value at a 95% confidence interval, which means the developed model is acceptable. For the validation of the model, a comparison was carried out between Predicted crashes by multiple linear regression model using observed data on same facility and Observed crashes of the same data set used for the model development. Figure 2 shows the correlation between predicted road crashes by the Multiple Linear Regression model and observed road crashes and identified that the R^2 value for the linear regression model was 58.67%. Figure 1 shows the plot of the observed crash per hour and predicted crash by the model per hour.

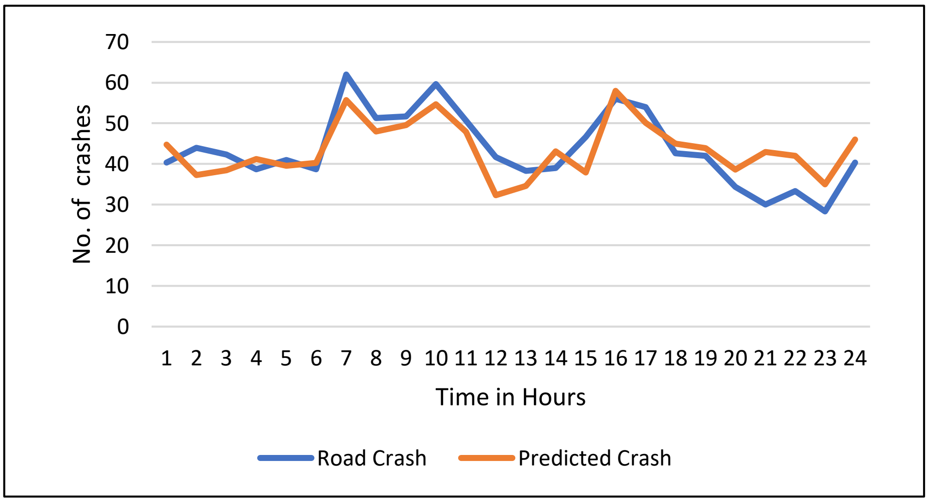


Figure 1: *Observed and Predicted road crashes*

Table 4: *F-test for two-sample for variables*

	Observed Crashes	Predicted Crashes
Mean	43.625	43.616
Variance	77.684	45.432
Observation	24	24
df	23	23
F	1.7099	
P (F<=f) one-tail	0.1029	
F Critical one-tail	2.0144	

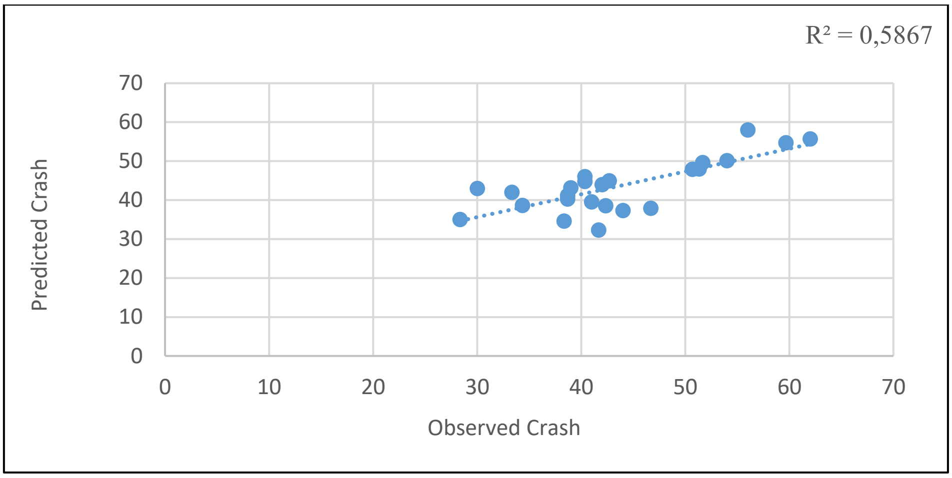


Figure 2: *Observed and Predicted Crashes (MLR Model)*

VI. Artificial Neural Network

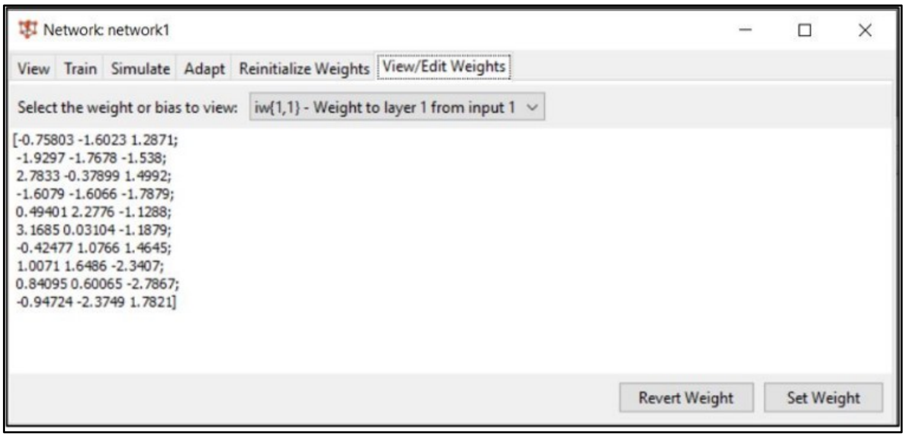
Recently, ANN is widely used in solving engineering problems like classification, prediction, and function approximation. This neural network is similar to the human brain in which it composed several series of nodes and weights factors that connect the all nodes together in a systematic style that consists of the input layer, hidden layer, and output layer. This model is now used in road safety as predicting crashes and previous research shows that this model predicts complex observation more precisely than the traditional regression model. As compared with the regression model than ANNs do not form a functional relationship between the dependent variable and independent explanatory variables as established in other statistical approaches.

The key element of a neural network as follows:

1. Each neuron has a net-input value which is multiplied by the weights plus the bias in the input layer of the network and also all neurons are highly interconnected in the processing.
2. In the network, the input layer composed the data as is known as independent variables, one or more hidden layers which do the processing and the output layer contains the

observed or desired output value. Every layer of network consists of neurons that connected every other neuron in the previous layer by a link that represents the weights.

3. In the neural network, there is some transfer function which is known as Activation



Function that is used for mapping from input to hidden nodes and from hidden to output nodes respectively.

I. Development of ANN Prediction Model

This model was developed in MATLAB software. The steps for developing the ANN model for prediction of road crashes are as follows:

1. The data imported in a variable window with a title as Input and Target from the Excel sheet. With the use of the "nntool" command the neural network dialogue box will be opened.

2. Also, the data set was divided into three sets, training data (about 70% of the total data set), validation data (about 15% of the total data set), and testing data (about 15% of the total data set).

3. The activation function used for developing model were:
   Input hidden layer: Tan-sigmoid transfer function
   Output hidden layer: Linear transfer function

4. The network is created with 3 hidden layers and 10 neurons. Then setting an initial value for weights and evaluating the output and also measured the errors. The weights continuously to be modified until a minimum error is computed. These are all done in a Training phase shown in figure 3.

Figure 3: *Image of Weight modification screen in MATLAB software*

5. After the training phase, the validation of the network model is carried out by comparing the predicted value with the observed value. In this phase, there is no adjustment carried out in the weights, and this process is carried out with a training process to improve the performance of the model.

6. And the last procedure is the testing phase in which the predicted values are compared with the input values using data that was not used in the training or validation process. Again, no adjustment occurs to the weights.

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7. The figure of the Artificial Neural Network model is shown in figure 4.

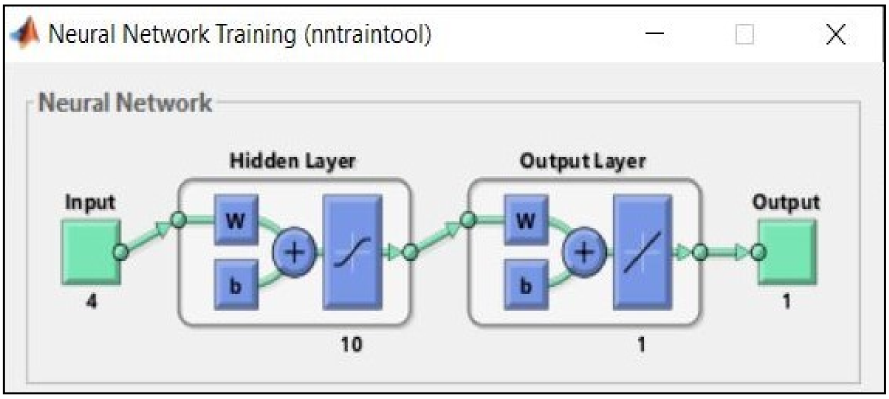

Figure 4: *Architecture of ANN model*

The network also gives the regression graph and R-value for different phases of the model means training phase, validation phase, testing phase. Here figure 5 shows all regression graphs with their R-value. The results found very satisfactory with the value of coefficient of determination (R square 0.8896). Also, F-test was performed between predicted and the observed value of road crashes and the result shown in table 4. Figure 6 and 7 shows the relation between predicted road crashes by the ANN model and observed road crashes per hour with an R^2 value of 88.79%.

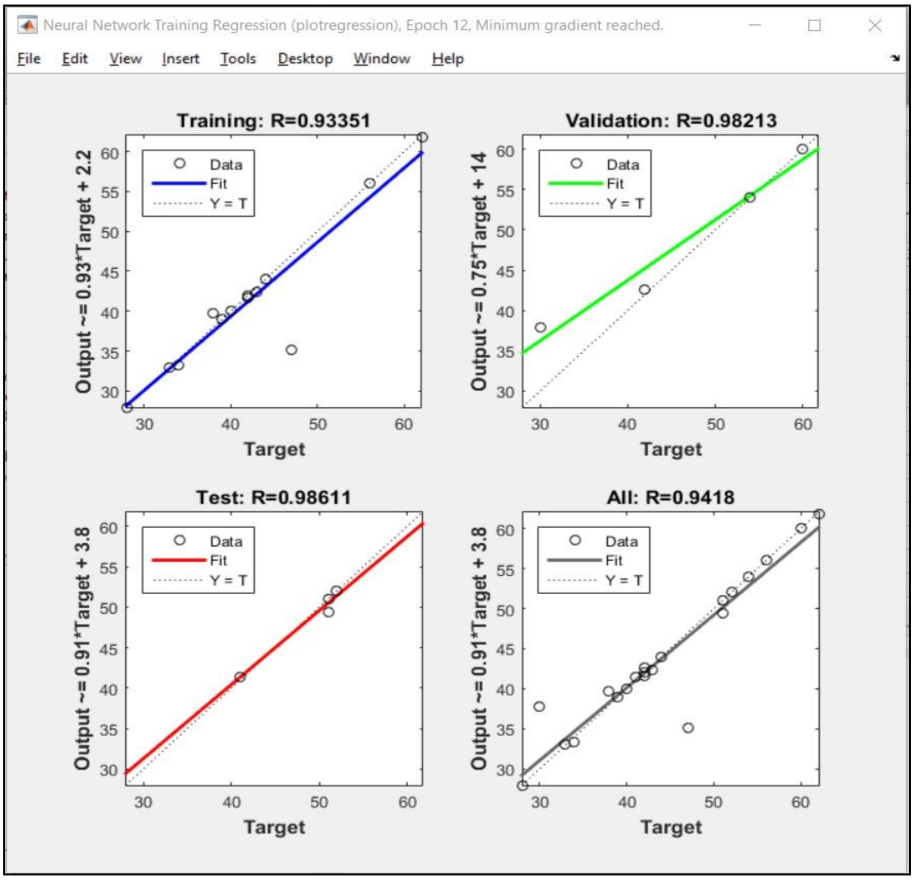

Figure 5: *Correlation between Observed and Predicted Accident Rate (ANN Model)*

Table 5: *F-test for two-sample for variables*

	Observed Crashes	Predicted Crashes
Mean	43.625	43.426
Variance	77.684	73.926
Observation	24	24
Df	23	23
F	1.0508	
P (F<=f) one-tail	0.4532	
F Critical one-tail	2.0144	

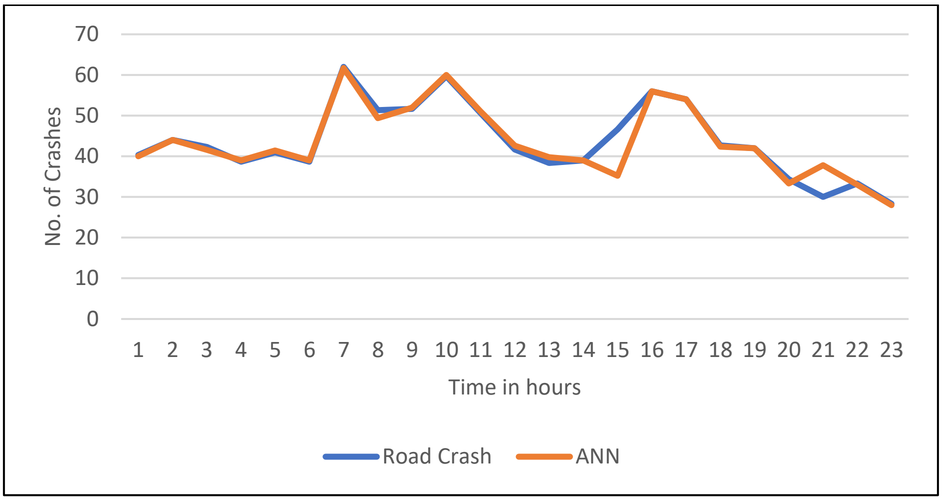

Figure 6: *Observed and Predicted Road Crashes by Artificial Neural Network*

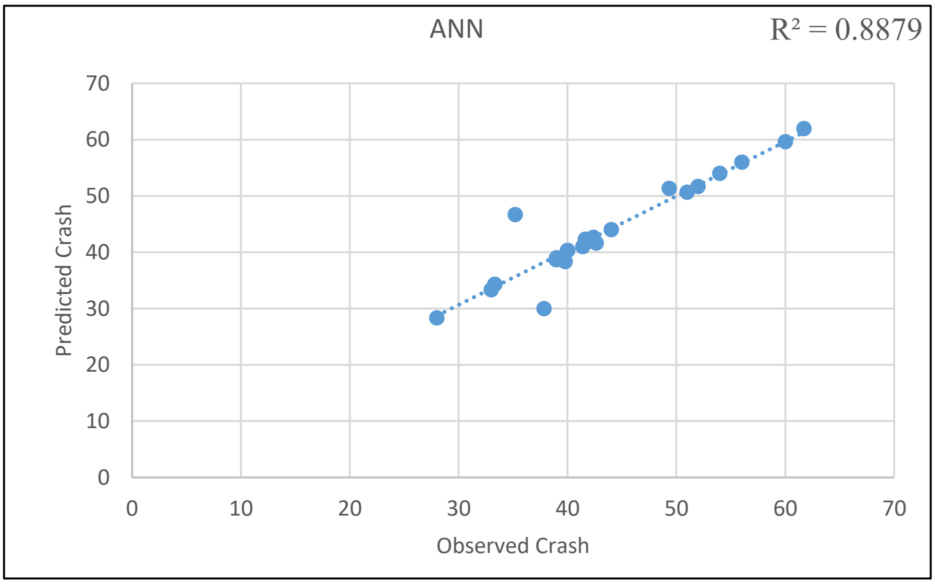

Figure 7: *ANN Model Validation Graph In between Observed and Predicted Accident Crashes*

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VII. Conclusion

The study was conducted with an objective of comparison between two models and determined which model give better result. From this research, it can be concluded entirely that:

The comparison between of these models was carried out by validation which is the plotting graph between predicted crashes by the models and observed crash, it was discovered that the ANN gave the better result. The R^2 value of ANN model is 88.79%. Meanwhile, the MLR model gave 58.67% which is lower than ANN model. Clearly, the result shows that the ANN model gives much better result compared to the Multiple Linear Regression model for the prediction of road crashes in this study.

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ANALYTICAL STUDIES RELATING TO BANDWIDTH EXTENSION FROM WIDEBAND TO SUPER WIDEBAND FOR NEXT GENERATION WIRELESS COMMUNICATION

Rajnikant Rathod, M. S. Holia

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Gujarat Technological University
rathod.45@gmail.com,msholia@bvmenginnering.ac.in

Abstract

In a recent scenario of advancement in the upcoming next-generation system reconstructed speech(voice) signal by the side of the receiver side found stiffened, barely audible, and slim because of limited bandwidth of 300-3.4 kHz. To get back the genuineness of speech(voice) signal, narrow band speech encoders must be upgraded to wide band encoders supporting 50-kHz bandwidth. The extensive period has been left for advancement from N.B. to fully W.B.'s well-suited systems. The terminal and network must be altered to make the N.B. system compatible with the W.B. system. During that span novel technique has been urbanized to widen the N.B. bandwidth of speech (voice) signal at handset end (receiver) for humanizing final speech quality. The technique of attaining the original W.B. signal from a band-limited N.B. speech(voice) signal without actually transmitting the W.B. signal is called bandwidth extension. The same concept applies to attain super wideband from the W.B. signal. B.W.E. based on sinusoidal transform coding, linear prediction, non-linear device is giving good results compared to spectral folding/spectral translation approaches employed by various researchers. In the modern scenario of advancement in technology, various coding algorithms have been urbanized for S.W.B. and F.B. to obtain the full benefit of advancement in available telecommunications bandwidth, predominantly for the internet. In the proposed method based on source filter model fundamental thought adopted for the B.W.E. are the separate extension of the spectral envelope and the residual signal. Each part is processed separately through different speech enrichment procedure to get the highband component and added to the resampled and delayed version of the signal to acquire the final extended output which is compared through intelligibly(subjective) and quality(objective) perspective and results are compared with baseline algorithm and next-generation super wide band coder algorithms to prove that obtained results are comparable with both algorithms. Algebraic evaluation for getting missing high band components from the original W.B. signal is not needed and method tremendously well-organized and commence only minor time interval or delay..

Keywords: Super wideband, Linear prediction analysis, Enhanced voice service coder, Mean opinion score

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I. Introduction

Third and fourth generation wireless communication (W.C.) system is becoming popular in the world market due to their low bit rate coder and it was proposed to provide interactive multimedia communication including teleconferencing, internet access and an assortment of another service that becomes practicable with low complex, low cost, low bit rate and less processing delay. So one can articulate that these are the major attributes that play a vital role while designing any particular coder. In digital telecommunication systems, it is always demanded to transmit speech(voice) signal powerfully[1,3].Public switched telephone network (P.S.T.N.) shrink the bandwidth(B.W.) of the transmitted speech(voice) signal from the frequency range of 50 Hz to 7 kHz to 50 Hz to 3.4 kHz. The condensed bandwidth leads to a stiffened, barely audible, and slim sound. As per the recommendation of ITU-T conducted listening tests it is well clear that the speech(voice) B.W. affects the perceived voice(speech) quality[2].

The introduction of the wide band(W.B.) communication system aggravated the transmission of the W.B. signal having a cutoff frequency of at least 7 kHz for improved speech quality in form of the intelligibility and naturalness. The restricted access problem in the employment of W.B. coders and communication is the up-gradation of current narrow band (N.B.) coders and transmission to the W.B. system where hardware and software up-gradation and compatibility are forever a major issue. Better speech signal quality performance offered by W.B. coders, at rest hasty alternate of complete N.B. coding and transmission systems is not sufficient due to remarkable infrastructure expenses incurred to network operators and also for the customers who want to make use of the system. One decade has been elapsed for changing over existing N.B. systems to fully W.B. compatible systems. The terminal and network must be updated to make the N.B. system compatible with the W.B. system. During that span novel approach has been urbanized to widen the N.B. B.W. of speech (voice) signal at the handset end (receiver) for humanizing final speech quality[5].Bandwidth extension (B.W.E.) system for speech signals is a compelling and reasonable option to acquire wideband speech with excellent quality sound for the existing wireless communication infrastructures viz. P.S.T.N. and Global System for Mobile Communication (G.S.M.)[1].

There are two types of bandwidth extension techniques of speech (voice). In one technique namely the blind bandwidth extension technique the missing frequency component is achieved from the available N.B. speech component with not necessary to transmit data about the stolen frequencies because the expansion is wholly w.r.t. N.B.'s speech signal, these techniques can be done at the enviable end of the channel. The other technique namely the non-blind bandwidth extension technique depends on the steganography (data hiding) method. The greater part of the prior strategy makes W.B. speech by source filter model(S.F.M.) demonstration [4], excitation signal, and linear prediction(L.P.) coefficient for the spectral envelope. The B.W.E. techniques of speech because of the data hiding method insert high-frequency segments data into the N.B. speech bit stream, and then at the user end terminal, the WB speech is recaptured w.r.t. high-frequency data. A limitation of the B.W.E. technique with side data is that a similar technique is bolstered at the two ends of the transmission line[7,8]. In this paper bandwidth extension of speech(voice) signal based on S.F.M. is carried out.

This paper is mainly structured into six sections. Sect.2. describes the problem definition and Sect.3. denotes the details of reported previous works. In Sect.4, theory related to bandwidth extension from N.B. to W.B. and W.B.to S.W.B. has been discussed. In Sect. 5, the results obtained through a series of simulation in MATLAB has been depicted. Finally, the concluding remarks are given in Sect.6.

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II. Problem Definition

In the modern state of affairs of wired and wireless communication systems reconstructed speech(voice) signal at the end device is found stifled and slim due to non-attendance of high band(H.B.)spectral components[1]. Limited bandwidth of 300-3.4 kHz trims down superiority and clearness of voice signal as a result of going astray high-frequency components which play a significant role particularly in consonant sounds[6]. So to get back the genuineness of speech(voice) signal N.B. speech encoders must be upgraded to W.B. encoders that support bandwidth(BW) of 50Hz-7kHz.

In the last couple of decades, trivial research has been carried out for upgrading existing N.B. systems to fully W.B. compatible systems. The terminal and network must be modified and upgraded to make the N.B. system compatible with the W.B. system. During that span novel technique has been urbanized to widen the N.B. B.W of speech signal at handset end (receiver) for humanizing final speech quality. This technique converts original N.B. signals into Artificial W.B. signals by estimating the missing high-frequency contents based on the existing low-frequency contents. W.B. improved speech reproduction with no reaching the natural quality of face-to-face exchange or the high quality of professionally recorded speech. Now a day's various coding algorithms have been built-up for super wideband (S.W.B.) (50 Hz –14 kHz) and full band (FB) (20 Hz –20 kHz) to obtain the full benefit of advancement in available telecommunications bandwidth, predominantly for the internet. In the recent scenario of advancement in next-generation wireless communication systems, numerous elegant devices hold up premium speech communication services at S.W.B.. S.W.B. can be attained from the W.B. signal by utilizing the concept of B.W.E. without the burden of data rate and changing of a network component. This paper focuses on the novel approach based on the S.F.M. for evaluating the performance of the speech signal.

III. Previous works.

While studying bandwidth extension several parameters and constraints need to be taken into consideration and propose a highly efficient algorithm that introduces only negligible latency. During the literature review, many research papers, journals, and other articles on bandwidth extension are referred. A general overview of the bandwidth extension has been presented in many research papers [8-17]. This step led us to define the problem of research. [18] gives a solution to trim down the wideband speech coder bitrates by coding the parameters of wideband voice(speech) employing noteworthy enlarge in bitrates of N.B. coders.[19-21,22] were discussed various approaches based on the linear prediction algorithm using L.P.C. coefficients and focus on the codebook mapping approach and model the bandwidth extension and make subjective measurement comparison for various audio wave files. Performance assessment of speech(voice) signal based on the sub-band filter and source filter model are discussed in [17,23] and found that linear prediction is an effective tool for the bandwidth extension and play a very significant role in achieving data rate compression. The detailed linear perdition analysis and synthesis and stability criteria also studied and found that for next-generation wireless communication bandwidth extension from the signal itself (without sending sideband information) is useful for data rate reduction because no need for sending information in sideband is needed for reproduction of signal at the receiver side. Codebooks mapping [24,25], linear mapping [26], neural networks etc.. is used to estimate the missing components[27-29] bring into being the potential features of speech, and evaluate their performance for B.W.E. application.[30,31] targeted a narrative method to achieve bandwidth extended output at far end terminal without alteration and up-gradation of the current N.B. system. In [17] the author has done work on various methods for bandwidth extension. In [16] the author has designed the S.F.M. based on the vocal tract to retrieve bandwidth extended output.

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IV. Discussion

I. B.W.E. from N.B. to W.B. Speech Conversion

In Digital Signal Processing signals are band-limited w.r.t. use of sampling frequency,N.B.,W.B., S.W.B. Speech has a sampling frequency of 8Khz, 16Khz, 24Khz respectively. Based on N.B. to W.B. speech conversion and baseline algorithms(H.F.B.E.), the proposed method for W.B. to S.W.B. has been discussed. which is a blind method because they estimate missing H.F. component from available L.F. components. The proposed flow chart of bandwidth extension based on baseline and proposed algorithms discuss the achievement of W.B./S.W.B. speech signal at the receiver side without actually transmitting W.B./S.W.B.

II. General Model for BWE

The fundamental thought adopted here for the bandwidth extension system is the separate extension of the spectral envelope and the residual signal as depicted in "Fig.1".First, the incoming telephone-band signal is analyzed through the LPC-analysis. based on the spectral envelope and further telephone-band short time features the spectral envelope is extended. The extended version is essential to define the shaping filter characteristic. The extended residual signal for this shaping filter is calculated from the telephone-band residual signal as highlighted in "Fig.1". According to the linear model of speech production, the synthetic signal is generated by driving the shaping filter with the extended residual signal. The resulting power of the synthetic signal has to be matched to the telephone-band signal power such that both signals can be added to build the desired wide-band signal[6].

III. Baseline System Model for B.W.E.

As shown in "Fig.2",The baseline system model accepts decoded data as input from any lossy audio decoder and recreates high frequencies blindly i.e. by using only the decoded audio signal and nothing else. Since the bandwidth of the input signal is unknown it is first estimated by using a real-time bandwidth detection process. After detecting the highest frequency present in the signal at any given time, the decoded signal is divided into sub-bands up to half the detected highest frequency of the signal. Each sub-band signal is then individually passed through non-linearity to generate harmonics. The generated harmonics are gain scaled to achieve spectral envelope shaping and added back to the original signal[32,33].

IV. Proposed System Model for B.W.E.

"Fig.3",depicts the Proposed S.F.M. based Algorithm block diagram for W.B. to S.W.B. speech(voice) conversion. The block diagram is mainly categorized into four parts as narrated below:

(1) first and main important steps is to acquire the W.B. input signal from pre-processing stage and the framing & windowing is performed on WB input signal.

(2) In second Steps the output of the first step is carried out by L.P. algorithm to divide the signal into two parts spectral information and residual error signal, so one can say that missing H.F. component are estimated from accessible L.F. components only.

(3) In third step original L.F. component are extracted from input WB frame by zero insertion.

(4) In final step both the L.F. and H.F. component are added together to get estimated S.W.B. output.

V. Detailed Analysis of Proposed System Model

Framing

Partitioning of a speech signal into frames is the first basic component of our proposed approach. on the whole, a speech(voice) signal is not stationary, but it is typically is stationary in windows of 20 ms. Therefore the signal is divided into frames of 20 ms which corresponds to n1 samples:

$$n_1 = t_{st} * f_s \text{ ....(1)}$$

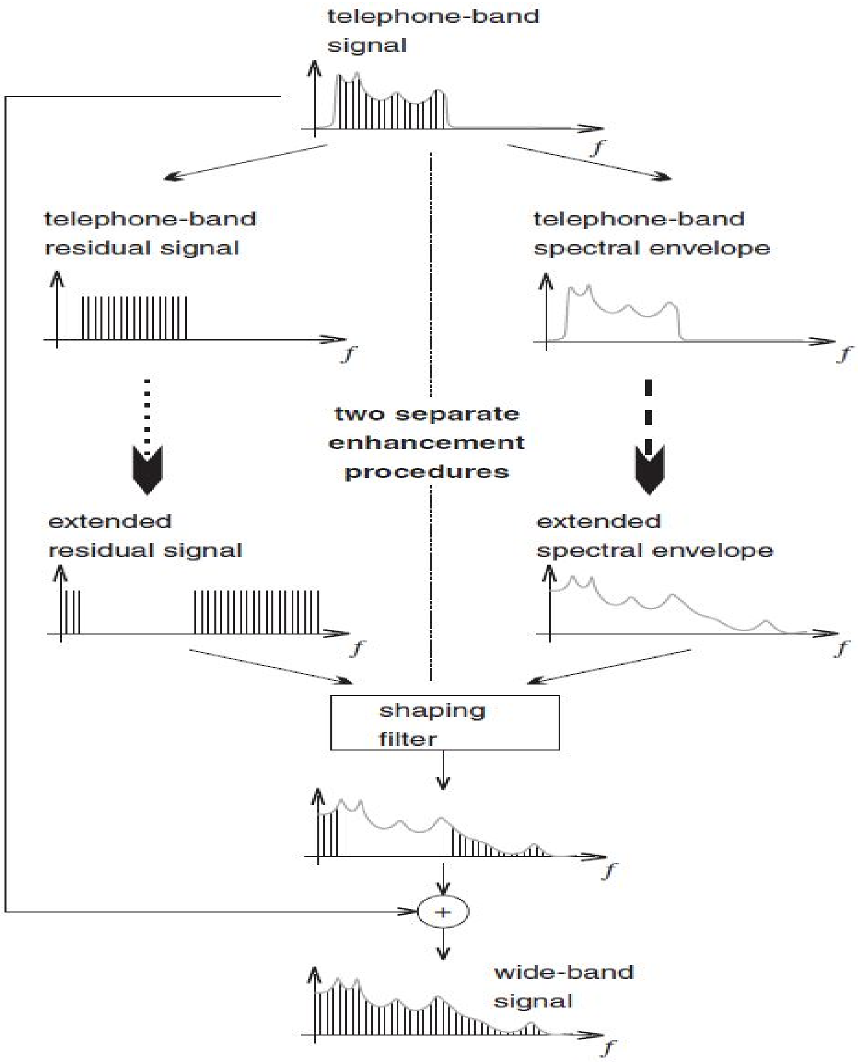


Fig. 1. General Model for B.W.E.[9]

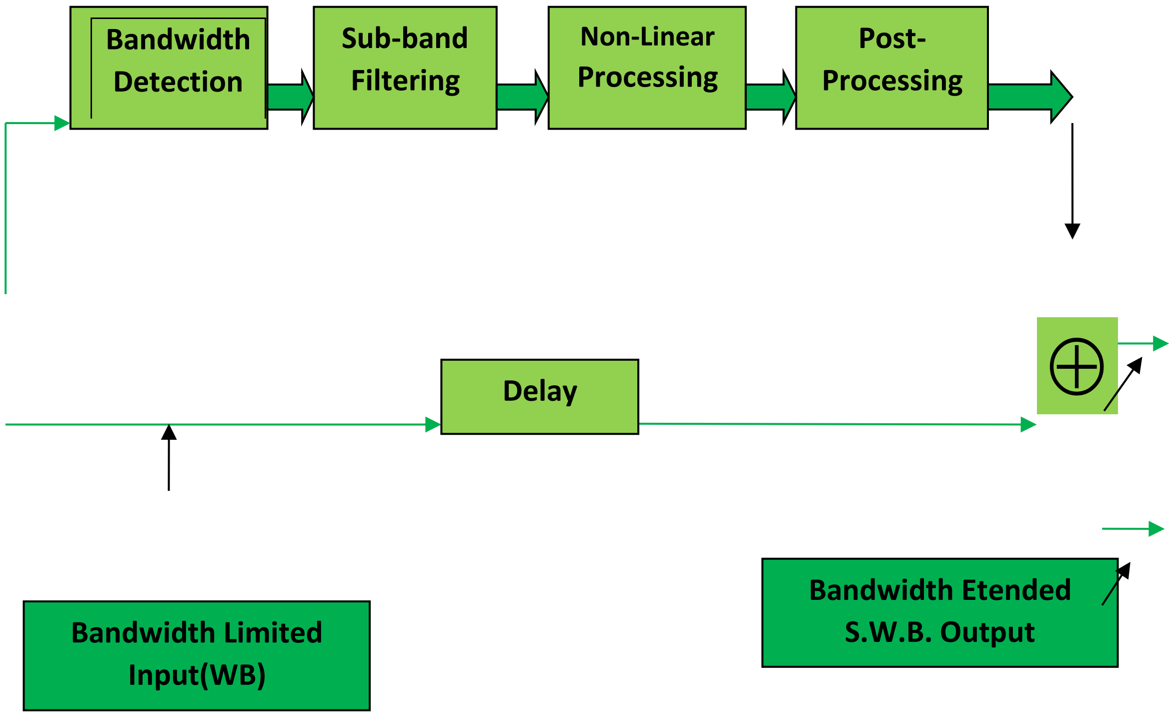


Fig.2. High Frequency Bandwidth Extension (H.F.B.E.) Algorithm[32

Fig.4 depicts pictorial representation for framing the signal into four frames of 20 ms.

Windowing

During frame blocking, there is a possibility that signal discontinuity may arise at the beginning and end of each frame. To reduce the signal discontinuity at either end of each block the next step employed is windowing. The window function exists only inside a window and evaluates to zero outside some chosen interval. When multiplied with the original speech frame, the window function taper down the beginning and the end to zero and thereby minimize spectral distortion at both the end. The simplest rectangular window function is given by

$$\omega(n) = \begin{cases} 1, & 0 \le n \le N-1 \\ 0, & \text{otherwise} \end{cases} \qquad \text{......................(2)}$$

A more commonly used somewhat smoother function (hamming window) is defined as

$$\omega(n) = \begin{cases} 0.54 - 0.46\cos\frac{2\pi n}{N-1}, & 0 \le n \le N-1 \\ 0, & \text{otherwise} \end{cases} \qquad \text{................(3)}$$

where n= sample number in a frame,N= total number of samples & 10-30ms window length[6].

Linear Prediction

Linear prediction (L.P.) is the heart of the bandwidth extension algorithm for N.B. to W.B. and W.B. to Super wideband(S.W.B.). In linear prediction, the present sample can be estimated as a linear combination of past samples[32]. "Fig.5", represent all-pole spectral shaping synthesis filter. Naturally, three filters namely glottal pulse model G(z), vocal tract(VT) model V(z), and radiation model R(z) are utilized to model the speech creation. The glottal pulse model(GPM) contour the pulse train before it is used as input to V(z). Three models together can be represented via single T.F. H(z), i.e.:

$$H(z) = G(z)V(z)R(z)$$

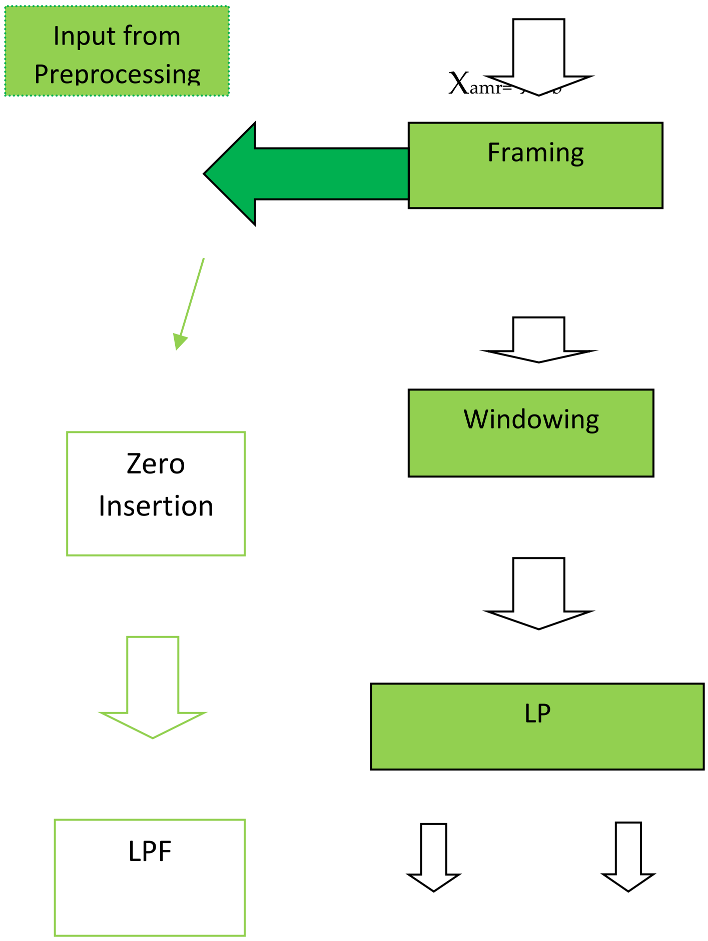
Where H(z) is called as the synthesis filter and is shown in "Fig.5", Obviously the synthesis filter can be represented via the inverse of the analysis filter, i.e.:

$$H(z) = 1/A(z)$$

In this way, we can parameterize a voice signal and it is a suitable and precise method[10].

H.F. & L.F. Component addition to get estimated SWB speech signal

As discussed in Step 2 of the proposed system model for B.W.E. hereafter the framing, windowing, and LP analysis the signal is divided into two different parts namely spectral envelope estimation and residual error signal. Both parts are processed separately as shown in the figure and shaped by shaping filter and High pass



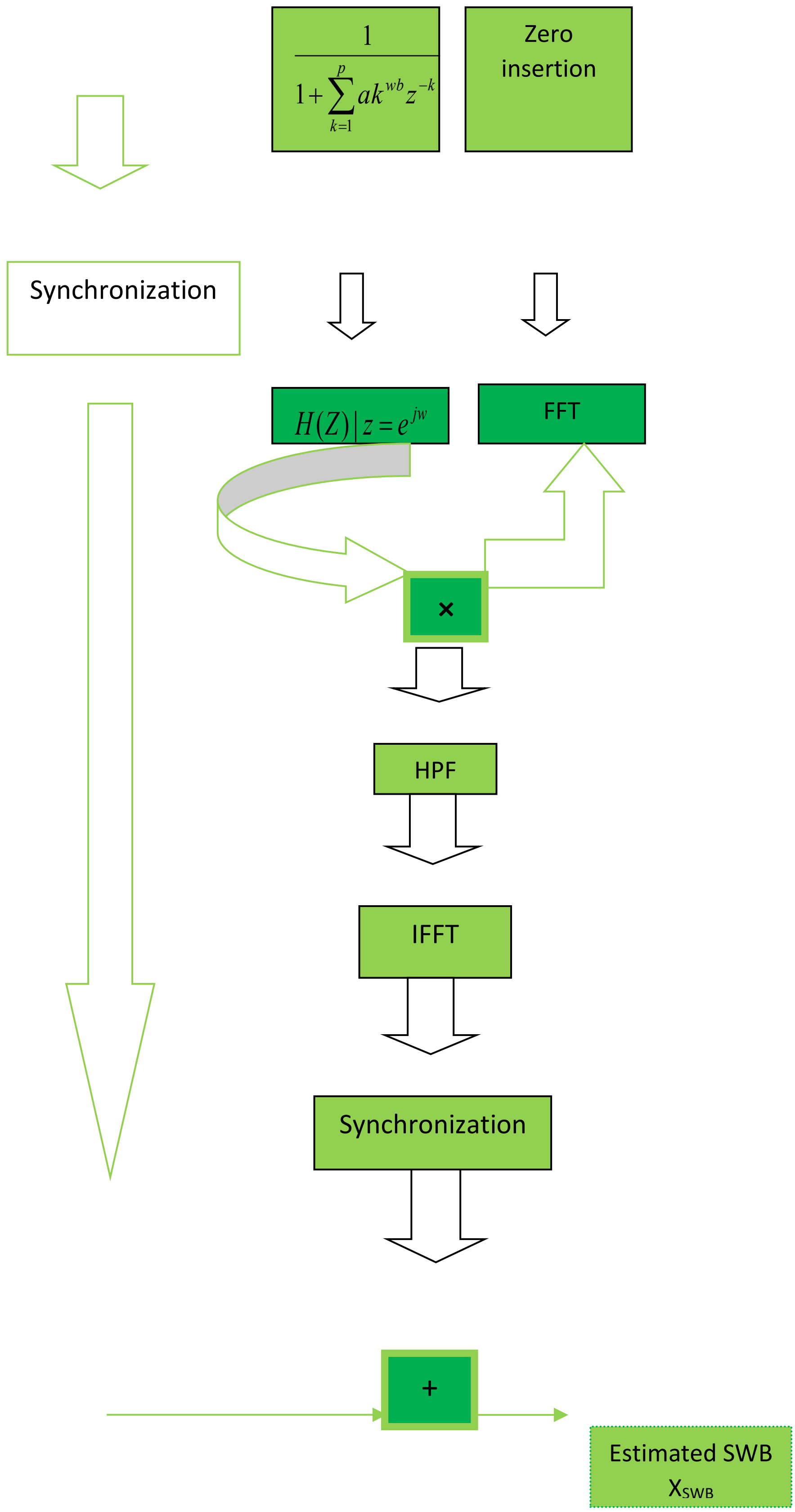


Fig. 3 Block diagram of the proposed approach for W.B. to S.W.B.

speech (voice) signal

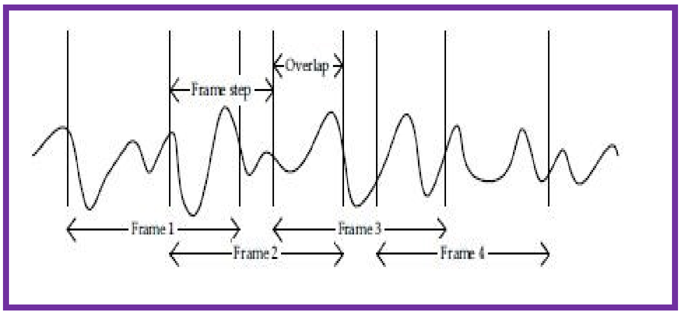


Fig.4. Pictorial Representation for Framing [7].

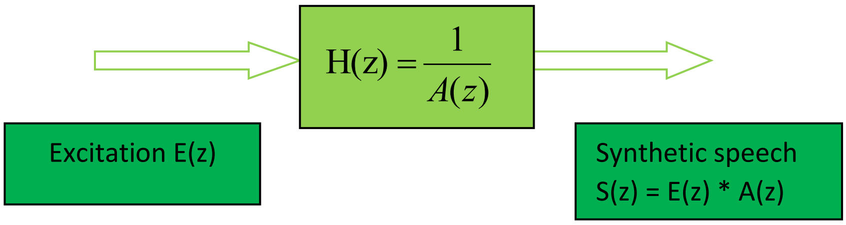


Fig. 5. All Pole Spectral Shaping Synthesis Filter

filter to get H.F. component. The Band's limited signal at the input side is resampled via zero insertion to get the L.F. component. after getting both components they are added together via the over-lap add method to get the estimated SWB output. "Fig.6", Depicts the proposed flow for W.B. to S.W.B. and subjective and objective measurement. As shown in the flow diagram first the simulation parameter is defined and the required filter is loaded. After that, the speech files AMRWB, EVS, S.W.B. are read by utilizing audio read function and it is passed through the H.F.B.E. algorithm function as shown in "Fig.7", H.F.B.E. baseline algorithm first W.B. signal is up sampled via zero insertion and low pass filter. after that to extract the highest octave from the up-sampled W.B. signal and find out the

absolute value of function bandwidth detection, sub-band filtering, and N.L.D. devices are utilized. After that to capture the required parts of the spectrum and omit the remaining part post-processing with Filtering is utilized and finally, it is added with a delayed version of input to get the required S.W.B. output.

"Fig.8", depicts the proposed algorithm proposed flow chart for obtaining the estimated S.W.B. signal. The basic difference between the baseline and the proposed approach is that in baseline only AMRWB input, filter, and gain parameter are processed while in the proposed approach three parameters like LPC order, NFFT Points, window length of S.W.B. are additional parameter to be processed. In the proposed method input W.B. signal framing, separation of a framed signal into a spectral envelope & residual error, and finding of missing H.B. components are done in a loop which is to process for the whole number of frames. then after adjustment of delay H.B. and N.B. components are added to get the estimated S.W.B. signal. then spectrogram, objective & subjective measurement are performed on the estimated S.W.B. signal w.r.t. input wave files.

All experiments reported here were carried out by utilizing voice records from The CMU file(database) [34] & TSP file(database) [35] at different sampling rate fs,

Data Pre-Processing and Assessment for W.B. to S.W.B.

"Fig.9",demonstrates the data pre-processing and assessment for W.B. to S.W.B.. TSP and CMU ARCTIC were down sampled to SWB signals databases so that both the databases have a common fs of 32kHz. Down sampling can be done employing the ResampAudio tool contained in the AFsp package [36]. The voice level of all utterances in both file(databases) maintained to 26dBov [37] to produce Xswb. After that next-generation voice coder (EVS) encoding [38] is applied to produce Xevs, Xswb down sampled to 16kHz and processed through BPF[39] as per recommendation P.341, so finally we can get the data Xwb, on which AMR-WB coding [40] has been applied to produce Xamr, (Xwb in Fig. 10 is replaced by Xamr). As shown in "Fig.3", Xamr is the input to baseline/proposed Algorithm to get the Estimated S.W.B. output after processing the signal through the Algorithm. The proposed B.W.E. algorithm is to evaluate and compare to AMR-WB and next-generation voice coder(E.V.S.) processed voice signals, baseline H.F.B.E.algorithm[32].Subjective& objective measurement for W.B. to S.W.B..

For quality measurement which is highly subjective in nature subjective evaluation comparison based mean-opinion score (C.M.O.S.), mean opinion score (M.O.S) ratings are performed on various speech files [28,41]. In each examination bandwidth, extended signals are compared with X_{EVS} and X_{EHBE}. Each examination was carried out by 56 listeners, among them 28 were male and 28 were female Speakers. They were requested to judge against the superiority of 13 randomly ordered pairs of speech signals X and Y, either X or Y can be processed with the proposed algorithm and remaining by baseline or next-generation coder. The selected wave files were judged by individual listener and give a rating to the selected wave files in the range of -3 to 3 (7 Scale) where -3 is much worse and 3 is much better. zero ratings meaning both are of the same quality.-2 & -1 for slightly worse and worse while 1 & 2 rating means better and slightly better. The age group selected for the above measurement is in between 21years to 50years. As shown in Table 1 Each Listener has given the rating in the scale of -3 to 3 for Each of the 13 wave files and finally, the average value of all listeners are calculated to rate/judge the M.O.S. Score of the proposed algorithm and baseline/next generation coder algorithm. here the table is prepared for proposed coder, the same way table can be prepared for baseline/next generation coder algorithm. The samples were played using logitech good quality headphones. speech files used for quality measurement are available online. For intelligibly measurement which is highly objective in nature PESQ can be characterized as

$$y = 0.999 + \frac{4.999-0.999}{1+e^{1.3669*x+3.8224}} \quad \text{..............(1)}$$

where x is the raw P.E.S.Q.output (ITU P.862.2). one can use the above expression to obtain an equivalent PESQ score for the M.O.S.L.Q. score (=y) as discussed in subjective measurement for W.B. to S.W.B.. the below expression can be used to get P.E.S.Q.output from M.O.S.L.Q. score[41].

$$x = \frac{4.6607 - \ln\left[\left[\frac{4.999-y}{y-0.999}\right]\right]}{1.4945} \quad \text{.............(2)}$$

V. Result Analysis

From the MATLAB based simulation results obtained through programming in MATLAB in terms of subjective measurement(mean opinion score) the result of the proposed coder is comparable in comparison with the baseline algorithm and next-generation super wideband E.V.S. coder as seen in "Fig.10",. by using equation 1 we can convert M.O.S.L.Q. score into P.E.S.Q. Score and we can get comparable result for proposed method based on S.F.M. in terms of P.E.S.Q. Score like mean opinion score in comparison with the baseline algorithm and next-generation Super wideband E.V.S. coder. The comparative analysis of all algorithms for various wave files has been carried out as shown in Tables 1 and 2 and from the results, it can be concluded that the result of the proposed coder is comparable in comparison with the baseline algorithm and next-generation Super wideband E.V.S. coder. By observing the spectrogram of input and output speech files for baseline, proposed as well as a next-generation coder and by comparing all the performed results one can say that in the bandwidth-limited input signal(N.B./W.B.) the required spectral component is absent due to missing HB information and the result obtained by proposed coder are comparable in comparison with baseline algorithm and next-generation super wideband E.V.S. coder as shown in "Fig.11",and "Fig.12".

VI. Conclusion

In this paper, an approach to B.W.E. lying on S.F.M.(L.P.) for W.B. to S.W.B. is discussed with measurement based on subjective and objective criteria. By performing an experiment for various speech files and comparing the spectrogram of estimated S.W.B. with the baseline algorithm & next-generation super wideband (E.V.S.) coder algorithm one can say that the results obtained are comparable to the next-generation super wideband (E.V.S.) coder algorithm & baseline algorithm. By observing various spectrograms one can say that in the bandwidth-limited input signal(N.B./W.B.) the required spectral component is absent due to missing H.B. information and the result obtained by the proposed coder are comparable in comparison with baseline algorithm and next-generation Super wideband E.V.S. coder.

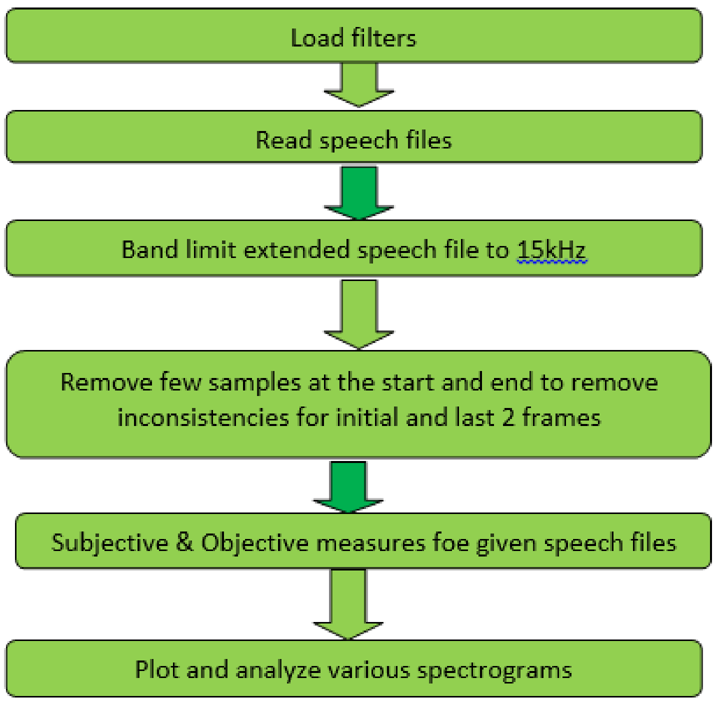


Fig.6. Proposed Flow for W.B. to S.W.B. & Subjective and Objective Measurement

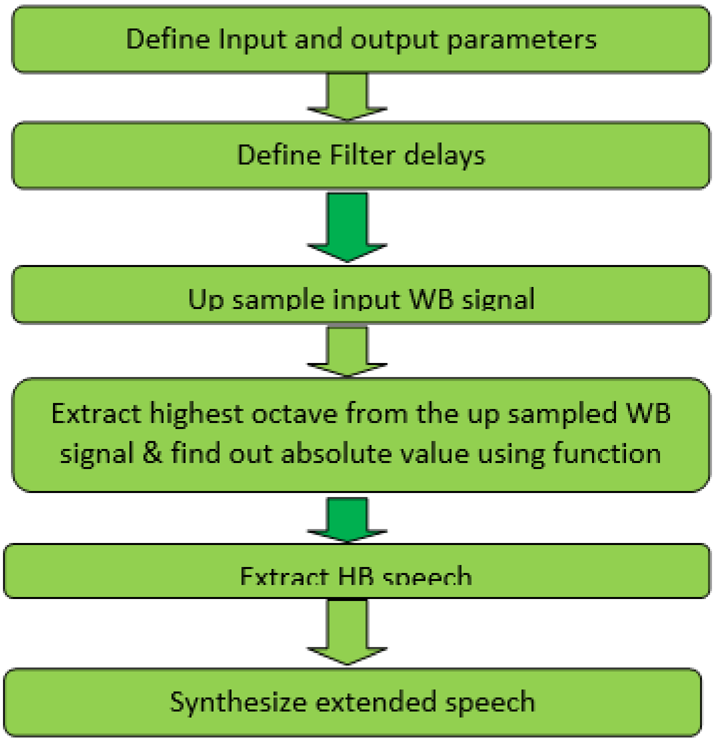


Fig.7.Baseline Algorithm Proposed Flow

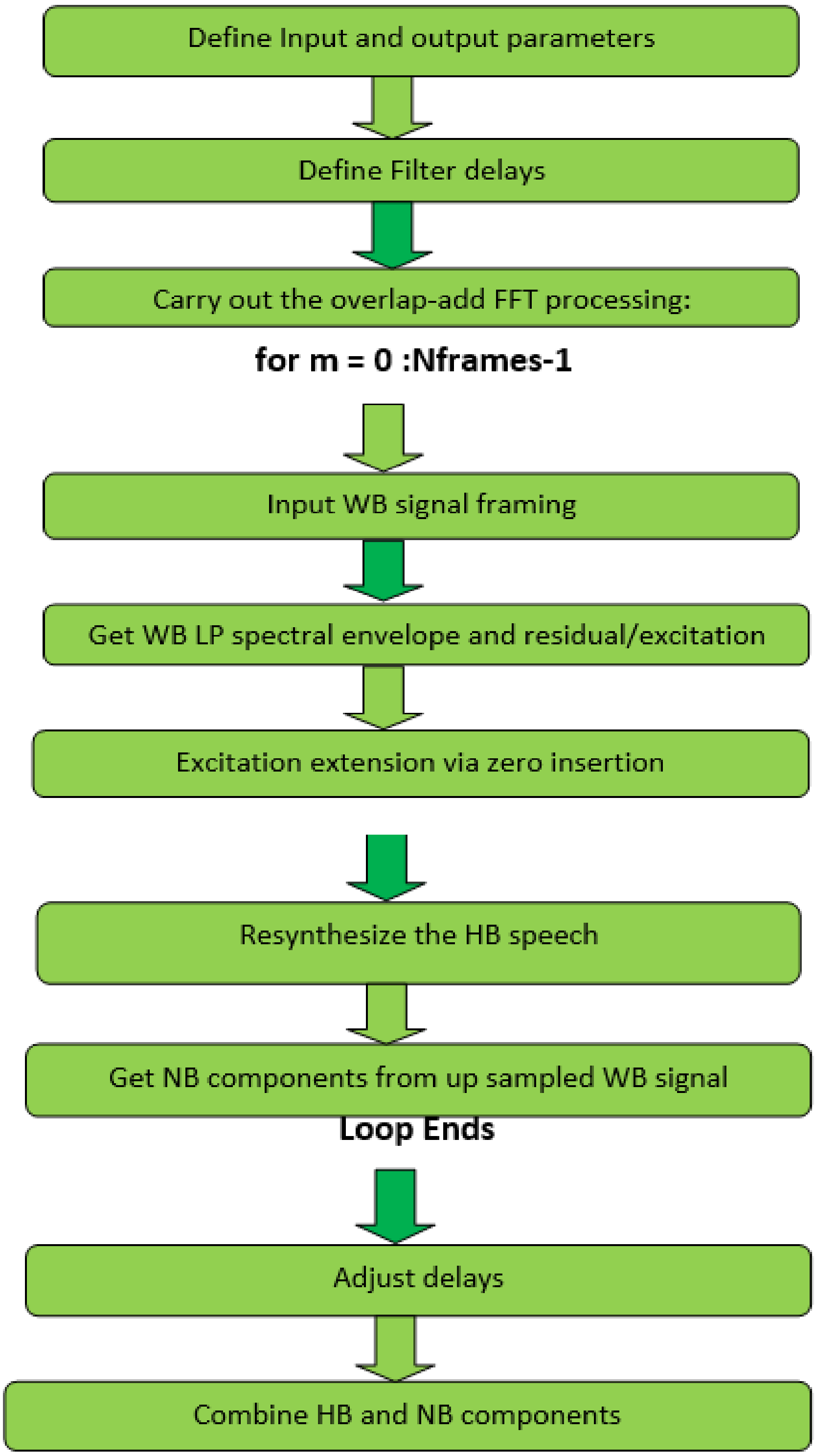


Fig.8. Proposed Algorithm Proposed Flow Chart

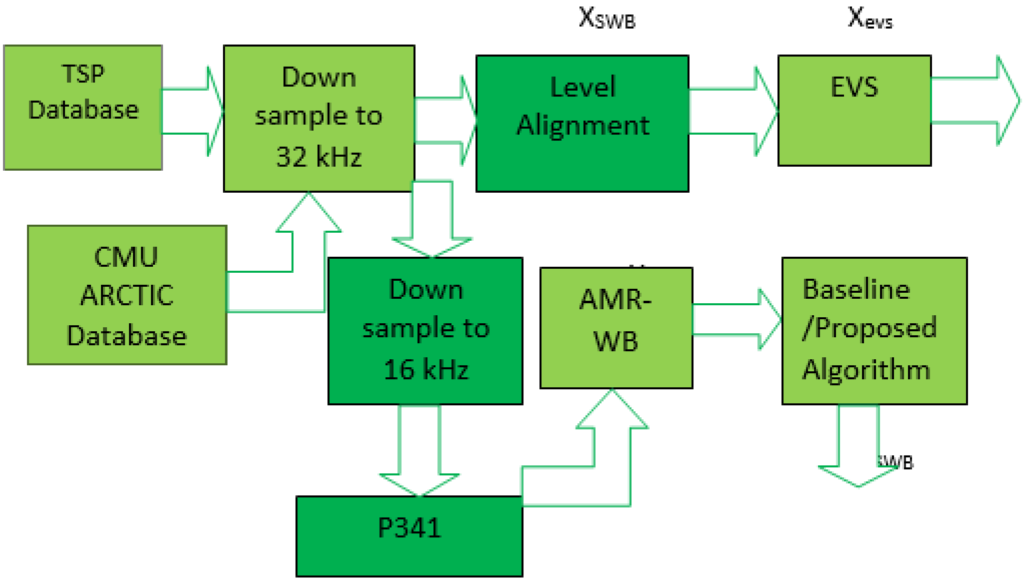


Fig. 9. Data Pre-Processing and Assessment for W.B. to S.W.B.

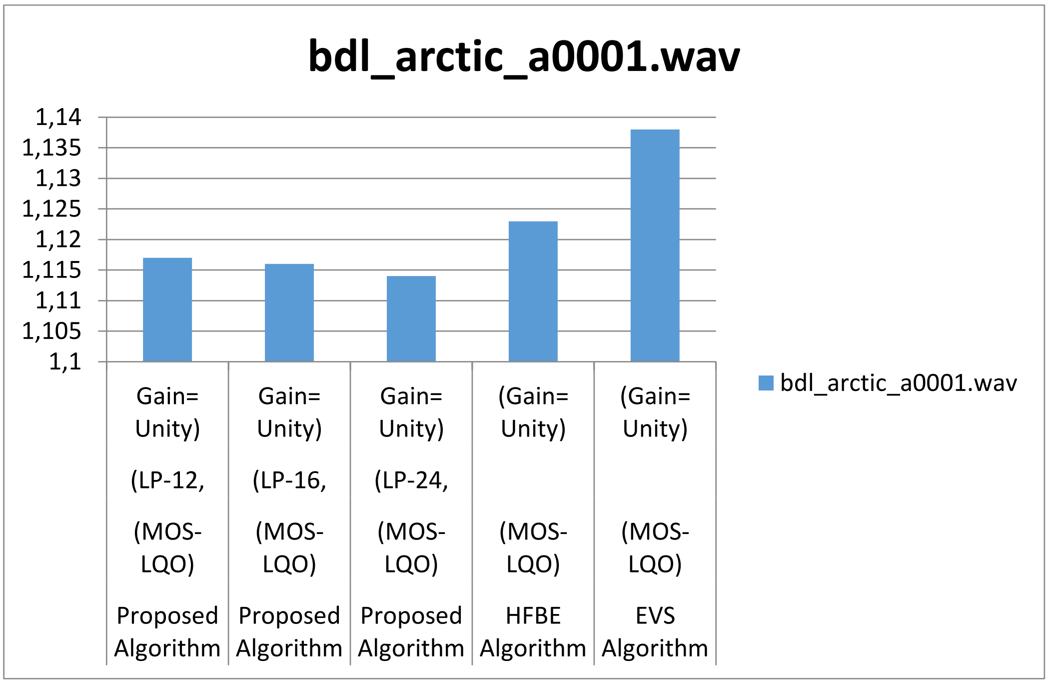


Fig. 10. MOS-LQO for PROPOSED, HFBE, LP_order=12,16,24 & EVS Algorithm for one SWB wav file

TABLE I. M.O.S.-L.Q.O. for Proposed, H.F.B.E., LP_order=12,16,24 & E.V.S. algorithm for 13 different speech files

Speech Files	**Mean Opinion Score**				
	Proposed Algorithm (LP_12)	***Proposed Algorithm (LP_16)***	***Proposed Algorithm (LP_24)***	***HFBE Algorithm (Baseline)***	***EVS Algorithm***
MA01_01	1.469	1.477	1.473	1.816	4.644
MA01_02	2.116	2.128	2.123	2.573	4.644
MA01_03	1.726	1.739	1.729	2.189	4.644
MA01_04	1.572	1.562	1.558	1.992	4.644
MA01_05	1.926	1.959	1.953	2.388	4.644
FA01_01	1.143	1.145	1.142	1.223	4.644
FA01_03	1.186	1.189	1.182	1.287	4.644
FA01_04	1.145	1.15	1.142	1.241	4.644
FA01_05	1.234	1.239	1.231	1.365	4.644
arctic_a0002	1.369	1.379	1.37	1.606	4.644
arctic_a0003	1.24	1.242	1.233	1.37	4.644
arctic_a0004	1.552	1.568	1.562	1.834	4.644
arctic_a0005	1.696	1.7	1.69	1.964	4.644

TABLE II. P.E.S.Q. for Proposed, H.F.B.E., LP_order=12,16,24 & E.V.S. algorithm for 13 different speech files

Speech Files	**PESQ**				
	Proposed Algorithm (LP_12)	***Proposed algorithm (LP_16)***	***Proposed Algorithm (LP_24)***	***HFBE Algorithm (Baseline)***	***EVS Algorithm***
MA01_01	1.335	1.34	1.336	1.8	1.094
MA01_02	2.114	2.125	2.121	2.48	1.094
MA01_03	1.712	1.721	1.718	2.17	1.094
MA01_04	1.509	1.528	1.524	1.991	1.094
MA01_05	1.913	1.925	1.918	2.34	1.094
FA01_01	1.126	1.128	1.123	0.73	1.094
FA01_03	0.165	0.17	0.164	0.92	1.094
FA01_04	1.138	1.142	1.139	0.78	1.094
FA01_05	0.77	0.78	0.772	1.114	1.094
arctic_a0002	1.128	1.137	1.131	1.54	1.094
arctic_a0003	0.78	0.79	0.782	1.138	1.094
arctic_a0004	1.46	1.48	1.470	1.7	1.094
arctic_a0005	1.66	1.66	1.63	1.958	1.094

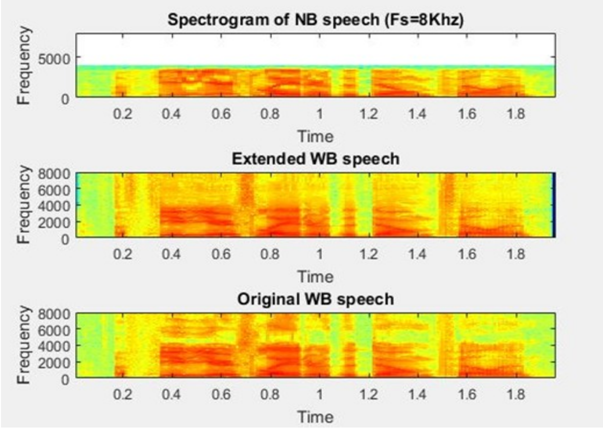


Fig.11. Spectrogram for speech file A1.wav

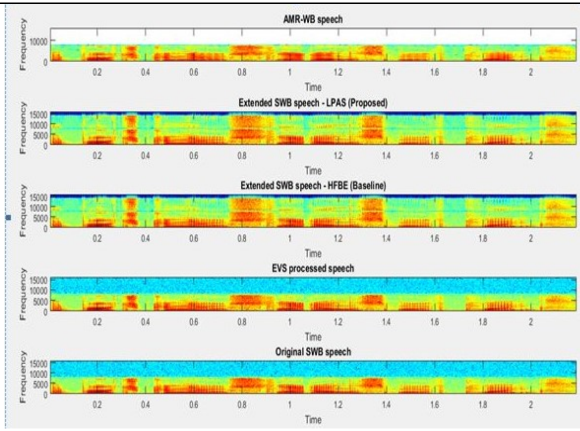


Fig. 12. Spectrogram for speech file MA01_01.wav

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SURVEY ON VARIOUS ECG SEGMENTATION TECHNIQUES

Dhruv Patel, Prof.Mayur Sevak, Parikshit Mishra, Vatsal Shah
•
Birla Vishvakarma Mahavidyalaya
dhurvpatel2308@gmail.com

Abstract

Heart is the most important organ of the human body. The heart pumps the blood throughout the body so it is necessary to track heart activity. An electrocardiograph is a technique to measure heart activity. In thistechnique,the electrode is attached on the surface of the body, and by recording those signals doctor diagnosis that symptoms of the person are normal or abnormal. ECG segmentation is one of the most important methods for the analysis of processing of ECG signals that comprises compression tasks, filtration, heart rate variability studies (HRV), and beats classification or grouping. In this study, we have surveyed various ECG segmentation techniques perform by various eminent authors working in this field. The purpose of this article is to provide an insight view of the algorithms and techniques utilized by these authors which can be helpful for the neophytes in this field.

Keywords: ECG, Waves of ECG, ECG Segmentation.

I. Introduction

SCA (Sudden Cardiac Attack) is the emerging disease in the twenty-first century irrespective of a person's age. Heart failure is one of the essential reasons that cause many people to lead to death.ECG is a technique used to measure the electrical activity of the human heart that offers cardiologists information about the functioning of the human heart. It is useful in determining and diagnosing heart rate, heart rhythm, abnormal electrical conduction, poor blood flow to the heart muscle, heart attack, coronary artery disease, hypertrophy of heart chambers. Figure 1 shows the ECG wave.[5]

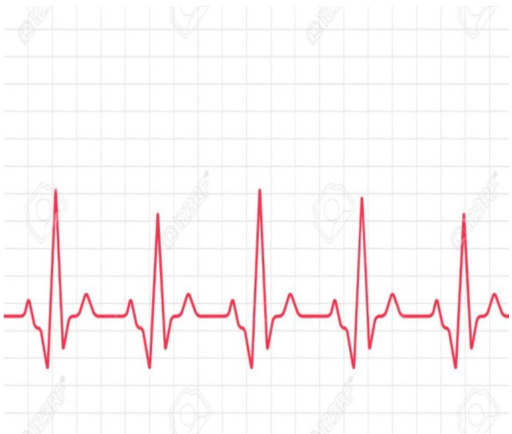

Figure 1: *ECG Wave.*

The whole ECG signal is decomposed in P-wave, QRS complex and T-wave. P-wave is a positive and first wave in ECG also known as atrial complex. It is produced due to the depolarization of atrial musculature. Q wave is a small negative wave that is continued as a tall R wave which is a positive wave followed by a small negative wave S wave. The QRS complex is also called the initial ventricular complex. It is due to the depolarization of ventricular musculature. Q wave is due to the depolarization of the basal portion of the interventricular septum. R wave is due to depolarization of the apical portion of ventricular septum and muscle. S wave is due to depolarization of the basal portion of the ventricular muscle near the atrioventricular ring. T wave is the final ventricular complex and is a positive wave. It is due to the repolarization of ventricular musculature. Figure 2 shows the waves that constitute the ECG.[6]

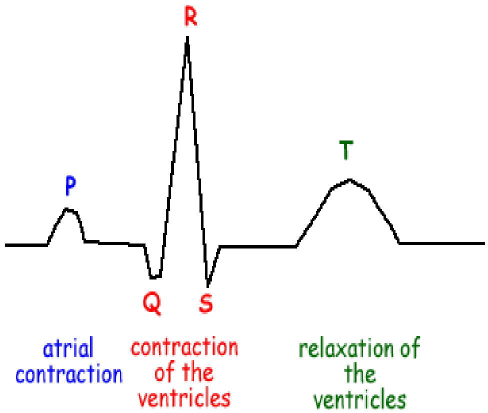

Figure 2: *Waves of ECG*

Analysis and processing of the ECG signal help to find the length of ECG segments (PR interval, ST interval, QT interval) and BPM of the signal to detect different types of heart activity or diseases. The length and BPM of the signal are used to indicate normal and abnormal behavior. The presence of noise may cause a change in amplitude and frequency of the signal that may cause an interruption in detecting the actual abnormality and may lead to error. A Digital filter can be used for the filtering of the ECG signal. The eminent analysis technique to determine the characteristic of ECG is by doing Segmentation of this wave. The main purpose of this analysis is to locate P wave, Q wave, R wave, S wave, T wave indices and to determine ECG segment length. A short detailed analysis of ECG can be achieved by using these techniques. In the Segmentation process, the whole signal is divided into characteristics like amplitude and frequency. Since ECG is a non-stationary signal, it is essential to preprocess the ECG signal before segmentation. For segmentation of ECG various algorithms like Wavelet Transform, Pan-Tompkins algorithm,METEORalgorithmetc. are available. From the ECG segmentation, we can calculate the waveindicesand length of,Q, R,S, Twaves and from that one can predict normality and abnormality in the ECG signal. If the abnormality is detected it can be classified atrioventricular Block, Hypokalemia, Hyperkalemia, Hypercalcemia, Hypocalcemia, Ventricular Tachycardia, Junctional Tachycardia, Atrial Tachycardia. ECG segmentation on MATLAB is shown in figure 3 which shows the P, Q, R, S, T wave indices using METEOR Algorithm.

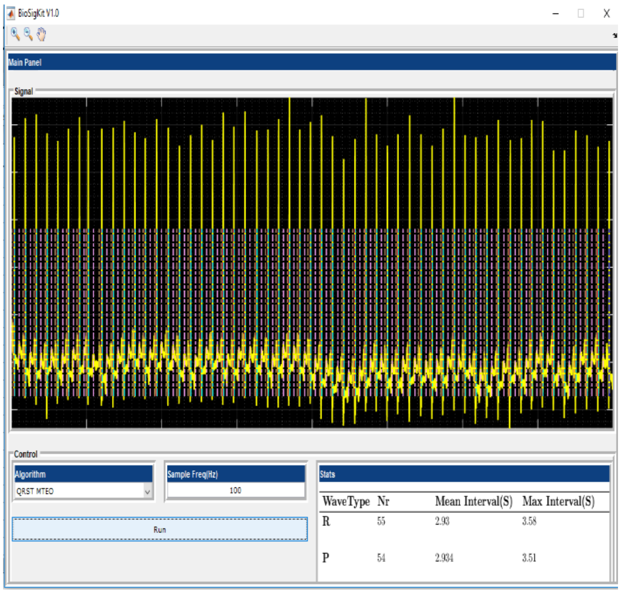

Figure 3: *ECG Segmentation*

II. Various segmentation process-A Survey

In Classification of Arrhythmia from ECG signal using MATLAB, The author Priyanka Mayapur et al [1]. has described the various arrhythmia associated with ECG and classify it based on length of the segments of the ECG as well as to detect the P, Q, R, S, T wave in ECG. The author has taken MIT-BIH, ECG recording then the software will remove the noise with Digital filters like IIR and FIR filters and detect the P,Q,R,S,T waves and states whether the ECG is normal or abnormal. Figure 5 shows the working of the system that is described in this research article. AHA and ESC database for analysis. The author has used inbuilt algorithms of MATLAB. Then the author has done plotting of ECG signal using the formula:

$$Y\mathrm{i} = \frac{\mathrm{yi-base}}{\mathrm{gain}} \tag{1}$$

where Yi is the ECG sample. Then the author has evaluated Morphological and Dynamic features. The Dynamic feature includes extracting R-R interval, HRV, and R to P ratio. The equation of HRV analysis is given by:

$$\mathrm{HRV} = \mathrm{HRVmax} - \mathrm{HRVmin} * 100 \tag{2}$$

The rate is given by

$$\mathrm{rate} = \frac{60}{\mathrm{R{-}R\ interval}} \tag{3}$$

R to P ratio is given by:

$$\frac{\mathrm{Rpeak(amplitude)}}{\mathrm{Peak(amplitude)}} \tag{4}$$

Morphological features include detection of P, Q, R, S, T wave indices, and QRS complex. The QRS complex is detected using the Pan Tompkins algorithm. Using the Moving Window Integration technique along with threshold detection method, P and T wave is detected.Figure 4 shows the flowchart of this article.

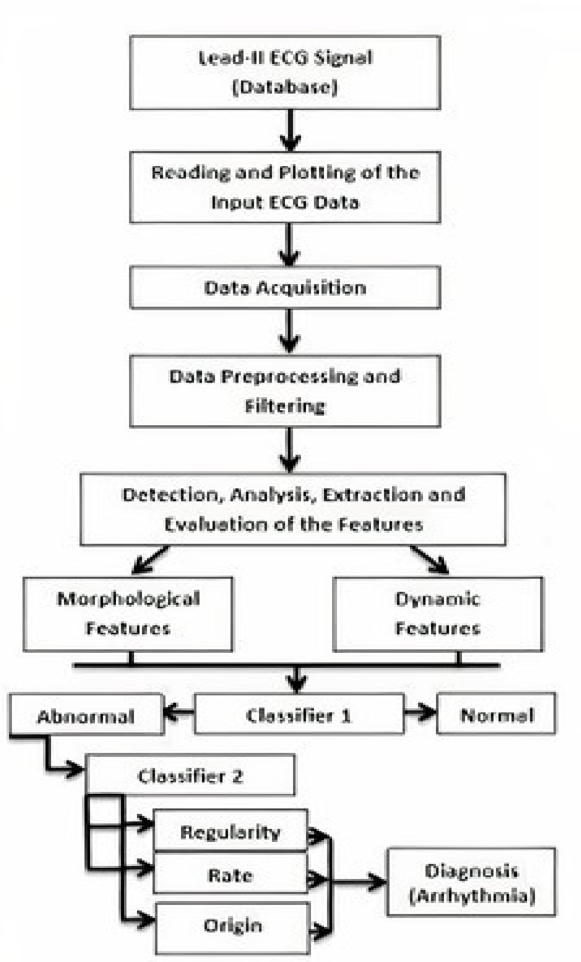

Figure 4: *Flowchart of the first article.*

Abnormalities State Detection from P-Wave, QRS Complex, and T-Wave in Noisy ECG, The authorsChandra Wijaya, Andrian, MawaddahHarahap, Christnatalis, Mardi Turnip, ArjonTurnip. [2] have utilized Bitalino and connect the ECG sensor with it after ECG recording Bitalino transfers the ECG recording through the cloud to the software. If the noise is present in the ECG recording then the software will remove the noise. In the softwareDigital filters like FIR and Butterworth filters are used to remove the noise.Lowpass, Highpass, and Bandpass filter have been realized which has cut off frequency 3Hz, 25Hz, 0.5-40Hz, and sampling frequency 1KHz each respectively. After filtering segmentation is done which computes the QRS complex and R-R interval. Finally feature extraction is done which detects P, Q, R, S, T wave indices.An experiment has been observed for 3 different activities performed by the people when sitting, walking, and jogging. The authors have taken ECG samples of 8 subjects and based on the experiments performed they finally compute the R peaks and BPM of the signals. Based onthe result obtained they classified it into normal and abnormal ECG. Figure 5 shows the working of the system that is described in this research article.[3]

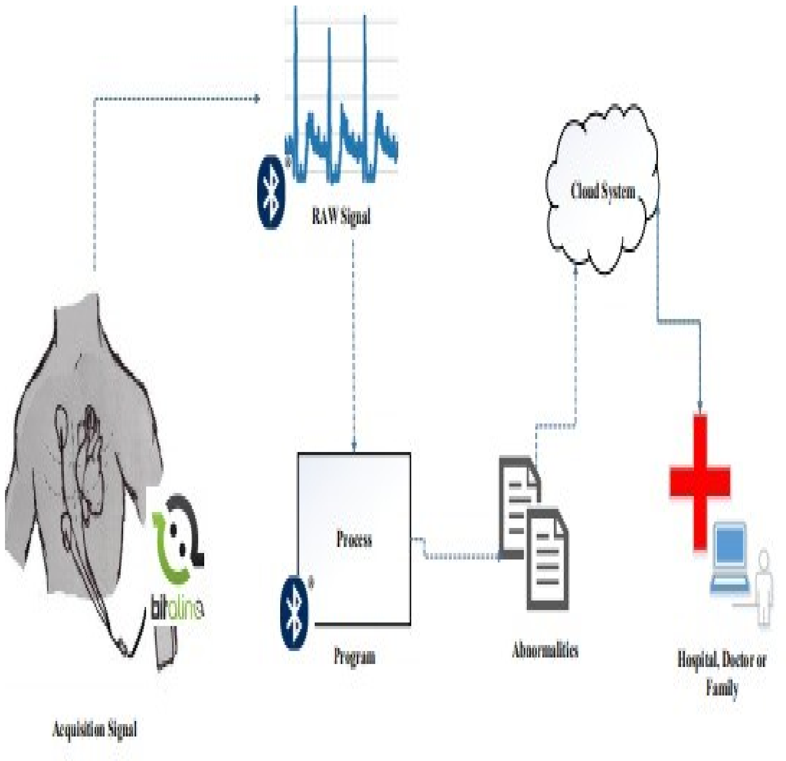

Figure 5: *Working on the system mentioned in the second article.*

In Optimizing the Detection of Characteristic Waves in ECG Based on Processing Methods Combinations. The author Kresimir Friganovic, DavorKukolja, Alan Jovic, Mario Cifrek, and Goran Krstacic [7]. has described the various algorithm like Pan Tompkins, Elgendi's algorithm based on two movingaverage filters, Sun Yan's algorithms based on Mathematical Morphology operations, Martinez's algorithms based on Wavelet Transform, Martinez's algorithm based on Phasor Transform withmodifications on MIT-BIH arrhythmia, Q-T database and detect the P,Q,R,S,T waves and compare the computation complexity as well as accuracy.Then after they have computed which algorithm is faster to compute ECG. They concluded that Martinez’s PT is more time demanding then Elgendi’s method and Elgendi’s method is more suitable for R peak detection. The MMF preprocessing and Martinez’s algorithm is used for Real-time ECG processing when accurate detection of the peak is sought. The figure 6 shows the flowchart of this article.[7]

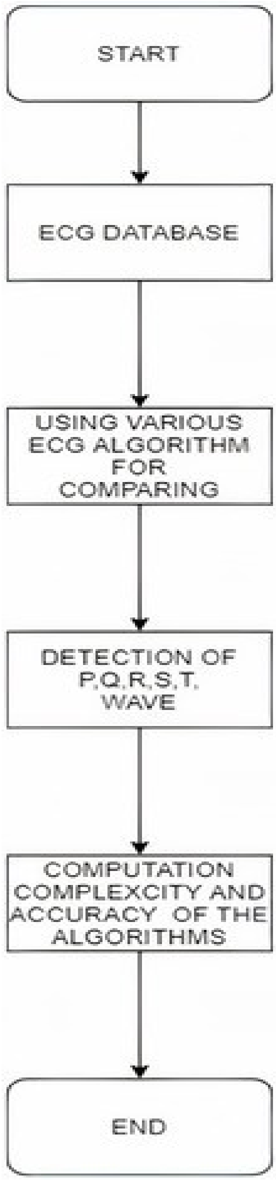

Figure 6: *Flowchart of the third research article*.

In Analysis of ECG Signal and Classification of Heart Abnormalities Using Artificial Neural Network. The authors TanoyDebnath and Md. MehediHasan.[4] describes the Preprocessing of the ECG signal and then feature extraction is done using the Pan Tompkins algorithm and Artificial Neural Network. Pan Tompkins algorithm is used for the detection of QRS complex and Artificial Neural Network used to detect P and T wave. Equation associated with the Pan Tompkins algorithm is shown below.The author hastaken 38 samples of ECG of males and females. On testing, they calculate the R-R interval and Heart rate interval of these ECG samples and they have classified... If it is abnormal they have classified it as Bradycardia, Tachycardia, First degree Heart Block, Second degree Heart Block, and Complete Heart Block. The conditions for the heart abnormalities are given below in table 1.

Table 1: *Conditions for heart abnormalities*

Sr No:	Heart Abnormality	Conditions
1	Tachycardia	Heart Rate>100BPM
2	Bradycardia	Heart Rate<60BPM
3	Second Degree AV Block	QRS dropped
4	First Degree AV Block	Long PR interval
5	Complete Heart Block	Complete drop out of the cardiac cycle

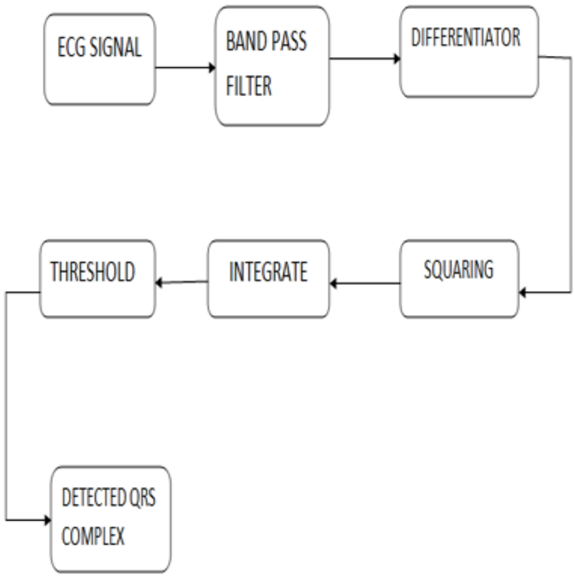

Figure 7: *Flowchart of fourth research article*.

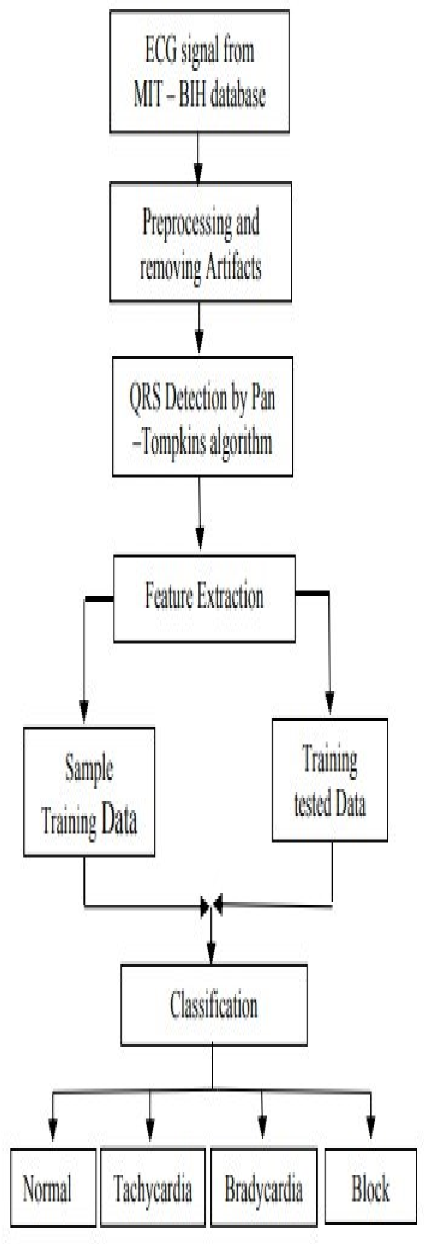

Figure 8: *Description of the fourth research article*

III. Conclusion

This paper concludes the work done to segment the ECG and prediction of abnormality by various authors. The author has applied various algorithms for the prediction of the abnormality and feature extraction like Pan Tompkins, Legend's algorithm based on two moving average filters, Sun Yan's algorithms based on Mathematical Morphology operations, Martinez's algorithms based on wavelet transform, Martinez's algorithm based on Phasor Transform. So in future this paper provides a good survey of the ECG segmentation and abnormality algorithms for researchers and also one develop their good ECG project based on this algorithm and one should also come to know how to deal with the ECG database.

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THE STATISTICAL APPROACH AND OVERVIEW IN DETECTION OF CANCER CELLS BASED ON FFT AND DWT EMPLOYING GENOMICS SIGNAL PROCESSING TECHNIQUES ON DNA

Ghanshayamkumar.B. Rathod, Vatsal Shah, Neel Macwan, Sakhiya Deep Jiteshkumar, Navadiya Harshkumar Ashvinbhai

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Birla Vishvakarma Mahavidyalaya
ghanshyam.rathod@bvmengineering.ac.in, shahvatshubh@gmail.com, neelmac094@gmail.com
sakhiyadeep007@gmail.com, navadiyaharsh111@gmail.com

Abstract

Cancer comprises a group of diseases that causes abnormal cell growth in the human body. Lakhs of people suffer from these diseases and ultimately they died due to cancer. So it is necessary to detect these diseases in an early stage. Genomics Signal Processing deals with advance research in genetics. So by applying various GSP techniques, it becomes easier to predict one of the most dangerous diseases Cancer. In this paper, we have represented the binary mapping of the raw genomic data to convert into digital data and on applying the Fast Fourier algorithm as well as the Discrete Wavelet Transform in our algorithm to predict uncertainty that is present in the coding region of DNA of the gene of Cancer cell. The purpose of this research is to provide an accurate prediction of cancer to the cancer researcher's so that the life efficiency of any cancer patient increases. We have implemented the algorithm on Matlab 2015a which consist of signal processing kit. The proposed algorithm is applying on several DNA sequences present in normal genes as well as cancer genes of Homosapiens chromosomes which is available on the National Center of Biotechnology Information (NCBI) database.

Keywords: Fast Fourier Transform; Genomic Signal Processing; DNA; Cause of Cancer; Discrete Wavelet transform; Binary Mapping; NCBI Database.

I. Introduction

Fast Fourier Transform is an algorithm that computes N Point Discrete Fourier Transform of the discrete sequences. The Discrete Fourier Transform converts the discrete sequence into frequency domain. This method is useful in many fields but computation of these method by using the equation directly becomes slow. So these transform computes the DFT very faster. As it factorizes the DFT matrix into the product of zero factors. As a result, it manages to reduce the complexity of computing the discrete fourier transform. The Fast Fourier Transform are much more accurate then discrete fourier transform. The equation of Fast Fourier Transform is:

$$x(k) = \sum_{n=0}^{(N/2)-1} [x(n) + (-1)^k x(n + \frac{N}{2})] W_N^{kn} \tag{1}$$

where $W_N^{kn} = e^{j2\pi/N}$ is twiddle factor. N stands number of point in FFT.Fast Fourier Transform is used in various application like recording, sampling of the data, Fast algorithm for discrete sine & cosine transform, Fast chebyshev approximation, solving difference equations & computation of the isotopic distribution. Genomic Signal Processing can be defined as the analysis, processing, and use of genomic signals to gain biological knowledge, and the translation of that knowledge into the system-based application that can be used to diagnose and treat genetic disease.[9] The purpose of the genomic signal processing is to combine the principles and techniques of signal processing with the understanding of the genomics to detect, classify, control, statistical and dynamical modeling of the gene networks. It is a fundamental discipline that brings the model-based analysis of the gene. Application of Genomic Signal Processing is tissue classification &discovery of the signaling pathway both based on the expressed macromolecule phenotype of the cell. The accomplishment of these applications is done by signal processing techniques such as Fast Fourier Transform, Discrete Wavelet Transform & Discrete Fourier Transform. DNA was first identified by Francis Crick and James Watson at the Cavendish Laboratory at Cambridge University. It is a double-helical structure comprises of four nucleic acid Adenine (A), Cytosine (C), Guanine (G), Thymine(T) a deoxyribose & phosphate group. The Adenine is connected with Thymine by hydrogen bond & The Guanine is connected with Cytosine by a hydrogen bond. Both polynucleotides of DNA contain some biological information in it. This information is replicated when the polynucleotides are get separated. RNA is produced by DNA through the transcription process. DNA usually occurs as linear chromosomes in Homosapiens. The set of chromosomes makes up the human genome. The genome has 3 billion base pairs of DNA. The biological information that is carried by DNA occurs in a piece of sequences of DNA called genes. Transmission of the genetic information occurs via complementary base pairing. The helical structure of the DNA is shown below in Figure 1. [3]. DNA molecules store the digital information that shapes the genetic scheme of living organisms [2]. By understanding the structure and properties of DNA one can predict the genetic diseases.

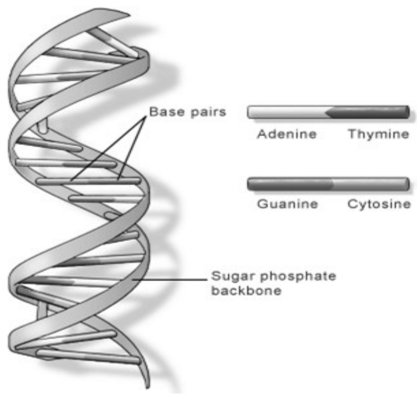

Figure.12.*Helical Structure of DNA*

Cancer is a deadly disease caused due to abnormal growth of the cells in the body and it destroys the body tissue. It begins with a genetic mutation. So because of the genetic mutation, there is unorderly growth of the cells in the body. The type of cancers is Breast Cancer, Prostate Cancer, Colon Cancer, Lung Cancer, etc. There many other types of cancer but these types of cancer are commonly found in the body. Breast cancer mostly occurs due to abnormal growth of the cells in the breast it mostly occurs in the men and rarely occurs in the women. The gene name BRCA 1 and BRCA 2 are responsible for Breast cancer. Breast cancer mostly begins with the milk-producing ducts. It is essential to predict such cancer because doctors have found that 5 to 10 percent of breast cancer genes are heritable in nature and it is passed over the family. The prostate is a walnut-size gland located between the penis and urinary bladder and the formation of the abnormal cells near the prostrate is known as prostate cancer. The genes CD82 CDH1 & CHEK2 is responsible for prostate cancer. The colon is a large intestine. It is an organ or part of the digestive system of the human body the abnormal growth of the cells in the colon causes colon cancer. The genes MSH 1and MSH 6 is responsible for colon cancer. This cancer is hereditary in nature. Lung cancer occurs due to the abnormal growth of the cells in the lungs. It mostly occurs with the person who smokes The risk of lung cancer increases with the number of cigarettes that individuals smoke if individuals quit smoking after smoking many years then the individual has reduced the chances for lung cancer development in their body. Figure 2 [4] indicates how genetic mutation occurs in a human body that causes cancer. By applying our algorithm, it becomes easy for the researcher to target cancer and to develop such devices or drugs which improve the life span of the patient. we design a mathematical model for cancer cell prediction by applying various signal processing algorithms.

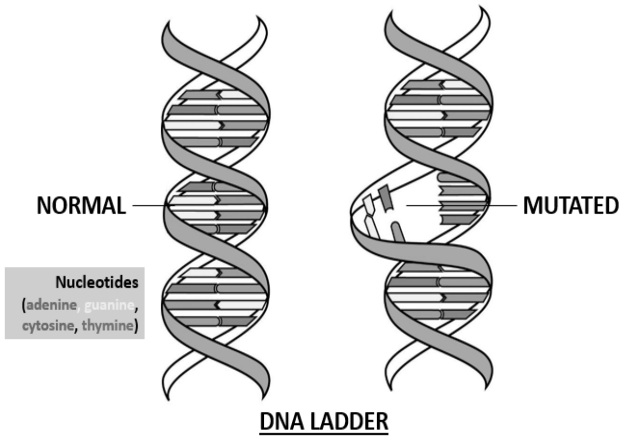

Figure.13.*Genetic Mutation in DNA Structure*

A wavelet is a mathematical technique that is used to abstract particular data from many types of data. Discrete wavelet transform means the transform which divides the signals into two orthogonal sets of the wavelets. The first discrete wavelet transform invented by Alfred Haar. If an input has 2^n numbers, the Haar wavelet transforms may be consider to pair up the input values, storing their differences and passing the sum. This process is repeats in recursion to prove the next scale which leads to 2^n -1 differences and a final sum. we have used here Haar wavelet transform the formula of the Haar wavelet transform is: The figure below shows wavelet transform [5].

$$y_n = H_n x_n \tag{2}$$

Where: H_n is a Haar Matrix

Y_n is an output

X_n is an input signal

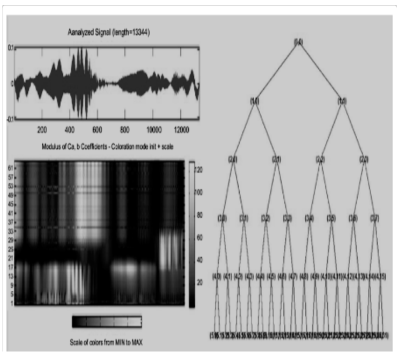

Figure.14. *Haar Wavelet Transform*

The NCBI Stands for National Center for Biotechnology Information. Which consists of information regarding genes genomic data & biomedical information. It consists of genes not limited up to humans but all organisms. It also consists of information regarding protein chains as well as gene expression, Taxonomy, Sequence Analysis. one can easily access the genomic data in order to predict the disease. The front end of the NCBI website is shown in figure 4.[6]

Figure. 15.*NCBI Website*

As we know that DNA consist of four chemical elements they are A(Adenine), C(Cytosine), G(Guanine), T (thymine). So binary mapping means mapping of these elements into the binary one. This is one of the most important element in our research. The table below shows the binary mapping of DNA. By using these Binary mapping concept, we have predicted the cancer cell. we have mapped the DNA sequence to its binary equivalent using Matlab 2015a.

Table1:*Binary Mapping of DNA*

DNA Components	**Binary Equivalent**	**Decimal Value**
Adenine	**00**	**0**
Cytosine	**01**	**1**
Guanine	**10**	**2**
Thymine	**11**	**3**

II. Methodology of the Research

The method that we have applied in the prediction of the cancer cell is as follows:

- First, take a DNA sequence of the Cancer gene as well as the Normal gene from the database available on the NCBI website.
- Then apply the Binary mapping into the DNA sequence.
- Thereafter find the Fast Fourier Transform of the converted binary sequence for Analysis.
- Find out the Discrete Wavelet Transform of the resultant binary coded DNA Sequence for Statistical analysis.
- Determine the ratio of the change in mean amplitude (ΔX) by Standard Deviation (S).
- If $\frac{\Delta X}{S}$ is greater than 0.5 then the Predicted Genesis of Normal cell.
- If $\frac{\Delta X}{S}$ is lesser then 0.5 then the Predicted Genesis of cancerous cell.

III. Flowchart of the Research

The flow chart below indicates the Algorithm of the Research.

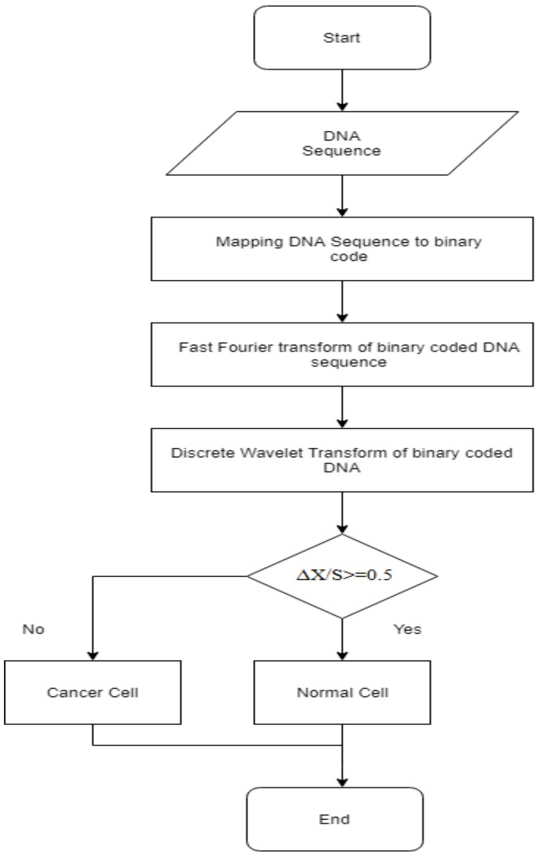

Figure. 16. Flowchart of the Research

IV. Fast Fourier Analysis

The Results for the Normal Cell and Cancerous Cell is shown below:

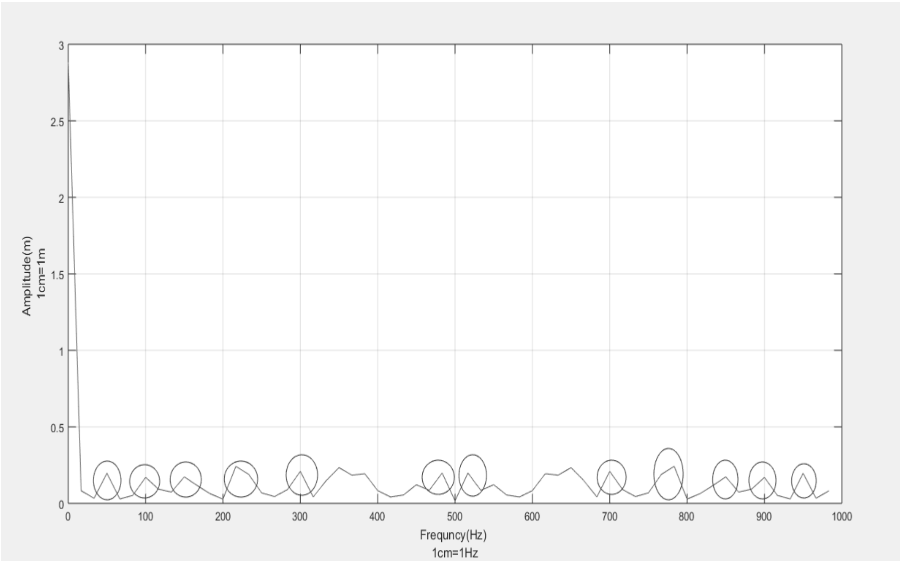

Figure .17. *BRCA1 Cancerous Cell*

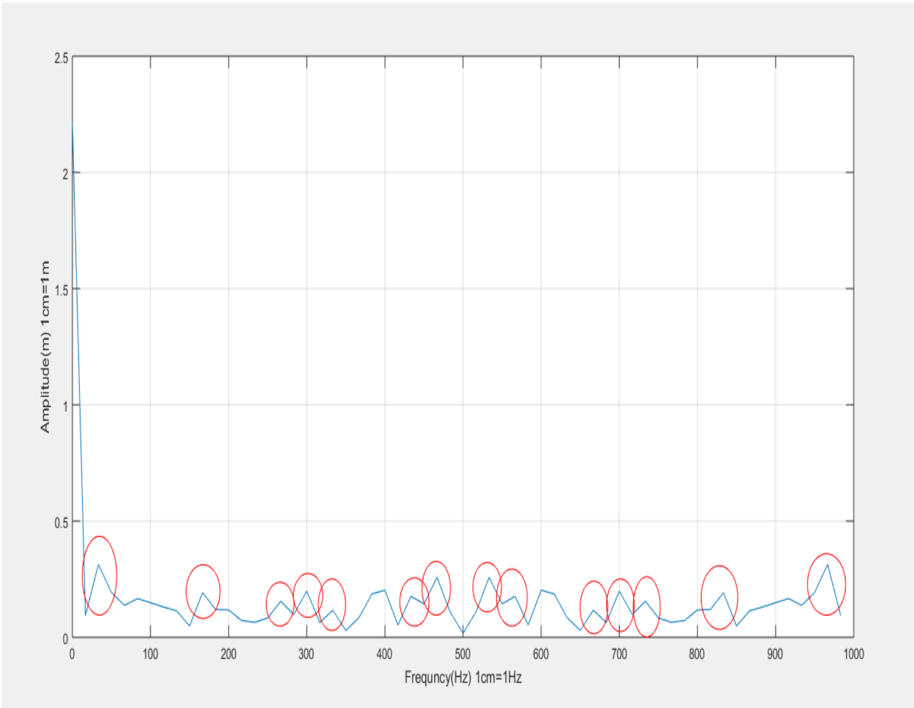

Figure. 18 . *PCA5 Cancerous Cell*

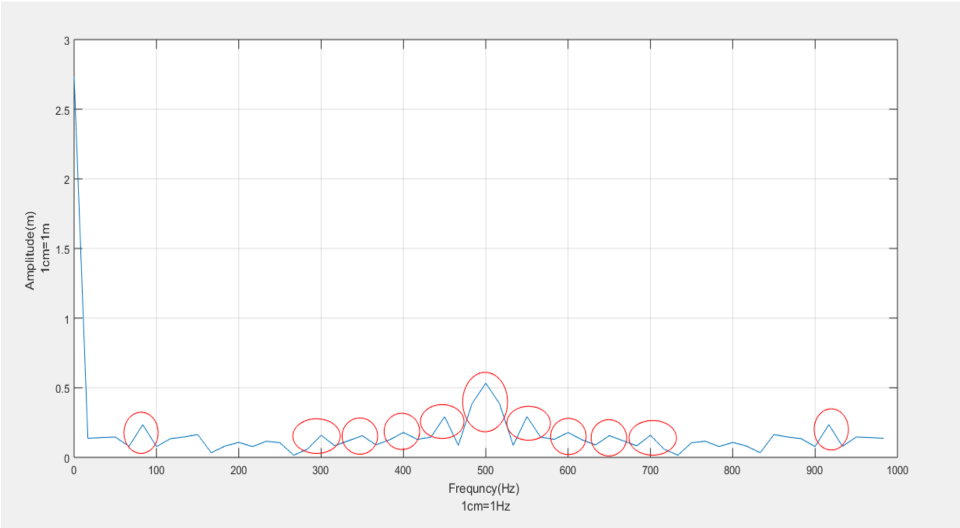

Figure .19. *TP63 Cancerous Cell*

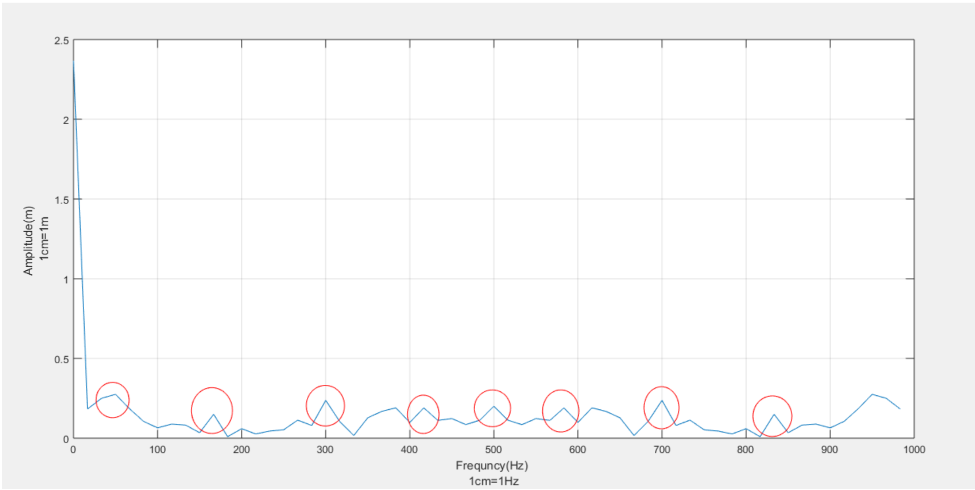

Figure. 20. *HBA2 Normal Cell*

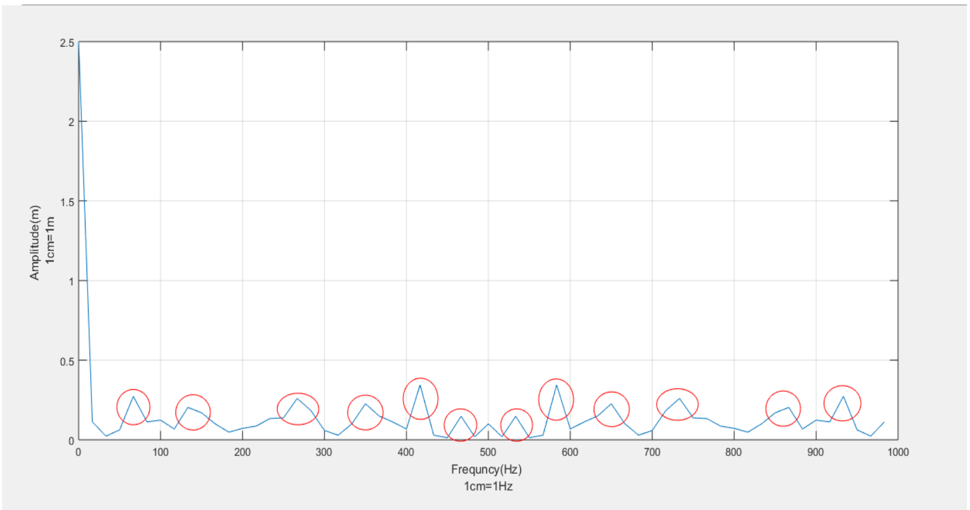

Figure .21. *HBG2 Normal Cell*

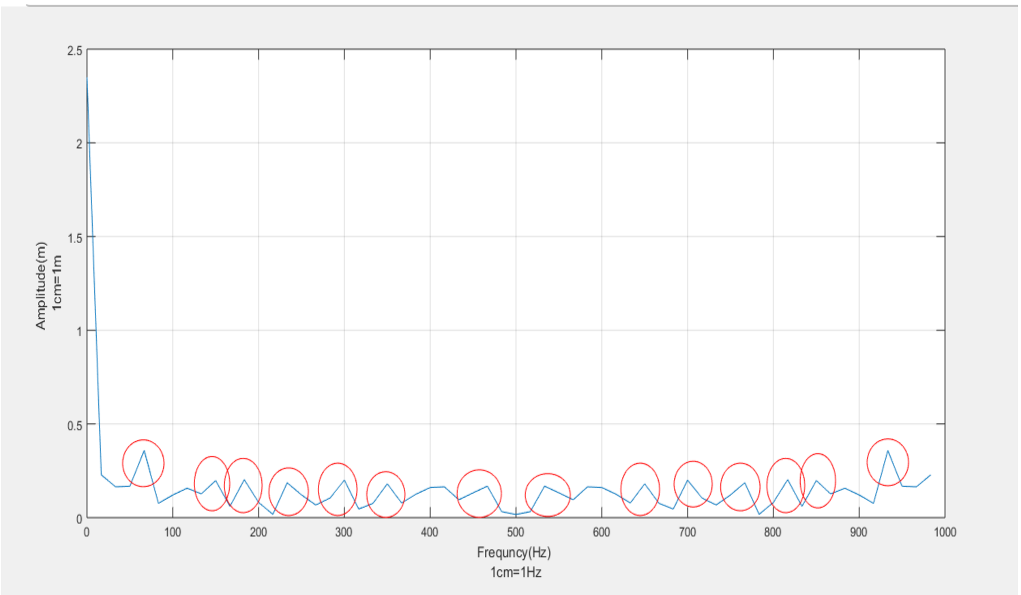

Figure .22. *Globin Normal Cell*

From these results, we have concluded that there are average 13 peaks in the waveform of the cancerous cell while there are average 11 peaks in the normal cells this means that the cancerous cells contain more noise compared to the Normal Cell.

V. Statistical Analysis

Table.2: *Genes of Cancerous Cell*

SR. No:	Name of Gene	Change in Mean Amplitude of Signal (ΔX)	Standard Deviation (S)	$\frac{\Delta X}{S}$
1	BRCA 1	0.075	0.6725	0.111
2	BRCA 2	0.241	0.5921	0.407
3	EGFR	0.125	0.6455	0.193
4	TP63	0.233	0.8703	0.2677
5	Estrogen	0.317	0.7988	0.3960
6	PCA5	0.208	0.6606	0.3148
7	GST	0.35	0.7636	0.4583

Table.3: Genes of *Normal Cell*

SR. No:	Name of Gene	Change in Mean Amplitude of Signal (ΔX)	Standard Deviation (S)	$\frac{\Delta X}{S}$
1	HBA1	0.45	0.7933	0.5644
2	HBA2	0.45	0.7811	0.57611
3	HBG1	0.9	0.922	0.97613
4	HBG2	0.917	0.7912	1.15896
5	GATA	0.917	0.7901	1.15877
6	GLOBIN	0.45	0.7973	0.5644

From the Statistical analysis we can say that if the ratio of change in mean amplitude of signal by standard deviation is greater than or equal to 0.5 then the predicted gene is of normal cell. Otherwise the predicted gene is of cancer cell table 2, 3 justify the same.

VI. Conclusion

In the presented work, an effective algorithm has been developed using MATLAB which consist of signal processing toolbox. And the most important is the mapping of the DNA sequences the mapping technique that is used here is Binary Mapping. A combination of the Fast Fourier based spectral analysis & wavelet-based methods were found to be more accurate due to their properties, such as feature extraction time-frequency domain representation, multi-resolution, scalability, de-noising and also compressing of big sample data or sequences of data. Fast Fourier analysis technique has been applied to raw genomic data for detection of the uncertainty of DNA sequences. So in the future, it has a great scope in early diagnosis of cancer as it depends on the permanent alteration in the DNA sequence of the gene. This can help in developing drugs, to drug designer. From information that one can get from genomic data one can determine how an individual will respond to particular drug and based on that design of new drugs will be done. And also without performing experiments, one can determine accurately diseases with the help of digital signal processing theory and techniques which further leads to a cost-effective experiment as it is non-invasive and require less amount of time.

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SENTIMENT ANALYSIS OF PRODUCT REVIEWS USING SUPERVISED LEARNING

Arkesha Shah

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GCET, Vidyanagar
arkeshashah1000@gmail.com

Abstract

Today, Online Reviews are global communications among consumers and E-commerce businesses. When Somebody wants to make a purchase online, they read the reviews and comments that many people have written about the product. Only after customers decide whether to buy the product or not. Based on that, the Success of any Products directly depends on its Customer. Customer Likes Products It's Success. if not, then Company needs to improve it by making some changes in it. For that, the need is to analyze the customers' written reviews and find the sentiment from that. the task of Classifying the comments and the reviews in positive or negative is known as sentiment analysis.in this paper, A Standard dataset reviews have been classified into positive and negative sentiments using Sentiment Analysis. For that different Machine Learning and Deep Learning Technique is used and also Compared the performance of word2vec-CNN Model with FastText-CNN Model on amazon unlocked mobile phone Dataset.

Keywords: Sentiment Analysis, SVM, Naïve Byes, FastText word-Embedding, CNN Model

I. Introduction

Sentiment analysis is one of the fastest-growing research areas, which helps customers to make better-informed purchase decisions from the web and social media. It also provides organizations the ability to measure the impact of their social marketing strategies by identifying the public sentiments towards the product [2]. Sentiment Analysis is a computational study to extract subjective information from the text[5].

Nowadays shopping for Mobile phones from online sites like Amazon and Flipkart Increases. With an ever-increasing demand for smartphones, the mobile phone market is expanding. With such a boom in the smart-phone industry, there is a need to extract meaningful information from the review of the brand and the model of phone [3]. There are numerous brands present in the market, out of which the brand phone Model select is very confusing for the customer. They read Various Reviews available on E-Commerce sites which act as a guiding tool for the customers and help to make a decision which brand phone model should buy. From the manufacturer's point of view, helpful online reviews mining customer requirements improving a product or designing a new product [5]. Sentiment analysis is a classification problem. This Problem solved using the following approach.

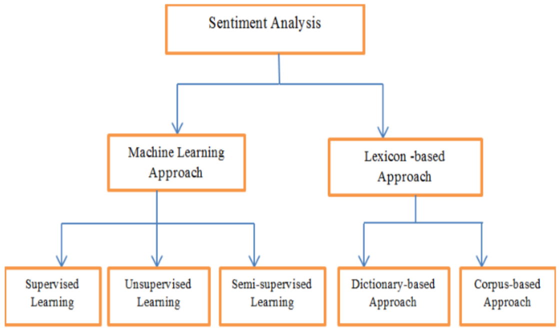

Fig.1: *Sentiment Analysis*

Machine Learning is a scientific discipline that explores the construction and study of algorithms that can learn from data [1]. In Machine learning, Model Learns by giving input as a history of past data based on that Model is capable of predictions or make decisions. The machine learning model is a Mathematical Model. Machine Learning Model classified into supervised Learning, unsupervised learning, Reinforcement Learning.in supervised Learning Model Classifies the data based on Known Labels that are given.in unsupervised Learning Model Classifies the data based on Similar Characteristics in Data. In Reinforcement Learning Model learns by trial and error using feedback from its actions and experiences.

II. LITERATURE REVIEW

There is a rapid growth of E-commerce Shopping, from that online Customer reviews playing an Important role in sales of a product. Research[5], focus on data analysis of mobile reviews data set. They find the relationship between different features. and Perform sentiment classification in positive and Negative which is helpful to consumers and the manufacturers. they take the unstructured Data to perform Pre-processing for sentiment analysis of mobile phone reviews. They used the Support Vector Machine (SVM) Machine Learning Model and got 84.87% Accuracy after cross-validation. In Research[1], They Used the Support Vector Machine (SVM) Classification Technique to classify text in positive and Negative from the smartphone product Reviews. the model Performance Measured using Precision, Recall, F-measure. the predicted Model obtained High Accuracy.

In Research[3] They performed Classification of Mobile phone Reviews in positive and Negative Sentiment. which are taken from amazon.com. Reviews are classified using different Machine Learning models such as Naïve Bayes, Support Vector Machine (SVM), and Decision Tree. These three Classifiers had cross-validated to find the best classifier from them. They found Support Vector Machine (SVM) as the best Classifier as they obtained Higher accuracy 81.87%.in Research[4] They performed sentiment analysis of the smartphone Reviews. they used the Machine learning approach to classify the reviews in positive and Negative. Machine learning Techniques Like Naïve Byes and Support Vector Machine (SVM) used. And found the SVM Technique reliable for mining of data.

In Research[6], Proposed Deep Learning approach for sentiment analysis of smartphone reviews using Twitter Corpus. For the Deep Learning approach, They Used Convolutional Neural Networks. (CNN). They also used Machine Learning Models like Naïve Byes and Support Vector Machine (SVM). They found that the deep learning technique is efficient than Machine Learning techniques.In Research [7], they Proposed a sentiment analysis approach through Deep Learning Technique. They Classified the Movie Reviews using Different Supervised Machine Learning Models and after the Compared the results with Used Convolutional Neural Networks (CNN) a

Deep Learning Technique. They found that deep learning model CNN gives reliable performance.

In Research[8] Proposed Deep Learning Approach for Sentiment Analysis that Applied on Hotel's Reviews. They applied Convolutional Neural Networks(CNN) on Hotel Reviews and Classified in Positive, Negative, and Neutral Sentiments. They Compared the Results of the CNN model with Other Models and found that Convolutional Neural Networks gives Better Performance.In Research[9] They Performed Sentiment Analysis of Restaurant Reviews given by the customers. They used Different Supervised Machine Learning Models to classify the Reviews. After that, They compared their Performances. They found that SVM Model resulted in the Highest accuracy of 94.56%.

In Research[11], they used Machine learning Classifiers such as Decision tree, Naïve Byes, KNN for prediction of sentiment. They compared the results of classifiers and find the best classifier from that they found naïve byes is the best classifier. In Research[12], They described the process of sentiment analysis on twitter data using machine learning for that they used Decision tree and Naïve Byes they found that the Decision tree performed well. In Research[13], They used Naïve byes and SVM Classifiers for sentiment analysis, compared the result, and found that Naïve byes performed well than SVM.In Research[14], They used unigram, bi-gram approach with Machine learning Classifiers such as Naive Bayes, maximum entropy classification, SVM. they measured the performance of classifiers using precision, recall, and F-measure. Found that bi-grams gave a good result. In Research[15], They used different supervised learning methods on a large scale amazon dataset for classifying their sentiment and get good accuracy.

In Research[2], Proposed Deep Learning approach for sentiment analysis of Product Reviews of Mobile Phones extracted from the Amazon. They used word2vec word-embedding Technique with CNN Model to classify the Mobile Phone Reviews in Positive and Negative sentiment. They used Google's word2vec pre-trained Model to Convert Text to word vectors of 300 Dimensional. if words that are not available in the pre-trained model they created the word vectors by randomly taking the Values between -0.25 to +0.25.CNN Model is Trained and Predict the Sentiment of new Mobile phone Reviews. They also used different Vectorization Techniques with Machine Learning models like Naïve Byes. A comparison is done and found that the Proposed approach has better accuracy of 0.9123 than the Machine learning model. they implemented CNN Model using deep learning Library Keras and Tensorflow.

III. Proposed System for Sentiment Analysis

The Steps Followed for Sentiment analysis of Mobile Phone Reviews are Shown in the figure as follows:

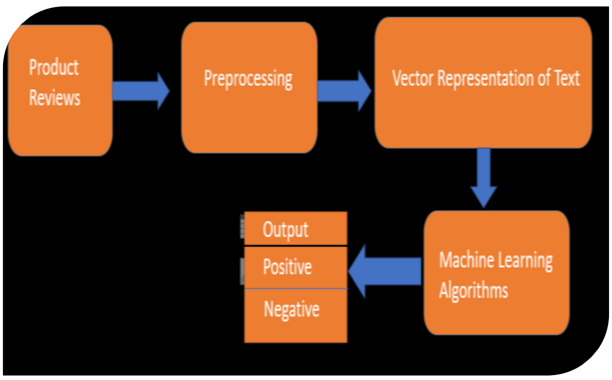

Fig.2: *Proposed Model*

A. Data Collection

Dataset used in this work is Smartphone Product Reviews released by amazon website [https://www.kaggle.com/ Prompt Cloud HQ/ amazon reviews-unlocked-mobile-phones/data] which is static Dataset [2]. In this Dataset, there are a total of 4,00,000 reviews and 6 Columns. Customers gave 1 to 5 Rating for their Reviews so based on that in this project Created Separate Column name as Sentiment in which Reviews above 3 Rating have assigned Value 1 that represents positive Sentiment and Value 0 represent negative Sentiment. The idea is to evaluate the performance of Machine Learning algorithms like SVM and Naïve Byes as well as the FastText-CNN Deep learning Model on Amazon product reviews (mobile phone reviews).

B. Data Pre-Processing

It is a necessary process before Data feed to Machine Learning Model. It cleans the unnecessary Data so that the Machine will Learn batter and also performed well. It is the process that converts raw data into to clean dataset. In this work, Cleaning data by removing rows having 'null' values. The final outcome of this project is positive and negative sentiment. there is no requirement of neutral sentiment. So, it is removed from the dataset. The steps that are carried out in pre-processing of data are as follows-

- Remove Punctuation: -It removes special Characters that do not contain any meaningful information.so it is removed from data.
- Remove Stop words: Stop words like a, an, the, he, she, was, etc. has importance in English grammar. but in Machine learning data there is no need for that because these stop words not provide any meaningful information Regarding Sentiments.
- Case Conversion: All texts converted into either Lower Case or Upper Case. So that any case sensitive issue not occur.
- Perform Tokenization: This divides the data into small units.in this case, divides the sentences into individual words, it gives structure to unstructured data. which means it assigns a list of integers to the sequence of unique words.
- Lemmatizing: It converts the word into its root word. Root words are words that have no prefix and suffix. For that, it used a dictionary-based approach.eg. pleased => please. In this work, I have used the wordnet library. For Text pre-processing, I have used the NLTK Toolkit of Python Language.

C. Vectorization

In this process, Text is converted into Numeric Form so that the Machine learning model can understand, the machine learning model is a mathematical model. It only understands the numerical information. For that different Techniques are used. In this work, I have used Techniques that are listed below:

- Term Frequency – Inverse Document Frequency (TF-IDF):
  It measures how important a word in a given document with a collection of documents. TF measures the occurrences of the word in a particular document. And IDF measures informativeness of word in a collection of documents. In this work, we have used TF-IDF with Bi-grams which means a sequence of 2 words instead of a single word.it creates the feature vector of two words.

TF calculated by:

TF = (Number of time the word occurs in the Text) / (Total Number of Words in Text)

IDF Calculated By:

IDF = (Total Number of documents / Number of documents with word t in it)

TF-IDF Calculated By:

TF-IDF = TF * IDF

- Bag of Words model using Count- vectorizer:

It is a vectorization technique. It creates a dictionary of unique words from the documents. Compare the dictionary with each document. if word present in the dictionary then it gives 1 otherwise 0 in this way, it makes Text into fixed-length Vectors by counting Occurrences of each word appears. In this work, to implement the Bag of words model We have used the Countvectorizer Built-in Function which is provided in the Scikit Python Library.

- FastText Word - Embedding:

Word-Embedding is a vector Representation of word. It represents the word in vector format.it is used to find the similarity between the words. FastText Model is an extension of the word2vec model. Instead of learning vectors for Individual words directly, FastText utilizing internal structures of the words and represents each word as an n-gram of characters. for example, take the word, "artificial" with n=3, the FastText representation of this word is <ar, art, rti, tif, ifi, fic, ici, ial, al> This helps capture the meaning of shorter words. So even if a word wasn't seen during training, it can be broken down into n-grams to get its embeddings. In this work, Created The word Vectors using FastText Pretrained Model wiki.simple.bin File. Which has 300 dimensions for each word.

D. Models that are used for Sentiment Classification are as follows:

- Naïve Byes: It is a classification technique based on Bayes' Theorem with an assumption of independence among predictors. This model is easy to build and useful for very large data sets. It works on Bayes theorem of probability to predict the class of unknown data sets.

Likelihood Class Prior Probability

$$P(c \mid x) = \frac{P(x \mid c)P(c)}{P(x)}$$

Posterior Probability Predictor Prior Probability

$$P(c \mid X) = P(x_1 \mid c) \times P(x_2 \mid c) \times \cdots \times P(x_n \mid c) \times P(c)$$

Here,

- **$P(c|x)$ is the posterior probability of *class* (*target*) given *predictor* (*attribute*).**
- **$P(c)$ is the prior probability of *class*.**
- **$P(x|c)$ is the likelihood which is the probability of *predictor* given *class*.**
- **$P(x)$ is the prior probability of *predictor*.**

But, in this work, if there are n independent features which represented as vector y=(y1,y2,…,yn) then Naïve byes use the following Equation and Classify the Results:

$$p(\mathrm{L}k \mid \mathrm{y1,y2,\ldots,y}n) = p(\mathrm{Lk})\prod \mathrm{n\ i{=}1}\ p(\mathrm{yi} \mid \mathrm{Lk}),$$

Lk represents kth number class.

- Support Vector Machine (SVM) : SVM (Support Vector Machine) is a supervised machine learning algorithm that is mainly used to classify data into different classes. SVM makes use of a hyperplane to separate various classes. SVM can be used for both Linear Data and Non-linear Data. In this work, We have used linear SVM to classify the Data because Data is linearly Separable, like whether Positive or negative.

- Convolutional Neural network (CNN): Convolutional neural network (ConvNets or CNNs) is Used for image classifications, object detections, recognition, text classification. There are some Components in CNN which are the following:

i. Input Layer: Reviews are converted in to feature vectors from the available word vectors of the fasttext pre-trained model. and target column which is sentiment 1 and 0, as a vector. These two are given to input to CNN Model.
ii. Convolution Layer: Convolution is the first layer to extract features from given input.it is a sliding window that slides over the list of word embedding in sequence and captures the meaningful information regarding sentiments. applied multiple filters on the given set of input so that learn more about the features.in this work, We have used a 1D convolution layer because it slides over only in one dimension.
iii. Embedded layer: It is defined as the primary hidden layer of a network system, it is instated with arbitrary weights and will learn an embedding for all of the words in the training dataset[2].the main work of the embedding layer is to convert a list of word indexes into a dense vector of fixed length.
iv. Pooling Layer: Reduce the computational complexity, CNNs use pooling to reduce the size of the output from one layer to the next in the network.
v. Fully Connected Layer: Fully Connected Layer is a fully connected neural network. These vectors are fed it into a fully connected layer like a neural network for Training.

here, each layer connected to other layer. final output is the probability of each label class.

vi. Dropout: to avoid overfitting of the model dropout layer is used.

vii. Output Layer: In this work, the sigmoid activation function is used that transform value between 0 and 1. which is good for binary classification problem. This layer returns the classification result.

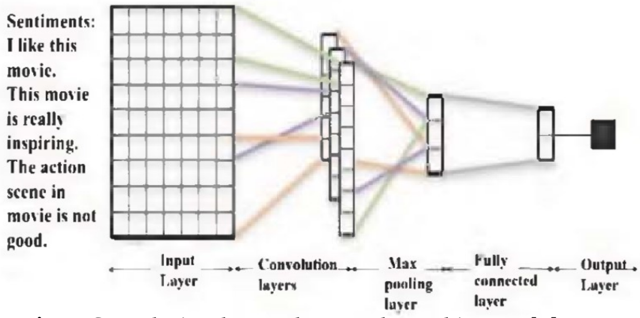

Fig.3: *Convolutional Neural Networks Architecture[7].*

IV. EXPERIMENTS AND EVALUATION

A. Experiment:

In this work, the input is Customer Reviews and output is the Sentiment column which derived from the Rating Column. Data Pre-Processing applied to Reviews. After that Feature Vectors are created using vectorization techniques, in this work feature vectors first created using TF-IDF Bi-grams, Countvectorizer. created feature vectors first applied as input to Machine Learning Models like SVM and Naïve Byes. From the Dataset 80% of data is used for Training Purpose and the remaining 20% data is used for Testing the model. after training the machine learning model they predict the sentiment of reviews. For FastText word-embedding, FastText pre-trained model wiki.simple.bin is used to create the word vector of Text Reviews. which generates a 300-dimensional word vector.in the dataset different lengths of reviews are present.so to make the equal length of reviews zero-padding used, the maximum sequence length used is 800.so review matrix size becomes 800* 300. The Review matrix and target label are given input as CNN deep learning model. CNN Model is implemented using deep learning Framework Keras and Tensorflow. after a trained CNN Model it is able to predict unseen data.

B. Result:

To find the best classifier different evaluation metrics used which are confusion Matrix, Precision, Recall, F1-score, etc.

- Confusion Matrix: it is the visualization of Machine learning algorithms on Test data. It defines how accurately Machine Learning Model Classifies the unseen Data.

- TP (True positives): No. of positive reviews that are correctly Predicted by the Model. Which are the same in actual data in the dataset.

- TN(True negatives): No. of negative reviews that are correctly predicted by the Model same as actual Data. FP(False positives): No. of negative reviews that are incorrectly predicted as positive by the Model.

- FN(False negatives): No. of positive reviews that are incorrectly predicted as negative by the Model.

The figure shows the confusion matrix of FastText Word-Embedding with the CNN Model. When the model trained with 4608 reviews out of 5761 reviews and tested with 1153 reviews, the model correctly classified 1091 reviews and the accuracy achieved to 94.62%

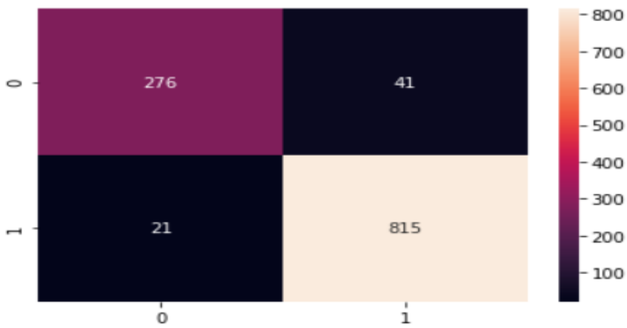

Fig.4: Confusion Matrix of CNN Classifier

Accuracy Calculated by:

$$\textbf{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

[2]

ROC Curve:

It is a probability curve for different classes. It tells how well the model Separates given target classes. The following is the ROC Curve for CNN Model.

True-positive rate(TPR) is also called as sensitivity, recall(ratio of no. of correctly identified positives, and total no. of positives)[2].

$$Recall = TPR = \frac{TP}{(TP + FN)}$$

[2]

False-positive rate(FPR) is also called as the fall-out,1-specificity (ratio of no. of incorrectly identified negatives and total no. of negatives)[2].

$$FPR = \frac{FP}{(FP + TN)}$$

[2]

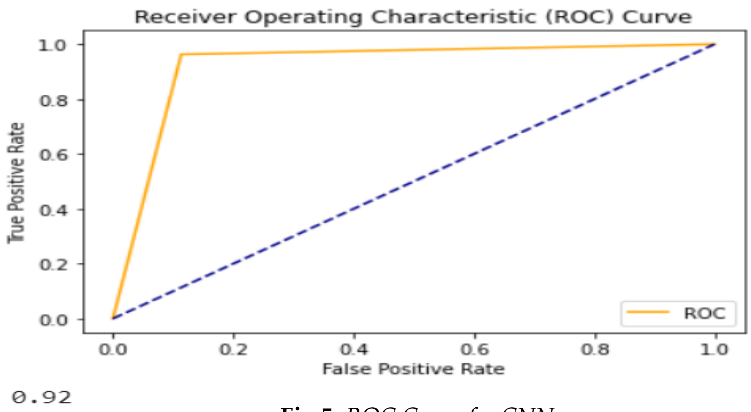

Fig.5: *ROC Curve for CNN*

In this work Performance of Machine learning Models like Naïve Byes and SVM compared with CNN Deep learning Model. and also compare the result of the FastText-CNN Model with the word2vec-CNN Model[2]. The accuracy of these models is listed below.

NO.	Model	Accuracy	Precision	Recall	F1-Score	Correctly classified
1.	TF-IDF Bi-grams + SVM	0.92107	0.91	0.98	0.95	1062
2.	TF-IDF Bi-grams + Naïve Byes	0.9071	0.89	1.00	0.94	1046
3.	Countvectorizer + SVM	0.9358	0.96	0.95	0.96	1079
4.	Countvectorizer + Naïve Byes	0.9176	0.95	0.94	0.94	1058
5.	FastText + CNN	0.9462	0.95	0.97	0.96	1091

Fig.6: *Machine Learning Models Results*

From the table, we can see that, FastText with CNN Model achieved the highest accuracy than the other Models. We have also Performed a comparison with Research Paper[2].

Model	Accuracy	No of Reviews
Word2-vec + CNN[2]	0.91323	5761
FastText + CNN	0.9462	5761

Fig.7: *Comparison Result*

We have Found that FastText Word Embedding with CNN Model Performance is Better than the Word2-Vec with CNN. Because In Paper[2], Authors created word vectors using random values for the words that are not present in the pre-trained Word2Vec model. which affected the performance of the CNN model and also they used Softmax activation function at the output layer which is generally suited in the Multiclass classification problem. As well as they used Adadelta optimizer which has slow convergence in comparison with Adam Optimizer. all these effects on word2vec-CNN Model Performance. But in this work, all the words available in the FastText pre-trained model, No Random values of word vectors are generated, As FastText functionality, it creates a vector of unseen word by adding n-grams of characters. which increases the performance of the CNN model. Also, We have used sigmoid function at the output layer, which is most generally used for binary classification problems in this work model classified into Positive and Negative Reviews. the optimizer used is Adam. all these improve the FastText-CNN Model Performance in comparison with word2vec- CNN Model.

V. CONCLUSION

In this paper, sentiment analysis of mobile phone Reviews are done using different Machine learning Models as well as also using FastText word embedding with CNN Depp learning Model. Comparisons of all these algorithms are done and also compared the Performance of FastText-CNN Model with the word2vec-CNN Model of Research Paper[2]. We have used various vectorization Techniques with machine learning models like naïve byes , SVM, and compare there performance with FastText deep learning model. We found that FastText-CNN Model achieved higher accuracy than machine learning models. Which means deep learning model performs better than the machine learning model. use of Different Vectorization Techniques affects the performance of the Models. With an increase, the size of data accuracy also increases. SVM based Classifier gives better accuracy than the Naïve byes. Classification of Positive & Negative Reviews influence consumer buying patterns.Use of different learning rate, no of epochs, different window sizes, different embedding sizes, number of filters and other optimization algorithms, the maximum Sequence length of Reviews, different activation functions, different batch size, etc. affects the Performance of the FastText-CNN Model. Implemented Machine Learning Techniques on Local CPU Takes a longer time than GPU.

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A NEURAL NETWORK APPROACH TO DESIGN REALITY ORIENTED COST ESTIMATE MODEL FOR INFRASTRUCTURE PROJECTS

Nirajkumar Suneja, Prof. Jagruti P. Shah, Dr. Zankhana H. Shah, Dr. Mehfuza S. Holia

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B.V.M. Engineering College, Vallabh Vidyanagar, Gujarat, India
nirajsuneja1179@gmail.com

Abstract

Great infrastructure projects are flagrant for costing more than in the beginning intended. Road project cost overrun (under estimation) and cost revision is common major problems reported by MoSPI (Ministry of Statistics and Programme) 20% cost overrun in India. It is difficult to maintain infrastructure progress within cost, time and quality because of their unpredictability, enormous scope, long length, high speculation and longitudinal site condition. Framework Estimate engineers need to create cost estimation before time on in development to determine its practicability safe and sound financial support, meet up superiority standards and worth for money. this research focus on cost of road infrastructure projects in early stage before construction. Various literatures government report, private companies report Cost estimate guides is studied and it's study gives the idea of current cost estimation methods and causes of cost overrun in projects. Be that as it may the prior on in project's life cycle, the less is known around the particular points of interest of what really has to be built and a site's interesting characteristics and how they will influence, Research gives effort on the identifying proper attributes or factors that are readily available at an early stage for fast, easy and accurate detailed cost estimate from the past related research work. Different organizations have plenty of historical project information and lots of don't have the tool the other way around, very fewer resources to estimate compare to traditional methods. Machine learning (ML) cost estimation model advance uses algorithms to discover relationship between diverse variables of project and their cost and developed model.

Keywords—Road infrastructure, Cost estimate, Cost overrun, Cost Estimate Model, Machine learning, Artificial intelligence

I. Introduction

The purchase and retail and manufacturing growth of whatever nation is mostly dependent relative on the advance of its infrastructure and India is no invulnerability. India has the one of the largest road system across the ball, across over a sum of 5.5 million km. This road system transport 64.5% of all products in the country and 90% of India's absolute traveler traffic utilizes the street framework to move.[4]

The likely expense of doing for 1,424 Projects is fixed at Rs. 21.34 lakh crore marks. These undertakings were before all else expected to be done at an expense of Rs. 18.17 lakh crore, of which Rs. 8.07 lakh crore or 37.8% of unsurprising expense have been now brought about. And the percentage of cost overrun in infrastructure project is shown in Chart 1.1 (below) from year review of 2014 to 2018.[7]

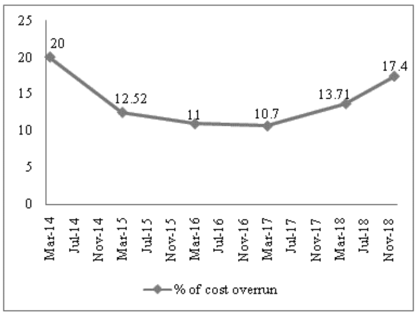

Chart 1 Percentage of cost overruns

The detailed estimate is the mainly precise form of estimates, other than it is moreover the majority lengthy; require the whole data to dispatch. Still to some extent small cost over-runs can reason to disturbance when a project is part of the pack of a wider program of outflow.

Following are cost drivers of infrastructure projects:-

1. Design & Development cost,
2. Material & Labour cost,
3. Land cost,
4. Insurance,
5. Professional services.
6. Legal& regulatory requirement cost (EIA: Environment impact Assessment).

The major factor responsible for cost overrun reportedly been (MoSPI Flash Report: 2019) [6]:-

1. Scope Changes
2. Design change/iterations
3. Inadequate DPR
4. Weak procurement planning
5. Unidentified risk
6. Balanced finance
7. Changes in rates of foreign exchange
8. Statutory duties/Taxes
9. General Price rise / inflation

Over-estimating the scope of projects and Under-estimating project costs are the two main reasons for cost overrun cost estimate / Underestimate.

Inside the worth estimation of road infrastructure comes that are there are three potential things where computable price figures either match or don't match with actual cost figures as shown in Table IX.

Table IX Possibilities of cost

Situation	**Remarks**
Est. = Act.	Ideal
Est. < Act.	Under-estimation of funds leading to fund shortage
Est. > Act.	Over-estimation of funds leading to fund surplus

A. Aim and Objectives

The Aim of this study is "Designing Reality Oriented Cost Estimate Model for Transport Infrastructure Projects" develop model for Gujarat state roads. The objectives of this study are to identify influence factors and used them into in model to which is develop using python 3.7 language and Jupyter notebook with Machine learning (Deep Neural Network) Algorithm.

B. Study Area Profile

To design reality oriented cost estimate model for Transport infrastructure projects (Road) of Gujarat Region with Machine learning (Deep Neural network) algorithm with python 3.7 language Jupyter Notebook IDE which are easy to use and open source.

II. Related Works

The literature review provides knowledge of value estimation ways, Models and varied techniques that are utilized in road building value estimation by engineers. The worth estimate might be a most important task done by price engineer Major program structure comes associated programs suffer from an inclination to cost heaps of or carry longer than beginning assessments plot. The reasons for this are advanced nature of significant assignments and projects infer that, their assessment helpful and plan typically conveys confined precision.[3]

At intervals the Project Management word, it meant that there are massive variations at intervals the project attained value metrics, which may or will not be monitored closely. In fact, the effectiveness of the danger management can replicate at intervals the attained value metrics similar to price variance and schedule variance.[10]

Value estimates are elementary to any or all or any project-related branch of data also, enormously impact arranging, plan, request, esteem the executives/planning and building the board. Trademark table to the obliged helpfulness of data directly through the principle levels of an undertaking, development administrators much of the time impact their mindfulness, understanding and constant PC to gauge venture costs. This paper presents thorough depictions of the extended cycle Fuzzy Hybrid Neural Network (EFHNN) and its application in theoretical worth assessing for building comes.[1]

In preparing the model, the creators beginning affirm the constituents that decide the hugeness of innovation administrations, consequently utilize partner worthy ANN for a worth appraisal model. The model predicts the significance of innovation administrations as a territory of development cost upheld venture type, designing administrations class, venture area, and task degree.[2]

Construction worth prediction is extraordinarily important for construction corporations to contend and grow at intervals the business. Correct construction worth prediction at intervals the primary stage of the project is extraordinarily important for project utility studies and booming completion. Several factors have an effect on the price prediction.[5]

Estimation of the worth of development comes may be an imperative assignment at interims the administration of these comes. The quality of development administration depends intensely on their adjust esteem estimation. Esteem Evaluating is one in each of the first essential angles for legitimate execution of any development company.[12]

Extended a way that appraises the difference in size of course development costs after some time. an engineered neural organization model was built up that relates generally course development costs, diagrammatical as far as a course development indicant, to the value of development material, work, and instrumentation, the attributes of the agreement and moreover the getting environmental factors winning at the time the agreement was let. Results show that the model is set up to copy past course development esteem patterns in American state with sensible precision.[11]

III. Neural Network

Neural Network (Machine Learning: ML) could also be a spread of knowledge analysis tools that pulls out info whereas not being expressly programmed to behave thus. NN is closely involving engineering (AI). Through NN, computer systems are developed to do to odd jobs love categorization, clustering, predictions, pattern recognition, etc.

1. Supervised Learning

2. Un-Supervised Learning
3. Reinforcement Learning

The neural organization is another technique for data preparing. Numerous ample and basic preparing units (neurons) structure the unpredictable organization framework. The neural organization is one sort of enormous scope equal association system with versatile displaying capacity, which reenacts the structure of human mind. In numerous sorts of neural organization models, the back-proliferation neural organization model is the most mainstream network on account of its better elements of self-study and self-affiliation. The any standard organization is made out of three sorts of neurons layer. The main layer is known as the information layer. The center one is named as the concealed layer (can be multi-layer). Furthermore, the main one is known as the yield layer. Each layer of neurons frames completely association, and the neurons in each layer have no association. The information data is moved and prepared through info layer and shrouded layer. The condition of each neural unit layer just influences the condition of next layer. In the event that the normal data can't be got in the yield layer, the course will transform into the enactment capacity and standardization of sources of info and return the blunder signal along the previous association way. Through adjusting the estimation of weight between every neuron, the mistake signal is communicated organized into the information layer, and afterward be sent into the following layer. The rehashed use of these two courses makes the mistake more and a lot more modest, until it meets the prerequisites.

IV. Methodology of model develoment

So as to accomplish the Aim of the investigation, a technique was created in three stages. In the primary stage, other cost assessment examines utilizing NN were investigated, and afterward the plan of the model for application in roadway development was characterized. In the last Phase, the model was tried to research the best organization arrangement so as to get more prominent exactness. The stages will be introduced in the accompanying areas.

A. Infromation available during conceptual project development level

The information obtainable is one amongst the distinctive options of the various forms of price estimates. The estimate level among the various forms of estimates obtainable does not provide clear and definite boundary. Because of this reason, some literatures use the terms abstract and preliminary estimate interchangeably. Throughout the abstract section, general info regarding the project are going to be obtainable comparable to the road length, road carriageway, terrain project, location of the project and therefore the project scope, right of way etc.[7] The identification of the influential factors or parameters affecting total project construction cost is necessary to develop cost-estimating model. The input parameters identified through literature review of road construction cost estimation.

B. Description and Analysis on preliminary data collection

The Government official site database was utilized for this research study. This database contains Road project cost data Gujarat state. Sources are representing in Table X from the source collected 124 road projects data.

Table X Data collection source

Government Organization
Gujarat State Road Development Corporation Limited
World bank
Infrastructureindia.gov.in : Data base of Infrastructure projects in India

Road and Building Department, government of Gujarat
Gujarat state highway project – 2
Asian development bank
PPPindia.gov.in
Total 123 Road Projects data collected

The data analyses with removing null values and Interquartile range (IQR) method in Excel. The final data collection resulted in production of set of data to be used as historical feed for develop cost estimation model. Totally 124 data were collected and out of these 113 data were used for conceptual estimation model development. Rejection of data is based on the project based on rigid pavement, Curves having null values. The rejected data could not be used for model development due to incompleteness of data, inconsistency of data, the percentage distributions of the data set in terms of factors are shown in charts and tables.

Table XI. Data proportion in collection

Type of Project	**No of Projects**	**Percentage**
NH	12	11%
SH	94	83%
MDR	7	6%
Total	***113***	***100%***
Scope of Project	**No of Projects**	**Percentage**
Widening and Improvement	113	100%
Flexible	113	100%
ROW	**No of Projects**	**Percentage**
0-30	74	65%
30-60	39	35%
Total	***113***	***100%***
Thickness of Pavement	**No of Projects**	**Percentage**
0 – 650	20	18%
650 -1300	93	82%
Total	***113***	***100%***
Overlaying	**No of Projects**	**Percentage**
0-450	106	94%
450-900	7	6%
Total	***113***	***100%***

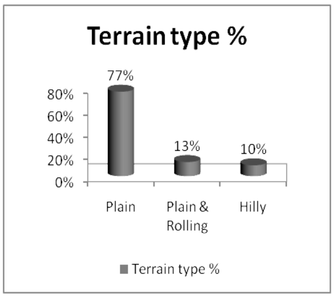

Fig. 1 Terrain Type

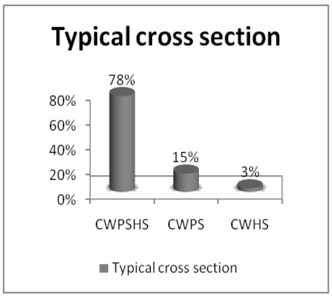

Fig. 2 Typical Cross section

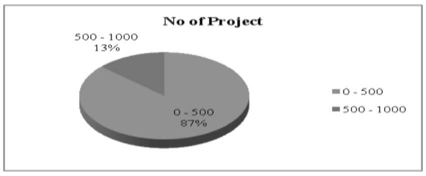

Fig. 3 Cost Distribution

C. The design and Modeling phase

A system for building up the model has been utilized to take care of the current issue. This philosophy consolidates five fundamental stages:

1. Assortment of Tool
2. Design Structure
3. Model implementation
4. Training and Testing
5. Discussion of results

This paper gives a model utilizing Regression Keras, which is based Deep learning rule. The computational instrument utilized was the Jupyter Notebook (IDE) that is embedded in the Python 3.7 Language. Firstly insert Required Libraries and modules.

Assigned input and output variables, the data should be in such the simplest way that the organization will decide the numerical connections between the information sources and their few yields. Then normalize data between zero to one.

Table XII Hot encoding

No.	**Chosen Factors**	**Code**
1	Type of road	NH = 1 SH = 2 MDR = 3
2	Scope of Work	New = 1 Widening & improvement = 2
3	Number of Lane	1L = 1 2L = 2 4L = 4 6L = 6
4	Length of Road	In Kilometres
5	Right of Way	In Metre
6	Type of pavement	Flexible = 1 Rigid = 2
7	CBR (%)	In Percentage
8	Terrain Type	Plain = 1 Plain & Rolling = 2 Hilly = 3
9	Thickness of Pavement	In Millimetres
10	Over Laying Thickness	In Millimetres

11	Width of paved Shoulders	In metre
12	Width of Hard Shoulders	In metre
13	Cross Drainage Structure	Yes = 1 No = 0
14	Protection work	Yes = 1 No = 0
15	Duration of Work	In years
16	Cost of Project	In crore

After creating array split the Training and Test Datasets in the ration of 0.60% and 0.40% respectively. The state of the preparation set (67 perceptions of 15 factors) and test set (46 perceptions of 15 factors).

After the split the data creating the Architecture of model built model with sequential creator 15 input dimensions with (ReLu) Activation function for passing one layer to another layer 3 hidden layer and one Output layer with one Out put dimension all the neurons are inter connected with each other which is done by using Dense module. The subsequent stage is to characterize an enhancer and the misfortune measure for preparing. The mean squared blunder is our misfortune measure and the "Adam" enhancer is our minimization calculation. The primary preferred position of the "Adam" analyzer is that we don't have to indicate the learning rate, similar to the case with angle plunge to Fits the model on the preparation dataset likewise give the contention, ages, which speaks to the quantity of preparing cycles which taken 2000 ages.

Table XIII Architecture of model

Model Type	Multilayer Perceptron (DNN)
Transfer Function	ReLu
Update Methods	Batch
Optimizer	Adam
No. of hidden layer	3
No. of PEs in the input layer	15
No. of PEs in the output layer	1

D. Experimental result and Analysis

Anticipate on the Test Data and Compute Evaluation Metrics of the Model Performance dependent on the Number of concealed layers, enactment capacity, and number of ages and learning rate has sway on the exhibition of neural organization. Different artificial neural network and multilayer preceptor models are develop by varying boundaries: No of concealed layers, No of shrouded hubs and actuation work.

This part presents the planned model, outcome and discussion. The projected model for prediction of cost estimation difficulty trouble utilizing NN is executed in Python adaptation 3.7 utilizing the Tensor-Flow system with Keras library. Keras is the library utilized to create profound learning show with Tensor-Flow as backend. Perfect way to assess the figure show is compare its genuine and anticipated comes about with the taking after Conditions.

$$MSE = \frac{\sum_{j=0}^{P}\sum_{i=0}^{N}\left(d_{ij} - y_{ij}\right)^2}{NP} \qquad (1)$$

$$MAE = \frac{\sum_{j=0}^{P}\sum_{i=0}^{N}\left|dy_{ij} - dd_{ij}\right|}{NP} \qquad (2)$$

$$MAPE = \frac{100}{N\,P}\sum_{j=0}^{P}\sum_{i=0}^{N}\frac{\left|dy_{ij} - dd_{ij}\right|}{dd_{ij}} \tag{3}$$

$$Total\ \boldsymbol{MAPE} = \frac{(MAPE_{Tr} \times N_{Tr} + MAPE_{C.V} \times N_{C.V})\ /\ (N_{Tr} + N_{C.V}) + MAPE_{Test}}{2} \tag{4}$$

$$TAP = 100 - Total\ \boldsymbol{MAPE} \tag{5}$$

Table XIV Model Result

	Data set	RMSE	MAPE	TAP
DNN	***Training***	3.73	2.3%	63.70%
	Testing	274.40	70.3%	

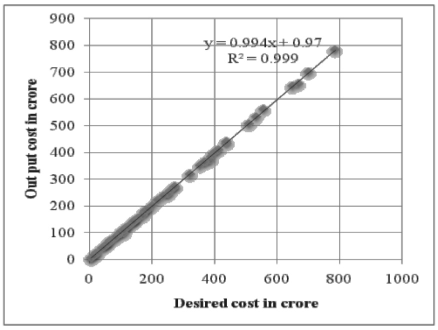

Chart 2 Desired output and actual network output for training set

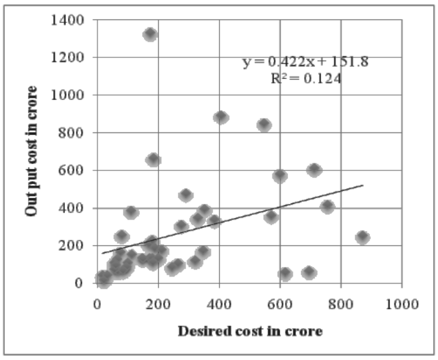

Chart 3 Desired output and actual network output for test set

We have assembled Regression models utilizing the profound learning structure, Keras. The guide utilized the Gujarat Road development cost information and fabricated a profound learning relapse model to anticipate the Cost in development in Crores.

Our model is accomplishing a steady exhibition with very little fluctuation in the train and test set RMSE. The ideal outcome would be a RMSE estimation of zero, yet that is practically unimaginable in genuine Cost datasets. Additionally, since the unit of the objective variable is in Crores, that likewise influences the RMSE esteem. There are different emphases, for example, changing the quantity of neurons, adding more concealed layers, or expanding the quantity of ages, which can be given a shot to see the effect on model execution.

Proposed the error of price estimation at the initial stage is more or less between ±25 and ±50. During this study was projected error categorization supported on MMRE as shown in Table VII. Agreeing to the table one can select expectation precision level and diminish time for preparing and selecting network parameters. High prediction accuracy needs longer to coach the network and look for advanced ANN models.[9]

Table XV Error Categorization in Percentage

MMRE	***Good***	Less than 25%
	Fair	25% – 50%
	Poor	More than 50%

V. Conclusion

Cost estimation done in the hypothetical stage of the extend grouping as a rule calculated generally which leads to huge incorrectness. The thought process for that has to have rugged thought of a extend in money related conditions. On the other side, venture subtle elements are not settled, well characterized due to need of data. In this paper, an attempt was made to prove that cost estimation inaccuracy at the initial planning phase. In conclusion, DNN might be a fitting instrument to assist unravels issues, which originate from various weaknesses, for example, taken cost assessment at the calculated stage with the precision of 63.70% to desire. Future work will be centered on creating a visual fundamental interface was created to encourage information passage for clients, where no past information of ANN is required to function DNN demonstrate. The interface given the client with numerous choices agreeing to the fifteen input parameters that depict the extend.

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EVALUATING THE PRIORITY INDEX FOR THE INFRASTRUCTURAL PLANNING OF SMART CITY- A CASE STUDY OF VADODARA

Ritika Kashyap[1],Jagruti Shah[2]

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[1]ITM Vocational University, Vadodara, India
[2]BVM Engineering College, Anand, India
kashyapritika10@gmail.com

Abstract

The Infrastructure sector contributes about 5% of GDP to the Indian economy and is highly responsible for the development of the country. As per the planning commission infrastructure investments are estimated to touch 8% GDP. Almost 37% of the investment in infrastructure came from the private sector. As per the census 2011, India's current population is 130 crore and 31% of the population is residing in urban areas. India stands at 58th rank out of 80 countries in the Quality of life Index 2020, which is based on various indicators like literacy rate, life expectancy rate, etc. To achieve a better quality of life and livelihood, more people are migrating from rural areas to urban areas, which is leading to urbanization. For accommodating this huge population in the cities, the government of India has initiated the Smart City Program. Under this program, 100 cities in India have been selected. A total of 6 cities of Gujarat is nominated for the same, amongst which Vadodara is one of them. This study comprises evaluating the best indicator suitable for the development of smart city- Vadodara and also providing the suitable recommendations for that indicator.

Keywords: Indicators, Infrastructure, Smart city, Urbanization, Vadodara

I. Introduction

Cities are prospering due to an increase in infrastructural facilities. Infrastructure sector is highly responsible for driving India's overall development. According to the planning commission, infrastructure investments are about to touch 8% GDP and about 37% of the investment in infrastructure comes from the private sector. India jumped 19 places to rank 35th among 160 countries in the World Bank's Logistics Performance Index (LPI) 2016 (source: lpi.worldbank.org). India's current population as per census 2011 is 130 crores, out of which 31% of India's population lives in urban areas and contributes 63% of India's GDP **Ошибка! Источник ссылки не найден.**. Urban areas are expected to house 40% of India's population and contributes 75% of India's GDP by 2030. In India, nearly 45.36 crore people are migrants which is around 37.8% of the total population of India. The main explanation for migration is urbanization.

The Urbanization rate is increasing in India. In 1901, only 11.4% of people were living in urban areas whereas it has increased to 31.6% in 2011. It is expected that by 2030, 40.76% population will be living in urban areas. The Issue of Sustainable urbanization can only be achieved by controlling the migration of people. For solving the problem of urbanization, the government of India has initiated the smart city mission. This mission will help in improving the quality of life of the people in cities. As per the study of Quality of life index, India stands at 58th rank among 80 countries. This study includes various parameters that are related to the daily life of the people living in cities i.e health and well-being, happiness, travel, digital life, safety and security, etc. From Gujarat, total of 6 cities were selected under the project of smart city development **Ошибка! Источник ссылки не найден.**. Vadodara is one of the leading cities in terms of growth and infrastructural development, so it has been selected for this study.

II. Objectives of Study

- To evaluate and prioritize the smart city indicators, which have been identified by the existing infrastructural facility of the Vadodara city.
- To provide the appropriate technology and recommendations for the most inspiring indicators for the city

III. Data Collection

From various literature reviews, we have found out that a Smart city has many dimensions [1]. These dimensions were shortlisted from the review and also from the reccommedations of local experts which will create an impact on the smart city development of the Vadodara city. These are- Economic factor, Environmental factor, Innovation and Learning factor, Information Communication & Technological Factors, Mobility Factors, Operational & Managerial Factors, Physical Factors, Political Factors, and Social factors. For all these given dimensions, we have found out 66 sub-factors which was used for the survey work of the smart city. In this research work, we had evaluated the priority index for the infrastructural planning of the smart city.

The method adopted for data collection is a primary survey. A total of 125 survey forms were distributed via emails and social networking sites. Overall 80 responses were recorded and data are collected from it. This survey is conducted at a professional level. So, all respondents are experts in their respective fields.

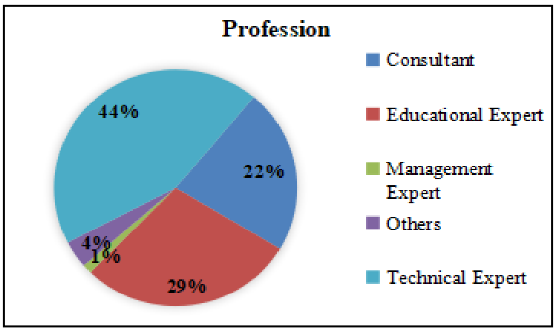

Figure 1: *Profession*

Figure 1, shows the percentage of responses given by the experts till now. 44% of the responses were given by technical experts, 29% were from educational experts and around 22% of responses were provided by consultants.

The response collected are divided into 5 major categories-

- Not Significant
- Fairly Significant

- Significant
- Very Significant
- Extremely Significant

Indicators with their sub-factors are listed below-

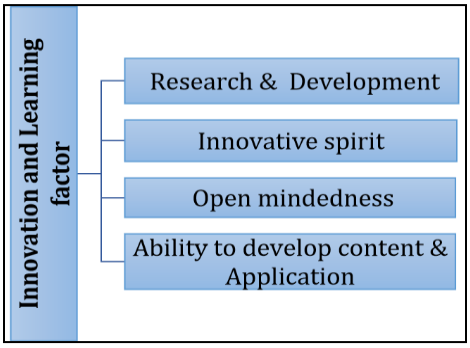

Figure 2: *Sub-factors of Innovation & Learning*

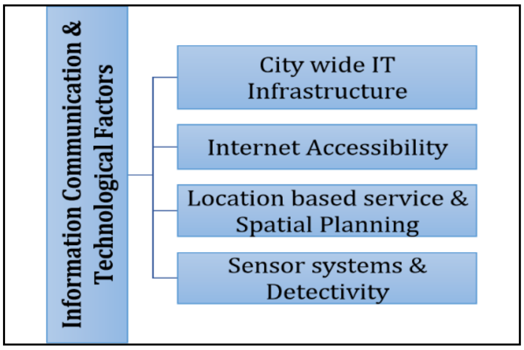

Figure 3: *Sub-factors of Information Communication & Technological*

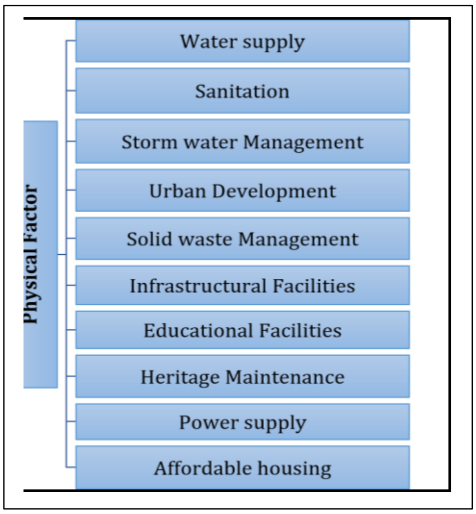

Figure 4: *Sub-factors of Physical*

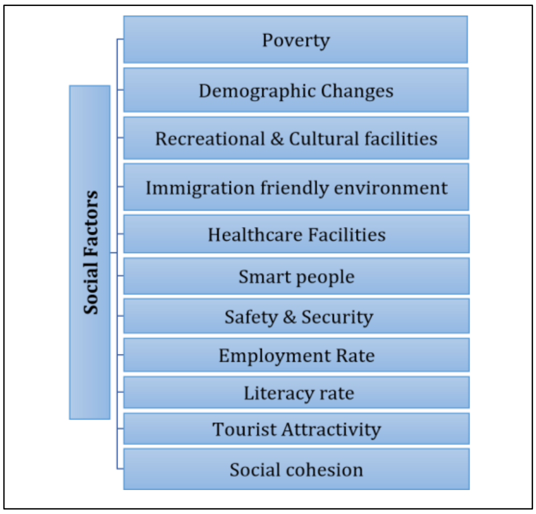

Figure 5: *Sub-factors of Social*

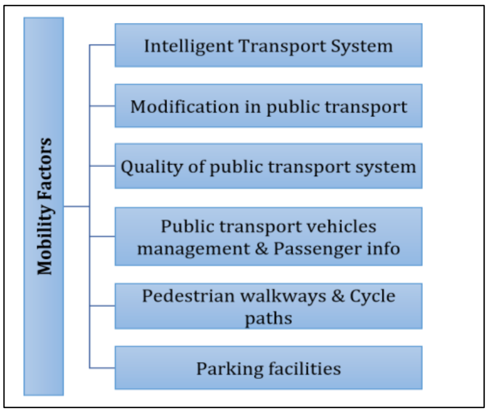

Figure 6: *Sub-factors of Mobility*

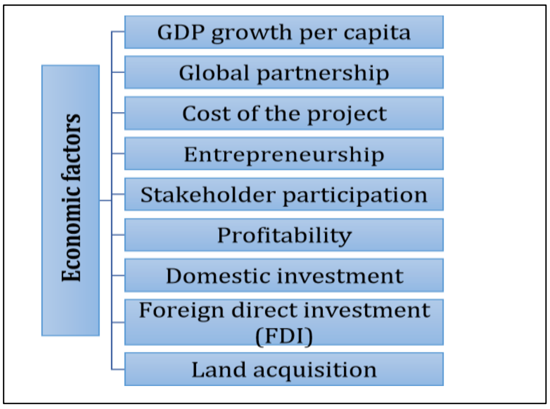

Figure 7: *Sub-factors of Economic*

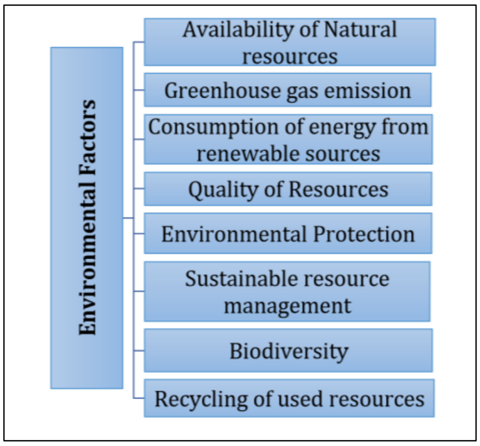

Figure 8: *Sub-factors of Environmental*

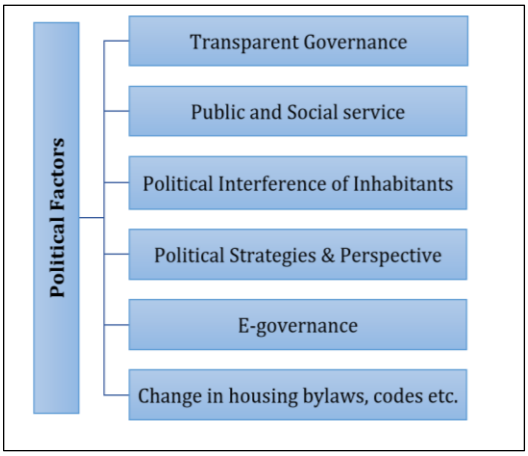

Figure 9: *Sub-factors of Political*

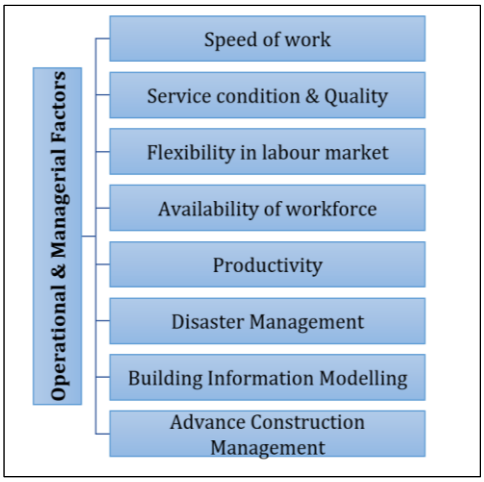

Figure 10: *Sub-factors of Operational & Managerial*

IV. Data Analysis

The primary data collected from the questionnaire survey were analyzed using the Relative Importance Index method for the ranking of these factors from the perspective of technical experts, educational experts, management experts, etc.

Relative Importance Index or weight is a type of relative importance analysis. RII method is used for providing the priority index to the factors of a smart city. RII was used for the analysis because it best fits the purpose of this study.

RII = Sum of weights (W1 + W2 + W3 + ……+ Wn) / A x N

where,

W = weights given to each factor by the respondents and will ranges from 1 to 5 where '1' is less significant and '5' is extremely significant

A = highest weight (i.e. 5 in this case)

N = total number of respondents.

I. Data Analysis for Indicators

Table 1: *RII for Smart City Indicators*

Sr.	Indicators	RII
1	Political Factor	0.62
2	Economic Factor	0.71
3	Operational & Managerial Factor	0.74
4	Social Factor	0.77
5	Innovation & Learning Factor	0.81
6	Physical Factor	0.83
7	Mobility Factor	0.88
8	Information Communication & Technological Factor	0.89
9	Environmental Factor	0.92

The table 1 shows the RII for the smart city indicators. It represents the overall ranking given to the indicators. Most priority is given to Environmental factors, followed by Information Communication and Technological factor.

II. Data Analysis for Sub-factor

Table 2: *RII for Economical Factors*

Sr.	Sub-Factors	RII
1	GDP growth per capita	0.63
2	Global partnership	0.64
3	Cost of the project	0.70
4	Entrepreneurship	0.56
5	Stakeholder participation	0.73
6	Profitability	0.66
7	Domestic investment	0.65
8	Foreign direct investment (FDI)	0.71
9	Land acquisition	0.89

Table 2 shows the RII for the economical factors. It has been divided into 9 sub-factors. Amongst them, land acquisition is given the most priority for the formation of a smart city followed by the participation of stakeholders.

Table 3: *RII for Environmental Factors*

Sr.	Sub-Factors	RII
1	Biodiversity	0.70
2	Green house gas emission	0.75
3	Availability of natural resources	0.79
4	Quality of resources	0.86
5	Consumption of energy from natural resources	0.90
6	Sustainable resource management	0.91
7	Recycling of used resources	0.93
8	Environmental Protection	0.95

Table 3 shows the RII for environmental factors. It consists of 8 sub-factors. Environmental Protection factor seems to be the most significant factor among all. In the same way the second most important factor is the recycling of used resources chosen by the stakeholders.

Table 4: *RII for Innovation & Learning Factors*

Sr.	Sub-Factors	RII
1	Ability to develop content and application	0.71
2	Open mindedness	0.73
3	Innovative spirit	0.78
4	Research and Development	0.86

Table 4 shows the RII for Innovation and Learning factors. It is divided into 4 sub-factors. Research and development is the most significant factor followed by Innovative spirit.

Table 5: *RII for Information, Communication & Technological Factors*

Sr.	Sub-Factors	RII
1	Location based service and spatial planning	0.71
2	Sensor system and detectivity	0.86
3	City wide IT infrastructure	0.86
4	Internet Accessibility	0.91

Table 5 signifies the RII for Information Communication & Technological Factors. It has 4 sub-factors and Internet accessibility is the most significant factor and its priority index is 0.91.

Table 6: *RII for Mobility Factors*

Sr.	Sub-Factors	RII
1	Public transport vehicle management & passenger info	0.72
2	Intelligent transport system	0.86
3	Quality of public transport system	0.87
4	Pedestrian walkways and cycle path	0.91
5	Modification of public transport	0.92
6	Parking facilities	0.93

Table 6 represents the RII for mobility factors. It has 6 sub-factors. Parking facilities are the most important factor for the development of smart cities followed by modification in public transport.

Table 7: *RII for Operational & Managerial Factors*

Sr.	Sub-Factors	RII
1	Flexibility in labour market	0.49
2	Availability of workforce	0.54
3	Productivity	0.58
4	Service condition and quality	0.59
5	Speed of work	0.60
6	Building Information Modelling	0.67
7	Advance construction management	0.83
8	Disaster Management	0.90

Table 7 shows the RII for operational & Managerial factors. It has been divided into 8 sub-factors. Disaster management is found to be the most important factor with an index of 0.90.

Table 8: *RII for Physical Factors*

Sr.	Sub-Factors	RII
1	Affordable housing	0.71
2	Power supply	0.76
3	Heritage maintenance	0.79
4	Water supply	0.81
5	Urban Development	0.83
6	Educational Facilities	0.85
7	Sanitation	0.86
8	Infrastructural Facilities	0.88
9	Storm water management	0.90
10	Solid waste management	0.96

Table 8 depicts the RII for Physical factors. It has 10 sub-factors. Solid waste Management tops the list having RII 0.96 followed by the stormwater management.

Table 9: *RII for Political Factors*

Sr.	Sub-Factors	RII
1	Political interference of inhabitants	0.48
2	Political strategies & perspective	0.49
3	Public and social service	0.57
4	E-Governance	0.58
5	Transparent Governance	0.60
6	Change in housing bye-laws codes etc	0.70

Table 9 displays the RII for Political factors. It has been divided into 6 sub-factors. Change in housing bylaws, codes, etc. has received the highest priority index of 0.7 followed by Transparent Governance.

Table 10: *RII for Social Factors*

Sr.	Sub-Factors	RII
1	Poverty	0.57
2	Demographic changes	0.59
3	Social Cohesion	0.65
4	Tourist Attractivity	0.66
5	Smart people	0.69
6	Employment rate	0.70
7	Literacy rate	0.71
8	Immigration friendly environment	0.72
9	Recreational and cultural facilities	0.75
10	Health care facilities	0.91
11	Safety and security	0.94

Table 10 shows RII for Social Factors. It has been divided into 11 sub-factors. Safety & security is the priority for the building of smart city.

Table 11: *Ranking of Sub-factors*

Sr. No.	Factors	Main group	RII	Rank
1.	Solid Waste Management	Physical factors	0.96	1
2.	Environmental Protection	Environmental factors	0.95	2
3.	Safety & Security	Social factors	0.94	3
4.	Parking facilities	Mobility factors	0.93	4

5.	Modification in public transport	Mobility factors	0.92	5
6.	Recycling of used resources	Environmental factors	0.92	5
7.	Healthcare Facilities	Social factors	0.91	7
8.	Internet Accessibility	ICT Factors	0.91	7
9.	Sustainable resource management	Environmental factors	0.91	7
10.	Storm Water Management	Physical Factors	0.90	10
11.	Disaster Management	Operational & managerial factors	0.90	10
12.	Pedestrian walkways & Cycle Paths	Mobility factors	0.90	10
13.	Consumption of energy from renewable sources	Environmental factors	0.90	10
14.	Land Acquisition	Economical factors	0.89	14
15.	Infrastructural Facilities	Physical factors	0.88	15
16.	Quality of public transport system	Mobility factors	0.87	16
17.	Sanitation	Physical factors	0.86	17
18.	Intelligent Transport System	Mobility factors	0.86	17
19.	Sensor systems & Detectivity	ICT Factors	0.86	17
20.	City wide IT Infrastructure	ICT Factors	0.86	17
21.	Research & Development	Innovation and learning factors	0.86	17
22.	Quality of Resources	Environmental factors	0.86	17
23.	Educational Facilities	Physical factors	0.85	23

24.	Urban Development	Physical factors	0.83	24
25.	Advance Construction Management	Operational & managerial factors	0.83	24
26.	Water supply	Physical factors	0.81	26
27.	Heritage Maintenance	Physical factors	0.79	27
28.	Availability of Natural resources	Environmental factors	0.79	27
29.	Innovative spirit	Innovation and learning factors	0.78	29
30.	Power supply	Physical factors	0.76	30

Table 11 shows the ranking of the top 30 factors using RII based on stakeholders' choice. Total 26 factors are extremely significant as the RII is more than 0.80.

V. Discussion

Total of 26 factors have been identified as "Extremely Significant" for development of smart cities as their Relative Importance Index is more than 0.80.

Overall top 10 factors by relative importance index in decreasing order are:

- Solid Waste Management
- Environmental Protection
- Safety and Security
- Parking facilities
- Recycling of used resources
- Modification of public transport
- Internet Accessibility
- Health care facilities
- Sustainable resource management
- Pedestrian walkways & Cycle paths

Solid waste management can be made more effective by the use of smart dust bin. Smart Community Bins consisting of Level indicators and RFID tags which can signal to Control center and real-time communication with Collection vehicles. Use of low emission incinerators. These incineration systems not only eliminate garbage, but they also generate steam which can be used to produce electricity.

Environmental Protection can be done by various methods which include usage of E-vehicle.

Safety and security can be insured by usage of Artificial Intelligence. The computer based intelligence coordinated well-being measures incorporate a concentrated video reconnaissance and the executives framework that screens and keeps beware of traffic developments, resources, wrongdoing, and security of open and their notoriety.

Parking management by removing private vehicular parking from the public space as much as possible, the public space can be retrofitted, shifting the focus to Pedestrians and Public Transportation. Limiting parking is only possible in combination with the creation of a network of footpaths, MSCPs (multi-story Car Parking's), Smart Bus + E Rickshaws System.

VI. Conclusion

From the research study, we have found out top ten factors based on the relative importance index. These factors are creating major difference while choosing for infrastructural facilities or planning for the smart cities. All these factors should be kept in mind specially for the country like India where population is increasing day by day. So from the perperception of stakeholders and professionals, these core facilities should be designed first and the rest thing should be parallelly or after the main core infrastructural facility can be designed for ovverall society development.

VII. Future Scope

This study was done considering Vadodara only, this type of study can be replicated for the other city, such as Surat, Ahmedabad, Rajkot, and also for the other states. It included the survey done from stakeholders only. Similarly, the city people and government organizations can be included. The ranking methods like the Critical Index Method, Significance Index can be used for the same as well as other cities. Different analytical methods and case studies also can be used. A Smart City model can be made using different model making software [3].

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MULTI OBJECTIVE OPTIMIZATION IN DRILLING OF GLASS FIBER/EPE FOAM SANDWICH COMPOSITE BASED ON GREY RELATIONAL ANALYSIS

Hariketan Patel[1], Jigneshkumar Patel[2], Bharat Gajera[3], Hiteshkumar Rana[4]

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[1, 3, 4] Mechanical Engineering Department, GIDC Degree Engineering College, Abrama Navsari, Gujarat, India

[2] Mechanical Engineering Department, Mahatma Gandhi Institute of Technical Education & Research Centre, Navsari, Gujarat, India

hari.mech.patel@gmail.com[1]

Abstract

A grey relational analysis is a novel decision-making technique for forecast, developing relational analysis in numerous areas of manufacturing or production processes in industry. In this research paper, the objective is to optimize the drilling process input parameters considering assigned weight fraction of output quality characteristics using grey relational analysis in drilling of Glass fiber/ EPE foam sandwich composite. The output quality characteristics considered are thrust force, torque and delamination under the experimental domain of spindle speed, feed and drill diameter. The drilling experiments were designed as per Taguchi design of experiments using L_{25} orthogonal array. The best possible input process parameters which give minimum thrust force, torque and delamination factor have been established by the combined methodology of orthogonal array design of experiments ANOVA and grey relational analysis. The results indicate that most significant factor is drill diameter followed by feed and spindle speed respectively. The experimental results have shown that with the help of grey relational analysis, output quality characteristics can be enhanced efficiently.

Keywords: Glass fiber, thrust force, delamination, ANOVA, grey relational analysis (GRA)

I. Introduction

This Sandwich composite materials are made of two high strength external skins bonded on a low strength core. The sandwich composite of glass and carbon fiber reinforced polymers have gradually invaded in many daily applications, automotive parts, aircraft components, marine industries and sports [1] They have some outstanding property to resist corrosion, easy ability for making intricate shapes, better maximum strength to weight ratio, etc. [2]. The skins withstand the bending stresses and give the structure hardwearing surface whereas light core material carries the shear stresses generated by loads, distributing them over a larger area [3]. Any engineering application of these sandwich composite materials may involve the various manufacturing methods [4]. Failure of laminated composites during drilling is a complex phenomenon that involves matrix cracking, delamination and fiber breaking, fiber pull-out, hole shrinkage, spalling, fuzzing and thermal degradation as they exhibit anisotropic and inhomogeneous structure, thus drilling of a composite material is a difficult task [5].
In drilling of composites, increase of feed rate and cutting speed have effects of reduction in cutting

force and torque examined by Pramendra et al [6]. Davim et al used Taguchi's orthogonal array and ANOVA to investigate the effect of input drilling parameters in drilling of GFRP composite on delamination and surface roughness. Their investigation shows that spindle speed is the most significant input parameters followed by others [7]. By experiments on HSS twist drill bit, Palanikumar et al have developed an approach combining ANOVA and the regression equations [8]. The complicated multi output response problem can be effectively solved using grey relational analysis (GRA) based upon grey theory [9]. Pawade and Joshi used Taguchi grey relational analysis (TGRA) to optimize SR and cutting forces in highspeed turning of Inconel 718 [10]. Palanikumar applied GRA for drilling of MMCs to obtain the optimized input process parameters for optimized multi response output quality characteristics [11].

The main objective of the present work is to optimize the process parameters in the drilling of glass fiber/EPE (Expanded polyethylene) foam sandwich composite. The optimization can be stated as minimize thrust force, torque and delamination with reference to independent input process parameters, spindle speed, feed, drill diameter. This multi objective problem can be converted into a single objective function using GRA, and a grey relational grade has been identified. Maximizing this grey relation grade, subjected to independent process parameter, is in experimental range. Taguchi method design is used to find the significance of each process parameter using ANOVA.

II. Materials and Methods

The glass fiber/EPE foam sandwich composite laminates were developed in house with hand lay-up method. The glass fiber is used as skin material, EPE foam as core material and epoxy resin as adhesive. The glass fiber sheets were supplied by Liyo Sign Composites SD private Ltd, Ahmedabad, Gujarat and EPE foam sheets were supplied by LATA Foam, Vapi, Gujarat. Epoxy resin and hardener were procured from Atul Industries Ltd, Gujarat under the trade name of Lapox L-12 and K-6 respectively. The epoxy to hardener ratio was taken as 10:1 as per the supplier's prescribed standard.

The glass fiber sheets and EPE foam sheets are cuts into required size. The glass fiber/EPE foam sandwich composite laminate was fabricated with 12 layers of glass fibers sheets (20 vol. % of reinforcement) having 6 layers on each side of laminates as a skin and 4 layers (each layer of 3mm) of EPE foam (32.2 vol. %) are used as core. The laminates were then cured in a compression moulding press at 60° C temperature for 20 minutes at pressure of 1 MPa. After removing the laminates, they were dried in an oven at 50° C for 3 hrs. to remove moisture and other volatile entities. Samples were cut as per the required dimensions of 120 × 120 × 5 mm^3. Samples were then post cured in an oven at 145°C for 5 hrs.

The drilling experiments were performed on radial drilling machine (Batliboi and company Pvt. Ltd, Surat, Gujarat, India.) powered by 15 kW main spindle motor. High speed steel Twist drill geometry of various diameters were used for experimentation as shown in Figure 1. The mechanism of the experiment setup is such that the specimen of fabricated laminate is fitted on the fixture of the radial drilling machine as shown in Figure 2. The process parameters under investigation were categorized as machine tool parameters and cutting tool parameters with their different levels as presented in Table 1.

Figure 1: *High speed steel Twist drill geometry of various diameters.*

Table 1: *Factors and factor levels for experiment.*

Experimental level	Spindle Speed (rpm)	Feed (mm/rev.)	Drill Diameter (mm)
1	500	0.05	4
2	710	0.12	6
3	1000	0.19	8
4	1420	0.26	10
5	2000	0.33	12

The thrust forces (N), torque (Nm) and delamination factor were considered as output quality characteristics. Drilling force along the axis of drill (thrust force: Fz) and moment (Torque: T) along the axis of rotation were recorded using drill dynamometers (make: KISTLER, type: 9257B, Winterthur, Switzerland), as shown in Figure 2. The experimental results with L_{25} orthogonal array (OA) for thrust forces (N), torque (Nm) and delamination factor are presented in Table 2.

III. Methodology for GRA

In GRA, black represent to have null information and white represents to have all information. A grey structural system has a level of information between black and white. In other words, in a grey structural system, some information is known and some information is unknown. The stepwise procedure for GRA is explained in the subsequent sections [9].

A. Data Pre-Processing.

In GRA, to normalize the original sequence pre-processing of data is performed to process within the range of zero to one for comparable sequence. when the sequence range is too large or when the goal and directions of parameters are disparate, data preprocessing is performed. The approach of pre-processing is to transfer the original sequence data by normalizing into a comparable sequence. Let the original reference and comparability sequence be presented as $x_0^0(k)$ and $x_i^0(k)$, i = 1, 2,….m; k = 1, 2, …..n, respectively, where m and n are the total number of experiment to be after sequence and the total number of initial data respectively. For this purpose, the experimental results are normalized in the range between zero and one. The various pre-processing methods for data sequence in GRA depending on the characteristics of distinguishing coefficient denoted by ζ. In the present investigation, the target for the output quality characteristics, thrust force, torque and delamination factor is 'lower-the-better', and the original sequence can be normalized as follows

$$x_i^*(k) = \frac{max\ x_i^0(k) - x_j^*(k)}{max\ x_i^0(k) - min\ x_i^0(k)} \tag{1}$$

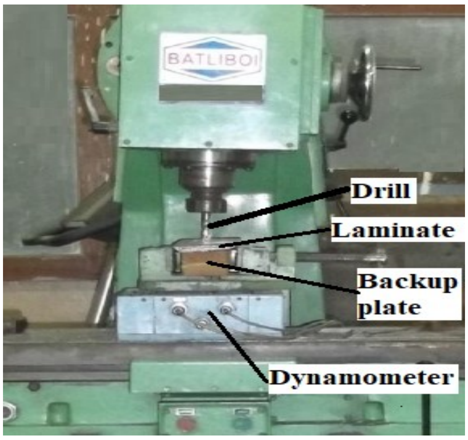

Figure 2: *Drilling process setup with drill dynamometer.*

Table 2: *Reference sequence and comparability sequence for delamination factor, thrust force and torque with experimental factor levels.*

Experimental runs	Comparability sequence			Reference sequence		
	Spindle Speed (rpm)	Feed (mm/rev.)	Drill diameter (mm)	Delamination Factor	Thrust force (N)	Torque (Nm)
1	500	0.05	4	1.23	81.99	29.93
2	500	0.12	6	1.27	106.05	41.47
3	500	0.19	8	1.32	132.82	55.53
4	500	0.26	10	1.37	159.74	70.16
5	500	0.33	12	1.41	173.92	83.02
6	710	0.05	6	1.26	85.63	33.43
7	710	0.12	8	1.3	112.46	49.56
8	710	0.19	10	1.36	139.82	64.43
9	710	0.26	12	1.41	166.22	74.93
10	710	0.33	4	1.32	118.8	42.93
11	1000	0.05	8	1.27	97.16	38.28
12	1000	0.12	10	1.32	123.72	52.66
13	1000	0.19	12	1.37	150.72	68.93
14	1000	0.26	4	1.3	102.62	37.24
15	1000	0.33	6	1.36	129.48	48.43

16	1420	0.05	10	1.29	107.99	47.2
17	1420	0.12	12	1.35	134.52	56.96
18	1420	0.19	4	1.28	76.36	34.2
19	1420	0.26	6	1.35	113.82	38.88
20	1420	0.33	8	1.39	137.42	55.21
21	2000	0.05	12	1.3	118.42	50.67
22	2000	0.12	4	1.23	85.56	26.16
23	2000	0.19	6	1.3	113.12	35.57
24	2000	0.26	8	1.35	139.19	50.3
25	2000	0.33	10	1.4	176.84	65.71

The alternate simple method,

$$x_i^*(k) = \frac{x_i^0(k)}{x_i^0(1)} \tag{2}$$

Where $x_i^0(k)$:the initial sequence, $x_i^*(k)$:for the i[th] experiment the sequence after the data processing, $max\ x_i^0(k)$:the maximum value of $x_i^0(k)$, and $min\ x_i^0(k)$: the minimum value of $x_i^0(k)$.

B. Grey relational coefficient (GRC)and grey relational grade (GRG)

After data preprocessing, grey relational coefficient (GRC) can be calculated using preprocessed sequence of quality characteristics. The GRC is defined as follows

$$\xi_i(k) = \frac{\Delta_{min} + \zeta\ \Delta_{max}}{\Delta_{oi}(k) + \zeta\ \Delta_{max}} \tag{3}$$

Where $\Delta_{oi}(k)$ is deviation sequence of reference sequence $x_0^*(k)$ and comparability sequence $x_i^*(k)$ respectively.

$$\Delta_{oi}(k) = \|x_0^*(k) - x_i^*(k)\| \tag{4}$$

$$\Delta_{min} = min_{\forall j \in i} min_{\forall k} \left|x_0^*(k) - x_j^*(k)\right|$$

$$\Delta_{max} = max_{\forall j \in i} max_{\forall k} \left|x_0^*(k) - x_j^*(k)\right|$$

Where $x_0^*(k)$ symbolizes reference sequencing and $x_i^*(k)$ symbolizes comparability sequence. is distinguishing or identification coefficient: . In the present study the value of is assumed as 0.5.
The grey relational grade is determined by the average of grey relational coefficients and it is given

$$\gamma_i = \frac{1}{n}\sum_{k=1}^{n} w_k\ \xi_i(k) \tag{5}$$

The association among reference and comparability sequences is designated by grey relational grade. For indistinguishable sequence, value of grey relational grade is equal to 1. The level of influence exercised by comparability sequence on reference sequence is also pointed out by grey relational grade. Subsequently, The Grey relational grade sequences the degree of significance by the comparability sequence over the reference sequence. if a specific comparability sequence is more significant to reference sequence than other comparability sequences, the grey relational grade for that comparability sequence and reference sequence will exceed that for other grey relational grades [9]. In reality, The GRA is a measurement of absolute value of data variance among sequences and can be used to estimate the association between sequences.

IV. Result and Discussion

Table 3: *Sequence after data processing.*

Reference sequence/ comparability sequence	Delamination factor	Thrust force	Torque
Reference sequence/ comparability sequence	1	1	1
Experiment 01	1	0.943	0.934
Experiment 02	0.778	0.705	0.731
Experiment 03	0.5	0.438	0.483
Experiment 04	0.222	0.170	0.226
Experiment 05	0	0.029	0
Experiment 06	0.833	0.908	0.872
Experiment 07	0.611	0.641	0.588
Experiment 08	0.278	0.368	0.327
Experiment 09	0	0.106	0.142
Experiment 10	0.5	0.578	0.705
Experiment 11	0.778	0.793	0.787
Experiment 12	0.5	0.529	0.534
Experiment 13	0.222	0.260	0.248
Experiment 14	0.611	0.739	0.805
Experiment 15	0.278	0.471	0.608
Experiment 16	0.667	0.685	0.630
Experiment 17	0.333	0.421	0.458
Experiment 18	0.722	1	0.859
Experiment 19	0.333	0.627	0.776
Experiment 20	0.111	0.392	0.489
Experiment 21	0.611	0.581	0.569
Experiment 22	1	0.908	1
Experiment 23	0.611	0.634	0.835
Experiment 24	0.333	0.375	0.575
Experiment 25	0.056	0	0.304

The desirability criterion for optimum drilling performance is minimum thrust force, minimum torque and minimum delamination factor. When sandwich composite laminates are in consideration, cutting forces are considerably higher because of skin act as abrasive reinforcement at the entry to the object, which causes deterioration in the performance of the process. The experimental results for delamination factor, thrust force and torque are presented in Table 2. For data preprocessing in GRA, thrust force, torque and delamination factors were based upon 'lower-the-better' principle; thus, Equation 1 was employed for data preprocessing. The result of experimental runs for comparability sequence and reference sequence was calculated and presented in Table 3. The distinguished coefficient ζ (0.5) was substituted in Equation 5 to generate GRC. The weight (w) assigned to output quality characteristics depends upon the requirement of process or its application. In the present investigation, equal weights (0.333) were assigned to thrust force, torque and delamination factor, and their summation is equal to 1.

The grey relational coefficients and grey relational grades for each experimental r un were calculated as per Equation 3 and Equation 5 and are presented in Table 4.From the calculated values of grey relational grade, it was observed that experimental run 22(A_5, B_1,and C_1) spindle speed 2000 rpm, feed 0.05 mm/rev. and drill diameter 4 mm has highest grey relational grade. Therefore, experimental run setting at experiment 22 of input process parameters gives minimum thrust force, torque and delamination factor (i.e. best multi performance experimental run) among all

Table 4: *Calculated grey relational coefficient and grey relational grade.*

Experimental runs (comparability sequence	Orthogonal array			Grey relational coefficient			Grey relational grade	Rank
	A	B	C	Delamination Factor	Thrust force	Torque		
1	1	1	1	1	0.899	0.882	0.927	2
2	1	2	2	0.692	0.629	0.650	0.657	6
3	1	3	3	0.5	0.471	0.491	0.488	15
4	1	4	4	0.391	0.376	0.392	0.387	22
5	1	5	5	0.333	0.340	0.333	0.336	25
6	2	1	2	0.75	0.844	0.796	0.797	4
7	2	2	3	0.562	0.582	0.549	0.564	10
8	2	3	4	0.409	0.442	0.426	0.426	20
9	2	4	5	0.333	0.359	0.368	0.353	24
10	2	5	1	0.5	0.542	0.629	0.557	12
11	3	1	3	0.692	0.707	0.701	0.700	5
12	3	2	4	0.5	0.515	0.518	0.511	14
13	3	3	5	0.391	0.403	0.399	0.398	21
14	3	4	1	0.562	0.657	0.720	0.646	7
15	3	5	2	0.409	0.486	0.561	0.485	16
16	4	1	4	0.6	0.614	0.575	0.596	9
17	4	2	5	0.429	0.463	0.480	0.457	18
18	4	3	1	0.643	1	0.780	0.807	3
19	4	4	2	0.429	0.573	0.691	0.564	11
20	4	5	3	0.36	0.451	0.495	0.435	19
21	5	1	5	0.563	0.544	0.537	0.549	13
22	5	2	1	1	0.845	1	0.948	1
23	5	3	2	0.563	0.577	0.751	0.630	8
24	5	4	3	0.429	0.444	0.541	0.471	17
25	5	5	4	0.346	0.333	0.418	0.367	23

experimental runs. But it does not give an idea about optimal setting of input process parameters for optimum output quality characteristics. A GRA technique was applied on generated grey relational grade to obtain optimal setting of input process parameters for optimal multi response performance. For all input process parameters with all factor levels average grey relational grades were determined as shown in Table 4.

The method is, group grey relational grade by factor level at each column in orthogonal array and then takes average of them. For example, in the first column of orthogonal array (Table 4), experimental runs 1–5 are at first level of factor cutting speed. The calculated grey relational grade for cutting speed at levels 1–5 is given as

$$A_1 = \frac{1}{5}(0.927 + 0.657 + 0.488 + 0.387 + 0.336) = 0.559$$
$$A_2 = \frac{1}{5}(0.797 + 0.564 + 0.426 + 0.353 + 0.557) = 0.539$$
$$A_3 = \frac{1}{5}(0.700 + 0.511 + 0.398 + 0.646 + 0.485) = 0.548$$
$$A_4 = \frac{1}{5}(0.596 + 0.457 + 0.807 + 0.564 + 0.435) = 0.572$$
$$A_5 = \frac{1}{5}(0.549 + 0.948 + 0.630 + 0.471 + 0.367) = 0.592$$

Using the same approach, average grey relational grade for each factor was calculated and is presented in Table 5. The grey relational grade value always gives tremendous performance to characterizes the amount of correlation among reference sequence and comparability sequence. The factor level with the highest value of grey relational grade is the most optimal level [9]. In other words, regardless of type of performance characteristics, highest grey relational value indicates to enhanced optimal performance [10]. Based upon this criterion, one can select the level of input process parameters that provides large average grey relational grade. The highest value of average grey relational grades from table 5 are identified as spindle speed at highest factor level 5, feed and drill diameter at lowest factor level 1 respectively. Hence, in drilling of sandwich composite laminates, by optimization of multi response through grey relational analysis cutting speed of 2000 rev./min, feed of 0.05 mm/rev and drill diameter of 4mm is the most optimum combination of drilling process parameters. For each drilling process input factor, the difference between maximum and minimum average grey relational grades are as follows: for spindle speed of 0.053, for feed of 0.278, and for drill diameter of 0.359. These numerical values give an idea about most important controllable factor that influences output quality characteristics of process. The most important controllable factor corresponds to the maximum of these values, that is, drill diameter of 0.359, followed by feed of 0.278 and spindle speed of 0.053.

It is observed from figure 3 and value of Table 5, that the drill diameter is the most significant input parameter when considering the multiple responses, which is followed by Feed Rate and at last the spindle speed. The mean GRG values for each drilling parameters is shown in Figure 3. In grey relational technique, the highest value of GRG corresponds to the optimal process output. Therefore, Spindle Speed of 2,000 rpm, Feed of 0.05 mm/ rev. and drill diameter of 4 mm gives the desired optimized output. It was observed that the increase of diameter of drill, increases in total surface area of contact of the drill bit with work piece. This leads to increase in thermal influence in region which in return increases the torque and thrust force generated in process.

Table 5: *Response table for Average grey relational grade by factor level*

Parameters	Level 1	Level 2	Level 3	Level 4	Level 5	(Maximum) –(Minimum)	Rank
Spindle speed	0.559	0.539	0.548	0.572	0.592	0.053	3
Feed	0.713	0.628	0.550	0.484	0.436	0.278	2
Drill diameter	0.777	0.627	0.532	0.457	0.418	0.359	1

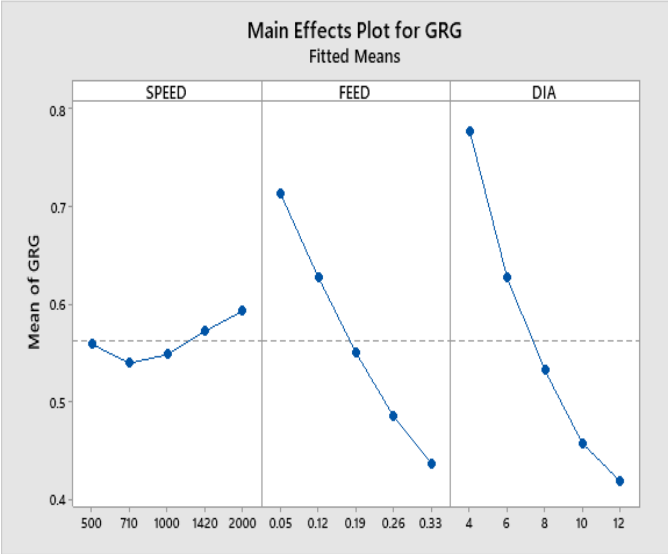

Figure 3: *Main effects plot for Grey relational grades.*

The thermal influence causes surface flaws and discontinuities get wiped out that leads to delamination. Furthermore, thermal heating in cutting region causes decrease in shear strength of workpiece and allows easy shearing of material during drilling process. The delamination is corresponded to variations in the torque and thrust force. The delamination has an effect on the hole quality. Similarly, the hole quality is tolerated by the increase in Feed Rate. It has also been observed that cutting speed with respect to feed and drill diameter have least effect during the drilling process. Thus, overall drilling performance is higher at higher grey relational grade for input process parameter cutting speed, as shown in Figure 3 It was observed from Figure 3 that there is a sharp decrease in grey relational grade with increase in feed. It is observed that at least feed of 0.05 mm/rev the cutting forces were lowest and with increase in feed of 0.33 mm/rev its swifts to increased values. At least value of feed, smallest value of output parameters was observed. Therefore, overall drilling performance is optimal at lower feed of 0.05, which was reflected by higher grey relational grade in Figure 3.

A. Most influential factor

The purpose of conducting ANOVA is to investigate the relative magnitude of the effect of each factor on the objective function. The ANOVA investigate which drilling parameters significantly affected the performance characteristics and to estimate the error variance. In the ANOVA table the F-value column is also called as Fisher's F-test value. The higher value of F represents the highest effect on the output whereas the lower value represents the least effect on the output characteristics. The ANOVA Table 6 clearly represent the percentage contribution of each input drilling process parameters. From the ANOVA table it is observed that the drill diameter has the highest influences on the output characteristics of about 59.60% followed by the Feed Rate.

Table 6: *Result of analysis of variance (ANOVA)*

Factor	Degree of Freedom	Sum of Squares	Mean Square	F-Value	Percentage Contribution
Spindle speed	4	0.008801	0.002200	0.98	1.26
Feed	4	0.247075	0.061769	27.49	35.38
Drill diameter	4	0.415478	0.103870	46.23	59.50
Error	12	0.026960	0.002247		3.86
Total	24	0.698314			100.00

The feed rate has about 35.38% significance with respect to the output characteristics. The spindle speed has very minimum significance on the output characteristics of lesser than 1.3%.

B. Confirmation test

After identifying the most influential parameters, the final phase is to verify the output by conducting the confirmation experiments. The $A_5B_1C_1$ is an optimal parameter combination during drilling process via the grey relational analysis. Therefore, the condition $A_5B_1C_1$ of the optimal parameter combination was treated as a confirmation test. The result of the confirmation test gives the thrust force, torque and delamination factor similar to those given in Table 2.

V. Conclusion

Multi response optimization using GRA was performed to study the drilling behaviour of glass fiber/EPE foam sandwich composite. Thrust force, torque and delamination were considered as quality targets of the drilling process. A L_{25} orthogonal array as per Taguchi design of experimentations was used to perform the experiments. The following conclusions can be drawn on the basis of GRA:

- The grey relational analysis for optimum multi response optimization of drilling parameters for quality drilling holes were obtained as: spindle speed of 2000 rpm, feed of 0.05 mm/rev, and drill diameter of 4 mm which leads to the minimization of thrust force, torque and delamination and ensures a good quality hole.
- Among the input process parameters under consideration, drill diameter exhibits strongest correlation with the thrust force, torque and delamination, which followed by feed and cutting speed.
- The ANOVA shows that drill diameter is the most significant machining parameter with percentage contribution of 59.50, followed by feed and spindle speed with percentage contribution of 35.38 and 1.26 respectively.
- GRA is a very useful technique to optimize the thrust force, torque and delamination during drilling of glass fiber/EPE foam sandwich composite under experimental domain. It does not involve any complicated mathematical theory, computation or simulation. Therefore, GRA concept can be utilized without any statistical background in industry.

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CHI-SQUARE STATISTICS BASED STATE ESTIMATION OF STOCHASTIC HYBRID SYSTEM WITH MISSING MEASUREMENTS

Robinson P. Paul[1], Vishvjit K. Thakar[2], Hetal Patel[3]

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[1] Electronics & Communication department,
GTU, Gujarat, India
[2] Gokul Global University, Gujarat, India
[3] 3Electronics & Communication department, ADIT, Gujarat, India
robinson.p.paul@gmail.com

Abstract

The objective of this paper is to estimate the successful state of Stochastic Hybrid Dynamical Systems (SHS) having a continuous and discrete dynamic state with lossy measurements without expanding the computational multifaceted nature of the calculation. Existing strategies for state estimation furnishes state estimation with computational multifaceted nature and time. Kalman and Particle Filter are the fundamental algorithms for state estimation of any Linear and Non-linear SHS. The measurements got by the sensors or any modules have limitation to provide accurate data. State estimation of any system with lossy data prone to inaccurate state estimation. In this paper, the Chi-square Statistics –Data Loss Detection (CS-DLD) algorithm based on Kalman Filter is proposed for of Stochastic Hybrid Dynamical Systems which detect the data loss and reconfigure the measurement for effective state estimation. The performance of the algorithm is checked by Linear Stochastics Hybrid System model of Aerial vehicle.

Keywords: State estimation; Dynamic Hybrid system; Lossy measurement; Chi-square statistics; Kalman filter; Particle Filter; Monte Carlo simulation; State update; Measurement update covariance matrices; Interactive Multiple Model

I. Introduction

The dominant part of the dynamic systems' approach, technique and measures have arbitrary likelihood distribution of its events known as stochastic conduct. It indicates the design which might be literally anticipated yet may not be anticipated impeccably. In a reasonable situation, a larger part of the dynamic system can be arranged as Stochastic Hybrid Systems (SHS) [1] where the system model governs by discrete and continuous dynamics. In the current stretch because of rapid advancement of integrated chips and its capacity, leading part of the dynamic systems contains computerized framework. The models range from miniature independent robots to gigantic planes. Indeed, even current development in the field of Autonomous vehicle additionally has contributed to the study of Hybrid framework improvement just as demonstrating better estimation and control of the Stochastic Hybrid

System. [2] Scientists Scholar have shown interest in the Stochastic framework's application like [3], [4], where the system model interacts with its continuous and discrete dynamics for better state estimation. In remote sensor systems, it is prominent that the remote sensor hubs, actuator hubs, and regulator hubs offer such a distinctive communication with constrained data transmission. As the quantity of hubs increases, the requirements for transmission capacity [5] exceeding the framework limit may bring about loss of data and system choke, which may to a great extent fall apart the framework execution. In the meantime, remote sensors and actuators are generally powered by batteries with constrained power resources., some of which are not even replaceable. Therefore, the effective state estimation algorithm, which handles the nondeterministic behaviour of the system, affected by the loss of measurement data and limitation of computation complexity handling is needed. Persuaded by the above essentials the for stochastic hybrid system event-triggered based approach will help to solve the problem of data loss as well as computation complexity since spearheaded by Åström and Bernhardsson [6] . In addition, it is notable that for state estimation lossy measurement is one of the most regularly happening marvels in this type of frameworks, see [7] [8][9] . In particular, The State estimation method of mixture system discussed in [10][11] unable to handle the lossy measurement with SHS modelling. The complication of the state approximation of the hybrid system is difficult than the others. State estimation procedure like AMM-ILS (adaptive multiple model iterated least squares), AMM-UKF [12] (adaptive multiple model unscented Kalman filter), IMM (Interactive multiple model) [13] and its diverse variety like IMM-KF(Interactive multiple model) – Kalman Filter), IMM-EKF(Interactive multiple model – Extended Kalman Filter) ,IMM-UKF (Interactive multiple model -unscented Kalman filter), IMM-UGHF [14] (Interactive multiple model – Unscented Gauss-Helmert model) [15] deliver good state estimation at the budget of sophisticated mathematics calculation. As Popular of the dynamic system can be effortlessly and effectively classified as the continuous time linear dynamics systems [16] but unable to incorporate discrete dynamics together. To overcome the above problem and motivated by the possibility of the fundamental Kalman Filter, the event triggered a state estimation method for the stochastic hybrid system with Chi-square statistics is proposed. The framework elements of the unmanned aerial vehicle (UAV) [17] is used to showcase the performance of our proposed Chi-square statistic - Data Loss Detection (CS-DLD) Kalman Filter algorithm for lossy measurement. The comparison of the results with standard Kalman Filter, Average and smooth filters show that our calculation gives improved estimation precision under the lossy measurement scenario with less computational complexity. The remainder of this paper is sorted out as follows: in Section II, Description of System dynamics of SHS is talked about. In Section III, we define the proposed methods for effective state estimation for lossy measurement. In Section IV, we outline the simulation results of the proposed method. The conclusion is given in Section V.

II. System Description

The state estimation of the Hybrid framework has numerous applications in the field of the biological, compound response, interchanges systems, aeroplane designing [18] , stock costs [19] and so forth. State estimation procedure introduced in [20] is a regular strategy which isn't helpful for all the hybrid system state estimation. State Estimation Problem has significant two classifications. Non-Switched Mode and Switched Mode state estimation. The Switched Mode is additionally ordered in Static and dynamic exchanged mode state estimation. Continuous-time stochastic hybrid framework model as,

$$H: \begin{cases} \mathrm{x_{t+1}} = \mathrm{A_m}.\mathrm{x_t} + \varepsilon_x \\ \mathrm{Z_t} = \alpha_m.\mathrm{x_t} + \varepsilon_z \\ . \end{cases} \tag{1}$$

Here, $\mathrm{x_t}$ represent state equation and $\mathrm{y_t}$ represents measurement equation at a time 't'. $\mathrm{A_m}$ represent state dynamic in matrix form for mode 'm' , ε_x and ε_z are zero mean process and measurement white Gaussian noise respectively. Here we assume that they are independent. The mode transition from one state to another is governed by the guard condition α_m.

$$\alpha_\mathrm{m}: \begin{cases} \alpha_1 = 0 \quad for\ \mathrm{x_{t+1}} \in \{Lossy\ measurment\} \\ \alpha_2 = 1 \quad for\ \mathrm{x_{t+1}} \notin \{Actual\ measuremt\} \end{cases} \tag{1}$$

The System mode transition from actual measurement to lossy measurement are shown in below Fig. The detection of the lossy measurement provides the opportunity to update the lossy measurement for accurate state estimation.

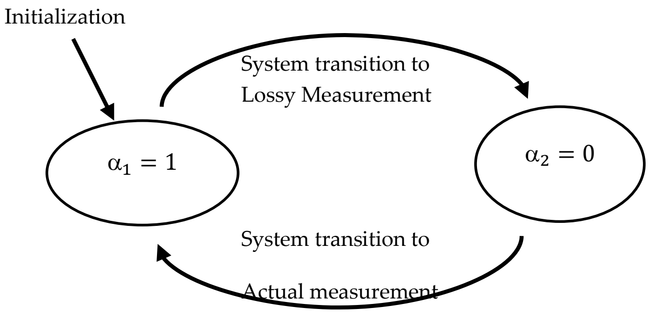


Figure. 1 *Event-triggered mode transition*

To deal with such kind of system where continuous dynamics are controlled by discrete dynamics, stochastic hybrid system modelling based on event-triggered helps to effectively predict the state with the use of Chi-square statistics with Kalman Filter for a linear system. The detail method is explained in Section 3.

III. The proposed method for state estimation

In this section, we will examine a proposed method for continuous time SHS. The performance of the proposed estimation algorithm with standard Kalman Filter (KF) [21] and Average Smoothed Filter (ASF) is investigated. The continuous-time dynamics system [22] is used with state-dependent transitions to model the UAV to detect the performance of the algorithms. This competent state estimation outcome will help us to implement the operative estimation algorithm for multiple modes hybrid system under the noisy state measurement scenario. The continuous dynamics of the system is given by

$$x_t = \begin{bmatrix} 1 & 3T \\ 0 & 1 \end{bmatrix} . x_{t-1} + \begin{bmatrix} \frac{T^2}{3} \\ 2\mathrm{T} \end{bmatrix} . \mathrm{a} + \varepsilon_x \tag{2}$$

which is known as state prediction and the measurement prediction is given by

$$z_t = \alpha_m . x_t + \varepsilon_z \tag{3}$$

Where $x_t = \begin{bmatrix} p \\ v \end{bmatrix}$; p = position, v = velocity and u_t = accelaration = a .

$$\text{Here , State Noise/Error} = \varepsilon_x = \begin{bmatrix} \sigma_p.\sigma_p. & \sigma_p\sigma_v \\ \sigma_p\sigma_v & \sigma_v.\sigma_v \end{bmatrix};$$

σ_v , σ_p = variance in velocity & position

$\varepsilon_z = \sigma_p.\ \sigma_p$ =Measurement Noise /Error

For the above structure, described in eq. (3) and eq. (4) with the distinct changeover from the lossy state to lossless state are simulated to detect the performance of the proposed algorithm for diverse % loss.

Pseudocode

Prior requirement: $\hat{x}_0$, $P_{x,0|0}$, F_k, H_k, y_k,

Set k = 1

❖ **Prediction**

Predicted state : $\hat{\mathbf{x}}_{k|k-1} = F_{k-1}\hat{\mathbf{x}}_{k-1|k-1}$

Predicted error covariance: $P_{x,k|k-1} = F_{k-1}P_{x,k-1|k-1}F'_{k-1} + Q_k$

❖ **Measurement Update**

Predicted measurement: $y_{k|k-1} = H_k\hat{\mathbf{x}}_{k|k-1}$

Innovation covariance matrix: $P_{y,k|k-1} = H_kP_{x,k|k-1}H'_k + R_k$

ek = $((y_k - \hat{y}_{k|k-1})'.P'_{y,k}.\hat{\mathbf{x}}_{k|k-1})^2$

if ek > $\chi 2$; Chi Square Test for 95% confidence interval

I Gain = 0

else

Gain: $K_k = P_{x,k|k-1}H'_kP^{-1}_{y,k|k-1}$

Updated state: $\hat{\mathbf{x}}_{k|k} = \hat{\mathbf{x}}_{k|k-1} + K_k(y_k - \hat{y}_{k|k-1})$

Error covariance: $P_{x,k|k} = P_{x,k|k-1} - K_kH_kP_{x,k|k-1}$

Set k = k + 1 and repeat from Prediction

Pseudocode describes the state and measurement update steps of the algorithm. The proposed method can be arranged in three principal classes. (i) System Initialization - which manages state elements where procedure and estimation condition choose the framework development. (ii) State Estimation-manages figuring of expected estimation of the state affected by arbitrary measurement with the assistance of covariance matrix with noise. (iii) Data Loss Detection- with Chi-Square Statistics of 95% confidence interval in which we abandon the lossy measurement and update it with the most appropriate Kalman gain for the compelling state estimation.

IV. Simulation results and discussion

The proposed estimation method CS-DLD Kalman Filter is compared with standard Kalman Filter (KF) [24] and Average Smoothed Filter (ASF). This productive state estimation result will assist in the effective state estimation of event-triggered SHS. In Table I, the comparison of the Average Mean Square Error for different methods is displayed for various % loss. Below enumerated parameters are used for the system simulation.

Parameter	Value	Parameter	Value
Time axis	100	Measurement noise (ε_z)	10
Control input (a)	1.5	Process noise (ε_x)	0.05
Initial state [positon;vel]	[10;10]	Monte Carlo Simulation	100

TABLE I:

Average MSE Simulation Results for % loss of 1 to 10 with DLDKF filter with and without Chi-Square Test.

% Loss	Non-Smooth Filter	Smooth Filter	Kalman Filter	Proposed DLD Kalman Filter	Proposed DLDKF with CS
1	10.2980	4.9543	0.6819	0.6821	0.8275
2	12.0445	5.5013	0.5593	0.5550	0.5357
3	17.1328	7.6611	0.7299	0.7080	0.7348
4	21.5035	9.6562	0.8835	0.8490	0.8133
5	29.2830	12.9872	1.2676	1.1587	0.6178
6	36.9649	16.5515	1.8699	1.6327	0.7572
7	44.5553	23.1757	3.1364	2.6889	0.6522
8	52.2752	26.1008	4.3134	3.7425	0.6933
9	61.5342	30.9080	5.6153	4.9190	0.6596
10	70.4166	37.0281	7.3795	6.4259	0.6106
Avg	**35.6008**	**17.45242**	**2.64367**	**2.33618**	**0.6902**

As appeared in Fig. 2, The state estimation of the proposed method is better than the non-smooth filter, smooth filter and standard Kalman Filter.

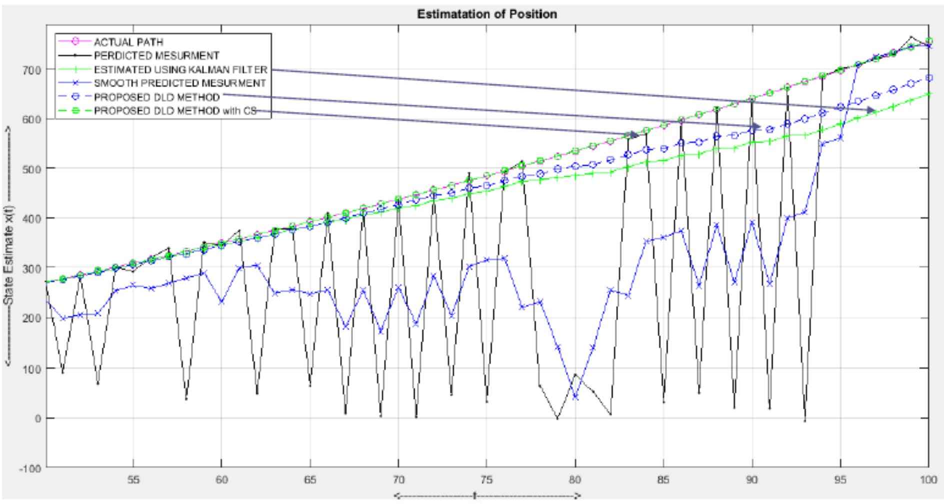


Figure 2. *Proposed Method State Simulation with standard methods*

It is plainly seen that that lossy information in the estimation, drive the state estimation calculation away from the real estimation of the state. Fig.3 shows the MSE (Mean square error) for a similar situation of Non-Smooth Filter (NSF), Average smooth Filter (ASF) and Kalman Filter (KF), where it is clear from the outcome that though Kalman Filter performs equivalent to the proposed method but unable to neglects the lossy measurement.

Fig. 4 and Table II, exhibit the hardware configuration used for the time performance calculation of our proposed algorithm. The simulation results show that with 19ms delay for 250 samples compared to standard Kalman filter, the proposed algorithm able to achieve good state estimation under the lossy measurement.

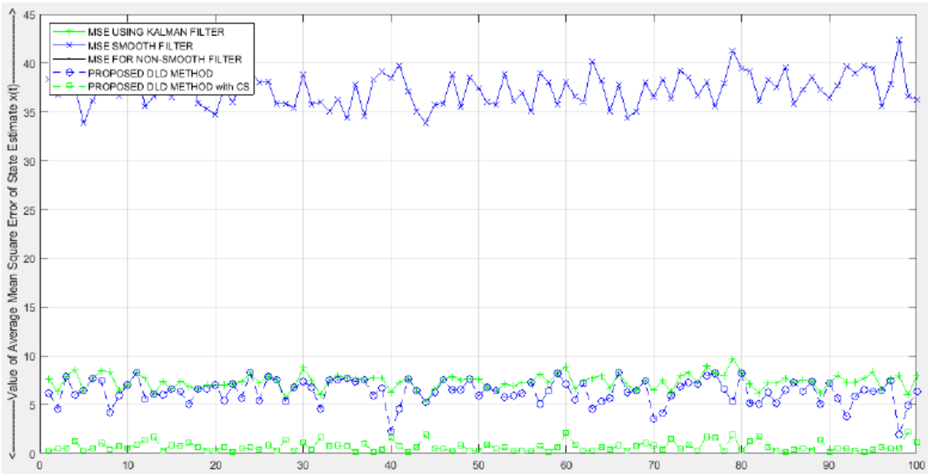
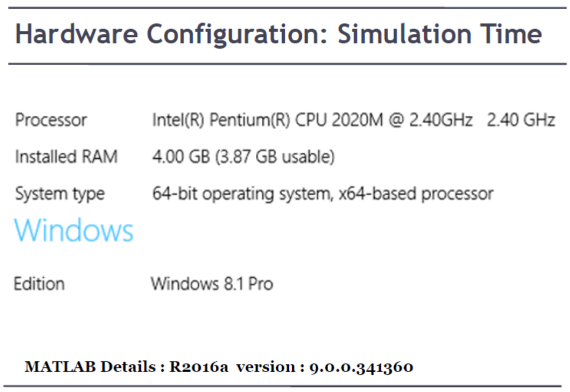


Figure. 3 *Average MSE value of state estimation at each time simulation*

For the compelling representation of the exhibition of our proposed calculation Table II demonstrates the MSE of the all technique where our proposed method gives preferable outcome over Kalman Filter (KF) and Average Smooth Filter (ASF) without expanding any computational complexity for the state estimation.


Hardware Configuration: Simulation Time

Processor	Intel(R) Pentium(R) CPU 2020M @ 2.40GHz 2.40 GHz
Installed RAM	4.00 GB (3.87 GB usable)
System type	64-bit operating system, x64-based processor

Windows

Edition	Windows 8.1 Pro

MATLAB Details : R2016a version : 9.0.0.341360

Figure 4. *Hardware configuration for the timing simulation*

TABLE II:

Proposed method computation time compared with standard Kalman filter for different samples.

Samples	State Estimation Proposed DLD Method Execution time	State Estimation Standard Kalman Filter Algorithm Execution time	Difference of Execution time In seconds
50	0.075896 seconds	0.060592 seconds	+0.015304
100	0.080629 seconds	0.062200 seconds	+0.018429
150	0.086943 seconds	0.072300 seconds	+0.014643
200	0.091026 seconds	0.074692 seconds	+0.016334
250	0.096695 seconds	0.077108 seconds	+0.019587

IV. Conclusion & future work

According to the present strategies and assessment are done, in the Event-triggered SHS framework with Chi-square statistics Kalman filter can be anticipated by the notable performance improvement in the event of the lossy measurement without expanding the complicated nature of the calculation. For linear SHS, Data Loss Detection Kalman Filter method gives 11.83% improvement over standard Kalman Filter is in terms of Average Mean Square Error while Chi-Square statics based Data Loss Detection algorithm gives 73.89 % better results in terms of Average Mean Square error compared to standard Kalman Filter for low Process Noise scenario. As the performance of the proposed algorithm depends on the process noise, the effect of process noise variation can be explored as further work.

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BLACK SPOT IDENTIFICATION FOR NATIONAL HIGHWAY- 47: A CASE STUDY OF GODHRA – GUJARAT MP BORDER STRETCH

Suresh Mohanlal Damodariya[1], and Chetan Ramanlal Patel[2]

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Civil Engineering Department, SVNIT – Surat, India-395007
smdamodariya@gmail.com

Abstract

Indian National highway network consists of only 2% of the whole road network, but it still carries 40% of the traffic, which might be causing road accidents on National Highways. Even newly constructed National highways getting tolls for their use are also suffering from accident occurrence on them. One such stretch, originating from Godhra and ending in Gujarat- MP border (length 91.91 km), is also suffering from an increase in accidents over the years. This road is connecting Gujarat state with two adjoining states named Madhya Pradesh and Rajasthan. Due to high access density, conflict points have increased on this highway and subsequently cause accidents. It is necessary to find black spots for such roads through available accident records.

In India, the accident data is being recorded by the concerned Police station through First Inspection Reports (FIRs), wherein very minimal details are collected. For identification of Black spots, it is necessary to locate the place where accidents took place. So, before collecting the Accident FIR data from the police station, a field videographic survey of the stretch in both directions was conducted, and all-important locations like median breaks, access points, petrol pumps, restaurants, village access roads, etc. have been noted according to project chainage for determining the exact location of the Accident.

The accident records for the toll road were used to convert the accident locations into proper chainage locations using field book data of the videographic road survey. After deciding the chainage of each accident location, the accident data was entered in excel sheets and arranged chainagewise. Black spots were identified according to the Ministry of Road Transport and Highways (MoRTH) criteria. There were sixteen black spots identified on this stretch from the study.

Keywords: Road safety, Accident location, Black spot, Access density.

I. Introduction

Accidents are continuously increasing in developing countries like India, and also, the World Health Organization (2015) has declared 2010-2020 as the decade of action for road safety. However, still, the accidents in most of the developing countries have been continuously increasing at a scary pace. Indian National highway network consists of only 2% of the whole road network, but it still carries 40% of the traffic, which might be causing road accidents on National Highways. Even newly constructed National highways getting tolls for their use are also suffering from accidents. One such stretch, originating from Godhra (128.117km chainage) and ending in Gujarat- MP border

(215.900km chainage) in Gujarat state of India, is also suffering from an increase in accidents over the years. This road is connecting Gujarat state with two adjoining states named Madhya Pradesh and Rajasthan. Due to high access density, conflict points have increased on this highway and subsequently cause accidents. It is necessary to find black spots for such roads through available accident records.

In India, the accident data is being recorded by the concerned police station through First Inspection Reports (FIRs), wherein very minimal details are collected. For the identification of black spots, it is necessary to locate the place where accidents took place.

An accident blackspot is a location where road traffic accidents have historically been concentrated. It may have occurred for various reasons, such as a sharp drop or corner in a straight road, so oncoming traffic is concerned, a hidden junction on a fast road, poor or concealed warning signs at a cross-road. In other words, the blackspot is that particular place at which maximum accidents take place, or there are more likely chances of more accidents at these locations.

According to Geurts and Wets (2003), there was no universally accepted definition of what should be considered as 'dangerous' location. Some researchers rank locations by accident rate, some use accident frequency, and some use a combination of the two. Geurts, Wets, Brijs, and Vanhoof (2005) suggested using Bayesian estimation values instead of historical count data to rank accident locations, which could overcome the problem of random variation in accident counts and would have a significant effect on the selection of the most dangerous accident locations. The authors generated probability plots, based on estimates from a hierarchical Bayes model to visualize the estimated probability that a location would be ranked as dangerous.

Tegge and Ouyang (2009) proposed a new safety analysis framework. An optimal network design module that estimates the most-probable site for each crash is combined with the standard regression analysis. The authors developed an effective solution algorithm based on Lagrangian relaxation for the network design model and proposed an iterative computation approach location estimation and statistical regression.

Liu (2012), based on a comprehensive analysis of the factors of speed consistency and acceleration, put forward a new method, namely synthesized analysis method of vehicle kinematical parameters, to identify the blackspots of highways in the mountainous district and gave applied technical procedure of the method. The case study indicated that the technique could efficiently identify the blackspots of highways with complex alignment conditions in the mountainous district.

Mohan & Landge (2017) identified the accident-prone locations along Amravati- Nagpur road stretch from Asian highway 46. The top accident-prone spots were selected as black spots based on Weighted Severity Index Method.

Keymanesh, Ziari, Roudini, and Ahangar (2017) identified black spots without accident information along "Iraanshahr-Sarbaaz-Chabahr" road in Baluchistan, Iran. They divided stretch into eight sections based on the uniformity and homogeneity of each section in terms of geometry and regional conditions. At each section, potential black spots were identified, and questionnaires were prepared to collect opinions from 30 experts who were well-familiar with the road. The collected data was analyzed using SPSS Software, leading to the identification of black spots. Finally, the identified black spots were compared against those obtained by traffic police based on accident information.

According to Washington, Afghari, and Haque (2018), hotspot identification methodologies had been evolved considerably over the past 30 or so years, correcting for methodological deficiencies along the way. Despite vast and significant advancements, identifying hotspots remains a reactive approach to managing road safety – relying on crashes to accrue to mitigate their occurrence. Many factors, including crash severities (e.g., fatal versus injury crashes), random fluctuations of crashes from year to year, different exposure levels (traffic volumes), variation in geometric design and operational features (e.g., signal phasing, shoulder, and median design), variation in weather (e.g., rain, wind, fog) and differences in driving populations (e.g., younger drivers, older drivers) complicated the process of identification of blackspots.

According to Ahmed, Sadullah, and Yahya (2019), errors in accident data errors led to wrong identification of black spots and hazardous road segments and consequently, wrong projection of accident estimates and fatality rates, and detection of wrong parameters responsible for accident occurrence, thereby making the entire road safety exercise ineffective. For Middle-income countries, the error for the light, severe, non-fatal, and fatal injury accident categories varied between 93–98%, 32.5–96%, 34–99%, and 0.5–89.5%, respectively. In comparison, very few studies for low-income countries showed that the error in reporting non-fatal and fatal accidents varied between 69–80% and 0–61%, respectively. The average error in recording information related to the variables in the categories of location, victim's information, vehicle's information, and the environment was 27%, 37%, 16%, and 19%, respectively. Among the causes identified for errors in accident data reporting, Policing System was found to be the most important. The authors recommended that there should be reforms in the policing system, and public awareness should be created to reduce errors in accident data.

Till now, very few studies have been done in India for correctly finding the locations of the Accident and identifying black spots on National Highways in India. In each country, different methods have been prescribed for the identification of blackspots. In India, according to the Ministry of Road Transport and Highways (MoRTH) criteria, a road accident blackspot on National Highways is a road stretch of about 500m in length in which either five road accidents involving fatalities/ grievous injuries took place during the last three calendar years or ten fatalities took place during last three calendar years.

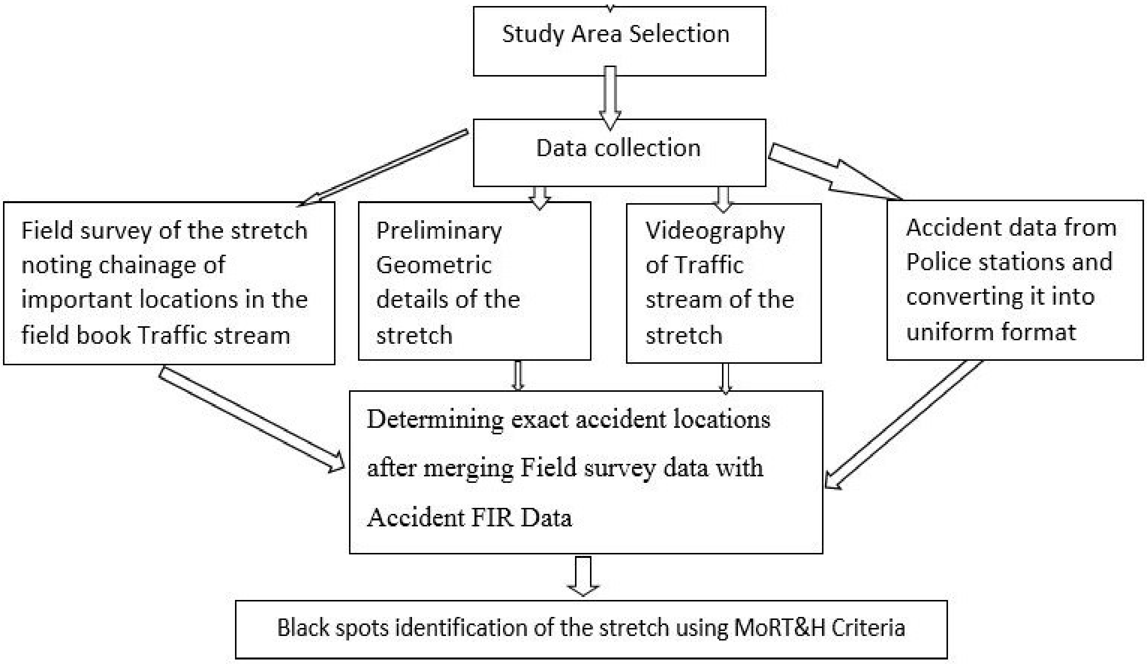

Figure 1:*Study Methodology*

The main objective of the paper is to determine the exact location details of all the accidents, which are in the form of FIRs recorded for each Accident in the local language, and subsequently, find blackspots for the stretch. The accident FIR data for five calendar years from 2012 to 2017 was collected from concerned police stations and their location. From the videographic field survey of the stretch, the location for each Accident according to toll road project chainage for the stretch determined. These accident data were then arranged according to chainage, and MORT&H criteria for identification of black spots will be used to determine black spots on the stretch. From the above such refined data filtered according to location for three calendar years 2015, 2016, and 2017, sixteen black spots were identified. The methodology has been suggested to determine the exact location from the accident records available with police through Accident FIRs.

II. Study Area

NH-47 connecting Ahmedabad with Indore is one of the vital highway corridors of the country. It serves as an essential link to connect Indore - Ahmedabad important cities with its rich hinterland part of Gujarat, Rajasthan, and Madhya Pradesh. NH-47, which originates from Ahmedabad and ends at Indore. The starting point of the selected stretch is the Godhra bye-pass (chainage 128.117 km), and the endpoint is Gujarat-MP Border (chainage 215.900 km) on this National Highway. The length of the stretch is 91.91 km. The stretch is connecting two districts – first, PanchMahals having 1210 villages and 14% Urban population, while the second, Dahod having 696 villages with 9% urban population as per the 2011 Census of India. Due to so many villages coming across this National Highway, there are several median access points and access points on the sides of NH merging with villages.

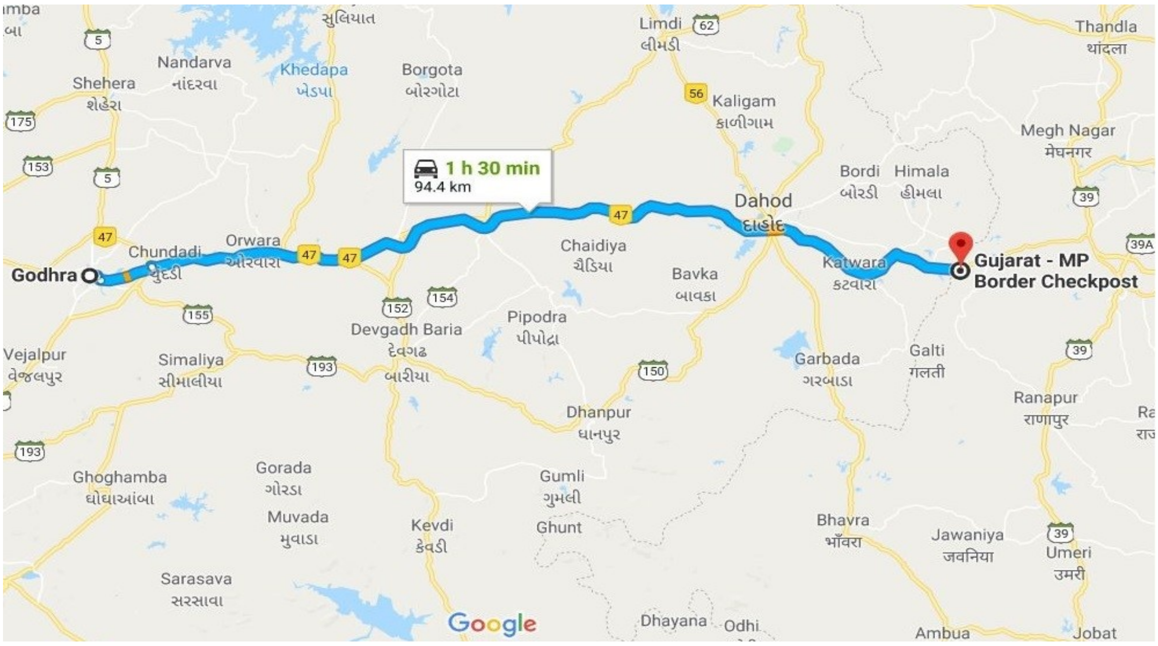

Figure 2: *The selected stretch of NH-47*

This National Highway stretch is a four-lane divided carriageway, with starting chainage as km 128.117 to ending at km 215.900 in Gujarat state. It has four flyovers, 4 number of railways over bridges. It has three bypasses, comprising 11.09km, six major bridges, 16 minor bridges, 32 minor culverts coming across the NH. The cross-section of the highway consists of a four-lane divided carriageway (2 x 7.00m), 1.5m wide paved shoulder on either side of the carriageway, and a median of 1.50 width.

III. Data Collection and Analysis

I. Accident data Collection

The selected stretch comes under the jurisdiction of five police stations, namely Godhra A – Division police station, Godhra taluka police Station, Limkheda police Station, Rabdal (Dahod Rural) police station, and Katwara police station.

The accident data from these police stations from the year 2012 to 2017 were collected. Each typical Accident FIR is written manually in the local language – Gujarati by concerned police station staff. At most police stations, the proper register is maintained for accident records under that police station while at other accident data entered on Accident FIRs of the police station. In all the accident FIRs / Registers of police stations, the nearest locations or place of Accident was mentioned, but the exact location of the Accident was missing.

Most of the time, it is very much challenging to decipher the accident details from such FIRs. From each such FIR, most of the details were then converted to proper excel format for uniform data entry. The accidents were filtered, and those which occurred on NH-47 were considered for data entry. There were 365 accidents, which occurred on NH-47 from the year January 2012 to December 2017. For identifying accident location on the stretch, project chainage was also included in the excel format for proper identification of the location. These steps were completed for each accident data of all police stations.

II. Infield surveying of the stretch through Videography

Videography of the whole stretch was done in a floating car on 10-08-2018 through mobile for both directional traffic for two runs. The Android application named "Travel Distance" was used to note the chainage at critical locations along the stretch. All details were also noted down in the field book along the stretch from Godhra Bye-pass (Chainage 128.117km) to Gujarat-MP Border (215.900km) and back Gujarat-MP Border (215.900km) to Godhra Bye-pass (Chainage 128.117km). Various land use along the stretch such as merging village roads, hotels, restaurants, important buildings (schools, police quarters, training centers, etc.), bus-stops, petrol pumps, etc. was noted down along the stretch, where control of access was merging with toll road stretch of NH-47.

III. Access density

During the field surveying on the stretch, all access points on the Left-hand side, Right-hand side, and median were observed, and their chainage was also noted down. However, it is a toll road; it has 31 median access points, 41 left side carriageway access points, and 53 access points on the right-side carriageway, so overall, the stretch is having an access density of 1.36/km, so that factor is also increasing conflicting movements on the stretch.

IV. Black Spot Identification

Each accident data FIR record consisting of its location, chainage, nature of Accident, cause of Accident, date of Accident, etc. were entered in excel (Sample for Excel sheet in Figure. 3) for determining the chainagewise location of the Accident.

Road Accident Report (3 Year Accident data - Chainagewise, Accident type and Nature of Accident)

			A			B	C	No of affected persons			
Sr	**Date**	**Time of Acc. (am/pm)**	**Accident Location**	**Chainage**	**Black Spot No.**	**Nature of Accident**	**Classification of Accident**	**Fatal**	**Grevious**	**Minor**	**Injured**
1	18-06-2015	UNKNOWN	PARWADI CHOKADI	129.700	1	Overturning	Fatal	1	0	0	0
2	08-07-2015	UNKNOWN	PARWADI CHOKADI	129.700	1	Right turn collision	Fatal	2	0	0	0
3	06-08-2015	UNKNOWN	PARWADI CHOKADI	129.700	1	Collision brush/Side Wipe	Fatal	4	0	0	0
4	06-11-2015	UNKNOWN	PARWADI CHOKADI	129.700	1	Skidding	Fatal	1	0	0	0
5	20-09-2017	UNKNOWN	PARWADI CHOKADI	129.700	1	Overturning	Fatal	3	0	0	0
6	19-03-2015	UNKNOWN	PARWADI CHOKADI	129.700	1	Overturning	Grievious Injury	0	1	0	0
7	30-11-2016	UNKNOWN	PARWADI CHOKADI	129.700	1	Overturning	Grievious Injury	0	1	0	0
8	10-05-2017	UNKNOWN	PARWADI CHOKADI	129.700	1	Collision brush/Side Wipe	Grievious Injury	0	1	0	0
9	25-09-2015	UNKNOWN	PARWADI CHOKADI	129.700	1	Head on collision	Minor Injury	0	0	4	0
10	04-02-2016	UNKNOWN	PARWADI CHOKADI	129.700	1	Right turn collision	Minor Injury	0	0	1	0
11	14-05-2015	UNKNOWN	GADH CHUDANDI	130.000	1	Overturning	Fatal	1	0	0	0
12	28-05-2016	UNKNOWN	GADH CHUDANDI	130.000	1	Overturning	Fatal	1	0	0	0
13	29-09-2017	UNKNOWN	GADH CHUNDADI	130.000	1	Collision brush/Side Wipe	Fatal	1	0	0	0
14	23-02-2015	UNKNOWN	GADH CHUDANDI	130.000	1	Overturning	Grievious Injury	0	2	0	0
15	15-03-2016	UNKNOWN	GADH CHUNDADI	130.000	1	Head on collision	Grievious Injury	0	1	0	0
16	13-05-2017	UNKNOWN	GADH CHUNDADI	130.000	1	Overturning	Grievious Injury	0	1	0	0
17	11-02-2015	UNKNOWN	GADH CHUNDADI	130.000	1	Overturning	Minor Injury	0	0	1	0
18	09-10-2016	UNKNOWN	GADH CHUNDADI	130.000	1	Head on collision	Minor Injury	0	0	2	0
19	02-10-2016	UNKNOWN	UDAY HOTEL	131.830		Overturning	Grievious Injury	0	2	0	0

Black Spots_Chainage_Acctype Page 1 of 10

Figure 3: *Sample Excel sheet for determining Accident location chainage*

In Excel, the accident FIR data was sorted chainage wise, and different accident classification year-wise was obtained. Table 1 shows the yearly trend of accidents on the stretch for the past five years. The accidents have been increasing every year since toll road became operational in the year 2014.

Table XVI: *Accident Trend for the Stretch*

Year	**Accident Nature**				
	Fatal	***Grievous Injury***	***Minor Injury***	***Non-Injury***	***Total***
2012	11	22	25	0	58
2013	18	6	27	0	51
2014	9	32	11	2	54
2015	26	27	10	5	68
2016	16	34	11	0	61
2017	31	29	12	1	73
Total	111	150	96	8	365
% value	**30.41**	**41.1**	26.3	2.19	

Table I indicates that fatal accidents are continuously increasing after the opening of the toll road. The fatal accident share is 30.41%, and the grievous injury accident share is 41.10%.

The accident data was sorted chainagewise – year-wise to determine black spots for the whole stretch, which satisfied the MoRTH [9] criteria of blackspot. The three-year accident data was filtered according to chainage, Accident classification wise and year wise.

For blackspot identification, according to MoRTH, road accident blackspot on National Highways is the road stretch of about 500m in length in which either five road accidents involving fatalities/grievous injuries took place during the last three calendar years or ten fatalities took place during three calendar years.

Out of a total of 202 accidents on the stretch for the years from 2015 to 2017, 165 accidents had taken place on the identified black spots.

After sorting chainagewise, year-wise accidents for the stretch, following blackspots, were determined based on the MoRTH criteria, as shown in Table II.

TABLE XVII: *Number and Nature of Accidents at Black Spots*

Black Spot No.	Fatal			Grievous Injury			Minor Injury			Non Injury			Total accidents at Black-spot
	2015	*2016*	*2017*	*2015*	*2016*	*2017*	*2015*	*2016*	*2017*	*2015*	*2016*	*2017*	
1	5	1	2	2	2	2	2	2	0	0	0	0	18
2	1	1	1	0	2	0	0	0	2	0	0	0	7
3	2	1	3	2	1	0	1	0	2	0	0	0	12
4	1	0	3	0	3	3	0	1	2	0	0	0	13
5	1	1	1	1	4	0	1	1	0	1	0	0	11
6	0	1	2	1	2	0	0	0	0	0	0	0	6
7	1	0	2	1	3	3	0	0	0	1	0	0	11
8	1	0	0	3	2	3	0	0	1	1	0	0	11
9	1	0	0	0	2	3	0	0	0	1	0	1	8
10	1	0	0	2	0	2	1	0	0	0	0	0	6
11	0	1	1	2	2	2	0	0	0	1	0	0	9
12	0	1	1	1	0	4	1	0	3	0	0	0	11
13	1	2	6	3	0	1	0	2	0	0	0	0	15
14	1	1	1	3	1	2	0	1	0	0	0	0	10
15	1	2	1	2	0	0	0	0	0	0	0	0	6
16	1	0	2	0	3	1	0	0	0	0	0	1	8
												Total	162

The chainage and locations of these 16 black spots were finalized, which are shown in table III as under:

TABLE XVIII: *Blackspot location details for the stretch*

Sr.	Chainage (km)	Location	Sr.	Chainage (km)	Location
1.	129.700	Parwadi Chokadi	9.	184.580	Rampura
2.	132.440	Chanchelav	10.	190.000	Rabdal
3.	139.000	Orwada Bus Stand	11.	196.360	Punsri
4.	164.300	Limkheda	12.	199.620	Jalat
5.	169.200	Dhadhela	13.	201.280	Gamla
6.	178.880	Dabada	14.	203.000	Katwara
7.	179.350	Kamboi	15.	208.580	Kathla
8.	180.220	Rozam	16.	213.310	Khangela

All these sixteen black spot locations have been tagged on the google earth map and represented in figure 4.

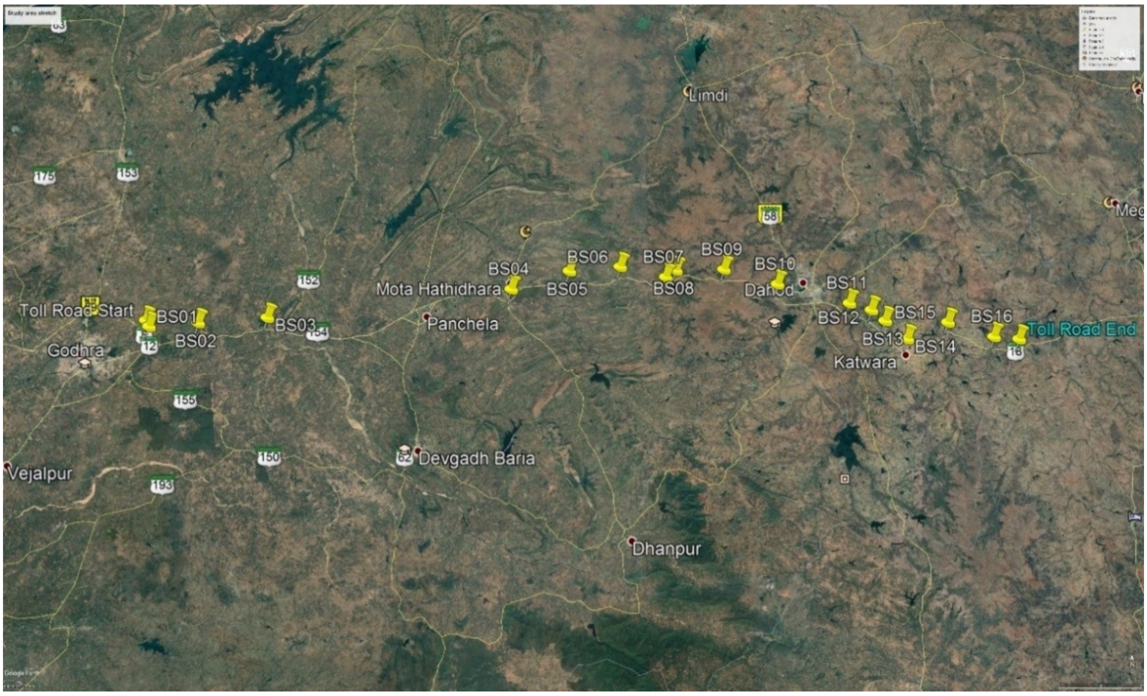

Figure 4: *Blackspot locations on Google earth*

V. Discussion and Conclusion

In India, accident data is mostly being collected and maintained through registers or Accident FIRs by the police department in the local language without noting proper locations of the accidents. Hence, it becomes difficult for Road safety authorities to determine the exact accident locations and take suitable measures for their improvement. Hence, for identifying black spots on the selected stretch of NH-47, raw Accident data from police stations were collected for the years from 2012 to 2017. Infield survey and videography were used simultaneously for deciding the location of each Accident from the FIRs, and the accident data was compiled in proper excel format with the most important details related to each Accident event along with its chainage. Then all these data were sorted chainagewise and year wise for identification of black spots according to MoRTH criteria. In the end, 16 black spots have been identified on this stretch. This methodology can help the road safety authorities to determine the exact location of the accident occurrence and subsequently determine black spots for such National highways in developing countries like India, where the exact GIS/GPS location of the Accident is not recorded properly as in other developing/ developed countries. This methodology will help the Traffic regulation authority in taking suitable measures to know the black spot locations and subsequently to carry out suitable engineering measures and planning measures. A user questionnaire survey can also be conducted to decide the causative factors for every critical location. Further, based on the users' feedback, it is easy to take preventive steps in reducing accidents on the highway.

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A REVIEW ON "TORSIONAL BEHAVIOR OF RECTANGULAR REINFORCED CONCRETE BEAMS WITH ENCASED WELDED WIRE MESH FIBER."

Vivek V. Mane[1], Dr.Nandkumar K. Patil[2]

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Ph.D scolar,Civil Enginnering Department,Sanjay Ghodawat University,Kolhapur,India
Professor,Civil Enginnering Department & Registrar,Sanjay Ghodawat University,Kolhapur, India
vivekmane02@gmail.com

Abstract

It is well known that there are four structural actions like axial force, shear, bending and torsion are developed with respect to their nature of loading on the structure. Torsion is always considered as a secondary effect up to 1960's. After that we proceed from working stress method to limit state method and shall go to ultimate load one to reduce the factor of safety. Also the novel structures are designed by Architects, designers having attractive overhanging components prone to torsion effect in the structures. Concrete is probably the most used man made construction material in the world. Concrete is homogenous in nature and strong to resist compression but posses Quassi brittleness in tensile strength such deficiency can overcome by introduction of fibers in the body of concrete. Since from last three decades a lot of research has been done on fiber reinforced concrete subjected to pure torsion but if fibers proportion is more, then difficulties in proper concreting get increased and chances of producing balling effect of fibers which affects the homogeneity of concrete. In other hand the considerable studies laid on FRP techniques by using Glass fibers, Carbon fibers and recently ferrocement jacking utilized for strengthen the existing structures subjected to predominant torsion effect. Although such techniques are very effective for existing structures but requires more additional cost for FRP materials with adhesive and also tend to fire except ferrocement jacketing. But such FRP techniques not overcome the inherent weakness of concrete. However there is also way to utilization of encased Welded Wire mesh in the concrete due to its high tensile strength and can produced the micro cracks behaviour like fiber reinforced concrete for proposed new construction. Here is an attempt to study the behaviour of encased Welded Wire mesh in the concrete subjected to pure torsion.

Keywords: Quassi brittleness, Polymer fiber jacket, ferrocement jacket, WWMF.

I. Introduction

1.1 Concrete

Concrete is probably the most used man made construction material in the world. Concrete is homogenous in nature and also strong in compression. In spite of this, it has some serious deficiencies with respect to tensile strength, flexibility, resilience and ability to redistribute stresses. Generally such deficiency like low tensile strength of the concrete material is overcome by introducing the systems like reinforced concrete and pre-stressed concrete systems. But these systems can counter balance the tensile resistance by introduction of reinforcement and tendons in the body of concrete and not improving the inherent weakness of the concrete matrix.

1.2 Fiber Reinforced Concrete

To improve the material strength of matrix, the fibers were used from ages together such as straws, horse hair, jute fibers, etc. The structural use of concrete containing fibers started as late as in 1960's. The fibers are having various types out of which there is also categorization like metallic and non metallic fibers. The non metallic generally having less young's modulus than concrete which give high resistance to toughness and metallic fibers have higher young's modulus than concrete which acts as high tensile resistance. Such fibers having the shapes like hook ended, crimped shape, notch on ends etc. The shapes are useful to increase their mechanical bond with concrete matrix. Concrete with discrete fibers, as an additional ingredient in it, is known as fiber reinforced concrete (FRC). Out of the several types of fibers, the experimentations have proved the superiority of steel fibers and have been used extensively in engineering applications which is called Steel fiber reinforced concrete (SFRC). However if fibers proportion is more, then difficulties in proper concreting get increased and chances of producing balling effect of fibers which affects the homogeneity of concrete.

1.3 Concrete Jacketing

It is a one type of composite material can be used to strengthen of existing structural member. It can be categorized with utilization different materials to strengthen reinforced concrete structural members like reinforced concrete jacketing, steel jacketing, FRP confining or jacketing and ferrocement jacketing etc As per research topic concern here study get concentrated to polymer fiber jacking and ferrocement jacketing.

1.3.1 Polymer fiber jacketing

It has more than one century history since from 1905 but such material came in utilization for concrete structure effectively since from last three decades. The fibers are generally glass fiber, carbon fiber, aramid. Also other fibers produced from papers, woods, asbestos sheets have been used. But all above said fiber sheets required good quality adhesive to achieve proper surface bonding with concrete body. FRP materials have very high tensile resistive property but also having relatively less young's modulus than concrete. Again they posses poor compressive stability so there is need to use as a composite material with concrete. The FRP can be differentiating with respect utilization of types of materials like GFRP, CFRP, aramid etc.

1.3.2 Ferro-cement jacketing

Since the mid-nineteenth century the ferrocement concept gets raised. Ferro- means containing iron. Hence ferro-cement which is made with wire mesh of small diameters having the ratio 1:3 of cement and sand. Ferrocement is used in making boats, planks for shelves in low cost housing projects, construction of sewage manhole covers etc. However there is also utilization of Ferro cement full, U shaped jacketing with full wrapping or in strips for structural members.

All above said concrete jacketing can be used in civil engineering application with respect to their raw materials availability, exact need, costing and suitability etc.

1.4 Torsion

In our structural mechanics concern there is consideration of axial, flexural, shear and torsional loads and with respect to that there is requirement of efficient structural designs. Out of which torsion is of paramount importance in the design of beams curved in plan, long span overhangs of balconies, canopies for auditoriums, stadiums, mezzanines, extra wide deck bridges with single piers, clear span gantry shops in factories, deck overhangs for aero planes hangers and so on. Although torsional stresses occur in many reinforced concrete structures, torsion was mostly neglected by design engineers before 1960's. It was assumed that torsional effects were minor and could be taken care of by the large safety factors used in flexural design. This assumption has been the principal reason for many cases of torsional distress and failure. It was only in the late 1950's that the torsional load began to attract serious interest of the design engineers. Also researchers moved from working stress to limit state and shall go to ultimate one to reduce the factor of safety and the novel structures are designed by Architects, designers having attractive overhanging components prone to torsion effect in the structures. So the negligence of torsional effects was no longer acceptable as the safety factors were more rationally defined.

II. Literature review

Before going to a detailed discussion on types of concrete Jacketing by various researchers of rectangular beams subjected to pure torsion. First there is need to considered various theories[10] developed to predict the torsion strength of plain concrete members. There are three theories available to calculate the torque carrying capacity of plain concrete. First one elastic theory considering Saint venant's elastic coefficient in year 1855 then plastic theory considering membrane and sand heap analogy from year 1903 to 1923 and lastly Skew bending theory considering with experimental observation in year 1968.

However test on specimens showed that elastic theory gives every times underestimates and plastic theory gives higher value which is not get in actual experiments means failure strength of plain concrete is between both theories. Then Hsu [2] proposed the equation based on skew bending theory for the plain concrete. In this theory he considered that beam specimens get failed similar like that specimens failed due to bending of beam. Only here the bending axis is considered as a skew axis acted 45° with longitudinal neutral axis of beam subjected to transverse loading. Based on the experimental investigations he formulated an empirical equation given as

$$T_c = 0.13\, x^2\, y \sqrt{f_{cu}} \tag{2.1}$$

Where,

T_c = Ultimate torsional strength of plain concrete.

x = Overall width of the cross section of the beams.

y = Overall depth of the cross section of the beams.

f_{cu} = Cube strength of plain concrete.

For the estimation of ultimate torsional strength of rectangular concrete beams with conventional reinforcements, various theories were developed to overcome the limitations of classical theories. Rausch and Cowan proposed theories based on space truss analogy and whereas the one proposed by Hsu is based on skew bending theory.

Based on skew bending theory, Collins et. al [4] proposed the following model for the ultimate torque.

$$T_{u3} = 2.A_{lt}.f_{lty}.z_3.\sqrt{\frac{k_3.p_3.b}{d}} \tag{2.2}$$

Where,

T_{u3} = Ultimate torsion moment available in mode3.

A_{lt} = C/s area of top longitudinal bar.

f_{lty} = Yield stress of top longitudinal steel.

$k_3 = \dfrac{b}{2d+b}$ = Torsion constant.

$z_3 = d - c_{lt} =$ Distance of Lever arm

c_{lt} = Concrete cover measured from the centre

$p_3 = (a_s . f_{sy} . d) / (A_{lt} . f_{lty} . s)$

b ,d = width and depth of rectangular section.

The space truss theory for torsion in concrete is any single theory which has received general and worldwide acceptance. Pandit G.S. [7] research is carried out to check influence of symmetrical and unsymmetrical reinforcement in rectangular section. The study is based on unsymmetrical reinforcement so the formula is generated by him to determine the ultimate torque or load carrying capacity given as follows

$$T_{ut} = 2.A_o \sqrt{\frac{a_{lt}.f_{lty}}{l_t} \frac{a_s f_{sy}}{s}} \tag{2.3}$$

Where,

T_{ut} = Ultimate torque carrying capacity.

$A_o = b_1 \times d_1$ = Area enclosedby shear flow.

$b, d =$ Shorter and longer dimensions of rectangle formed by connecting the corner longitudinal bars.

a_{lt} = Area of one longitudinal bar near top.

f_{lty} = Yield stress of longitudinal bar near top.

l_t = Spacing of longitudinal bar near the top.

a_s = Area of one leg stirrups.

f_{sy} = Yield stress of Stirrup steel.

s = Spacing of Stirrup steel.

In due course time Lampert-Thurlimann [3] and also Kuyt [6] modified Hsu's model by proposing a coefficient of reinforcement factor given as below

$$\begin{aligned} T_{urs} &= 2\sqrt{m}\ \frac{x_1\ y_1\ A_t\ f_{sy}}{s} \\ &= 2\sqrt{m}\ T_R \end{aligned} \tag{2.4}$$

Where,

T_R = reinforcement factor

$$m = \frac{\rho_l\ f_{ly}}{\rho_s\ f_{sy}}$$

Also,

ρ_l = volumetric fraction of longitudinal reinforcement; and

ρ_s = volumetric fraction of transverse reinforcement.

f_{ly} = yield stress of transverse reinforcement.

f_{sy} = yield stress of transverse reinforcement.

2.1 Steel fiber reinforced concrete (SFRC)

On the basis of significant and considerable study has been laid on steel fiber reinforced concrete rectangular beams since from three to four decades back in very well manner. As discussed earlier

that steel fiber contains higher yield strength and good bond property relationship with plain concrete so obviously steel fiber reinforced concrete give improvement in ductility effect, durability and strength etc. of concrete means to overcome the inherent weakness of concrete. Various Authors has studied well and also made theoretical analysis in the form of Hsu's skew bending theory with modification depends upon aspect ratio and volume fractions of steel fibers. Some of them laid steel fibers contribution in torque carrying capacity in the form of cube, split tensile and flexural strength means not directly correlated with fiber mechanical properties.
However in later study by Narayanan and Kareem Palanjian [12] who proposed the model to calculate torque carrying capacity of SFRC beam specimens with considering plain concrete contribution before cracking and steel fibers contribution after cracking individually. The ultimate torque or load carrying capacity is given by the equation.

$$T_{uf} = T_c + T_f = 0.13\, x^2\, y\sqrt{f_{cu}} + \frac{0.22\,\lambda\, x_0\, y_0\, x\, y\, F\sqrt{f_{cu}}}{(x_0 + y_0)} \tag{2.5}$$

Where,
Tc = Contribution of concrete same as that proposed by Hsu for plain concrete.
Tf = the contribution of fibers formulated equation based on space truss analogy.
F = $\frac{l}{d}\ \rho d_f$, Fiber factor directly proportional to volume fraction of fibers.

They replaced term of cube strength of plain concrete in Hsu's skewing bending theory by introducing fiber factor of cube strength of fibrous concrete and developed space truss model to calculate contribution of steel fibers containing their fiber aspect ratio and volume fractions. Such authors produced fiber factor 'F' due to which torque carrying capacity is directly proportional of that fiber factor. After that Pant and Parekar [18] carried out experimentation and comparison with previous research works and concluded that at a certain stage due to combination of aspect ratio and volume fraction of steel fibers, the balling effect get produced in the concrete body. The fiber coefficient 'Γ' is given as follows

$$\Gamma = 1/0.17 * \sin(15.25/(l/d.vf)) \tag{2.6}$$

So steel fiber contribution in torque carrying capacity is not directly proportional with fiber factor means fiber factor not increases the torsional strength linearly. Hence the ultimate torque or load carrying capacity is given by the equation.

$$T_{uf} = T_c + T_f = 0.13\, x^2 y\ \sqrt{fcu} + \frac{0.22\Gamma\,\lambda\, x_0\ y_0\, F\sqrt{fcu}}{(x_0 + y_0)} \tag{2.7}$$

Also Ghugal [19] has carried out analysis on steel fibers effects on different mechanical strength of concrete in that he mentioned the balling effect of steel fibers due to excessive percentage in the concrete body. So if fibers proportion is more, then difficulties in proper concreting get increased and chances of growing balling effect of fibers which affects the homogeneity of concrete.

2.2 Polymer fiber jacketing or FRP like CFRP, GFRP, ARAMID fiber etc.
As already mentioned above that strengthening of reinforced concrete beams with FRP reinforced systems have been utilize from around 1980s. FRP systems can be used for increasing shear strength of reinforced concrete beams in the form of completely or partially wrapping FRP systems around reinforced concrete member. Polymer fiber jacketing can be utilized four sided completely wrapped, three sided U-shaped wrapped and two sided vertically wrapped as per working condition, requirement and costing etc. ACI 440.2R-08 provides the guild line to shear design procedure by using FRP material. So with respect to concern topic the review of polymer fiber jacketing is carried out as follows.

Constantin E.Chalioris [20] has carried out experimentation on reinforced concrete beams

specimens. Such testing specimens are strengthen with fiber reinforced polymer material. He took experimental values from twenty four specimens which was taken from other researcher's documents with respect to that he casted and tested twelve numbers of specimens. As a results of that he proposed two different numbers theoretical models .first is a smeared crack model and second one is soften truss model . smeared crack model is considered up to pre cracking stage of specimens and second model useful for for post cracking stage for reinforced concrete specimens. Such prediction of models done on the basis of comparisons between analytically predicted behaviour curves and experimentally obtained results. This study offered elastic and after cracking response of reinforced concrete beams strengthen by FRP materials under the torsion phenomena.
Constantin E.Chalioris et al [21] concentrated the investigation on influence of carbon reinforced fibers used to contribute torque carrying capacity of specimens. In the experimentation they casted fourteens numbers rectangular and T-shaped beams without stirrups reinforcements but containing bonding of carbon reinforced sheets and strips acted as an external transverse reinforcement. All beam specimens tested under pure torsion action and made theoretical analysis of that. In the study they checked various parameters like cracking torque, ultimate torque with respect to their twists, and also observed the failure modes of the beams. The results concluded that the performance of rectangular beams having fully continuous wrapping are well in manner against ultimate torque as compare to beams which wrapped with FRP strips. Again the study showed that there is debonding failure gets occurred in U-shaped jacketing but FRP bonding could be effective in under reinforced elements.

A.R. Zojaji, M.Z. Kabir [22] has developed a theoretical model known as Softened Membrane Model for Torsion (SMMT) used to determine ultimate torque capacity of RC beams strengthen by FPR materials. Such SMMT developed by using tension stress equilibrium equations. To validate this proposed model they compared the test results obtained from both solid and hollow rectangular shaped beams. At last study showed that the proposed softened membrane model is reliable to determine the cracking and ultimate torques of RC beams strengthen by FRP fabrics. They studied about strengthening of beam specimens with various configuration varieties and observed each variety of configuration illustrated as well.

Shraddha B. Tibhe , Vijaykumar R. Rathi [23] investigated the performance of rectangular reinforced concrete beams contained with FRP as an external reinforcement to increase the torque carrying capacity. They casted total 39 numbers of specimens having the size of 1500mm x 300mm x 1200mm.In that three numbers of beams are known as control beams and remaining 36 numbers casted with FRP materials. Such FRP materials has categorized in two groups with utilization of CFRP and GFRP fabrics in various wrapping patterns. The wrapping patterns like U-shaped jacketing, vertical strips having particular spacing and combination of edge strips with vertical strips throughout the length of beam specimens. The study of beams has carried out with consideration of factors like torsion moment, angle of twist and ductility. Finally they concluded that beams bonded with CFRP fabrics showed more torsion resistant than GFRP bonded specimens.

Rafid Saeed Atea[24] has done experimentation to study about contribution of carbon fiber reinforced polymer (CFRP) against torsion resistant of beam specimens. They casted and tested total 12 numbers of reinforced beam specimens having T shaped do not contain and contained with CFRP fabrics. The study considered the continuity effect of beam and slab elements so here three sided wrapping by CFRP fabric are considered. In the test program two numbers of beams are controlled specimens no containing of CFRP fabrics and remaining are casted with various varieties. They checked effect of orientation of CFRP strips like 90° & 45° with respect to longitudinal axis, combination of transverse and additional longitudinal strips, effect of bolt anchorage and effect of utilization of continuous sheet between wed and flange. They studied the behavior of specimens in the form of torque-twist curves, strains produced in fabrics and concrete, torque in cracking and in ultimate respectively.

Sachin B. Kandekar , Rajshekhar S.Talikoti [25] investigated the behaviour of beam specimens covered with aramid fiber sheet. They selected mix design M30 grade for the same. The research 53 mentioned that the aramid fiber is the first organic fiber with high enough young modulus and strength which can be used as reinforcement in composite materials. The research concentrated to sudden failure occurrence at due to excessive loading and also affected due to seismic prone area. Hence the beams specimens get strengthen by aramid fibers sheet using of U shaped sheets. They casted and tested total 12 numbers beams specimens out of that three beams were designed for torsion moments and remaining nines were designed as conventional beams. Such design of beams were carried out as per IS456-2000 .The size of specimens kept 150mm x 300mm and 1m in length. The epoxy resin adhesive was used to maintain proper bonding of armaid fiber with concrete surface. The specimens were covered by such fiber sheets in continuous forms and in the form of 100mm wide strips along three sided faces of beams. The parameters like cracking and ultimate torque, angle of twist and twisted shapes of beams were observed. . Results showed that continuous wrapped RC beams sustain more torsional resistant with repect to other one. Also it is observed that beams in wrapped strips showed significant improvement in torsional strength.

2.3 Ferro-cement jacketing

As above said that ferrocement is used in making boats, planks for shelves in low cost housing projects, construction of sewage manhole covers etc. It can be also utilized for ferro cement full, U shaped jacketing with full wrapping or in strips for structural members. Such strengthening of RCC beams by using ferro-cement jacketing is one types of the alternative technique to polymer fiber jacketing. This system can overcome the tendency of fire than polymer fiber jacketing system. Hence as per topic concern let review ferro-cement jacketing technique as follow.

Dr. Gopal Charan Behera [29] attempted a research study on ferro cement jacketing which improves the torsion capacity of RC beams. In this research U wrapping technology has used for the same. Also this study gave an alternative technique instead of utilization of polymer jacketing to overcome their demerit. In experimentation program they casted beam specimens containing variation in different number of wire meshes and different reinforcement systems. The conventional reinforcement having variation like only longitudinal, fully under, partial and over reinforcement are considered. Again variations of the number wire mesh layers, size aspect ratio, mortar strength, concrete strength are considered. The three, four and five wire mesh layers are considered in the specimens. The author also developed the analytical model and soft computing method MARS to predict the analysis of beams. The analytical model is based on softened truss model of Hsu with modification on material properties. The test results get compared with theoretical one and observed in good agreement with experimental test results.

G.C. Behera, M.R.Dhal [26] investigated the ductility of beam specimens i.e. angle of twist at ultimate loads. The beams were strengthen by wrapping with U shaped ferrocement jacketing system. The test program contained with normal strength as well as high strength mortar and concrete grades. The total thirty numbers of beam specimens were casted and tested having variation in wire mesh layers and variation in torsion, shear and flexural reinforcement with and without U-shaped ferrocement wrapping. The MARS soft computing method is used to compute the theoretical values of specimens. The comparisons of angle twist at ultimate torque showed good in agreement with experimental test results.

Gopal Charan Behera et al. [27] concerted the study about ferro cement U shapped jacketing as a replacement of FRP jacketing used for retrofitting, repair and rehabilitation purpose etc. There are some demerits of FRp jacketing like it requires special adhesive, prone to fire and high in cost etc. However such ferrocement jacketing which has better cracking capacity, high in strength and good

bonding with concrete surface etc. So in the experimentation author has casted and tested total six numbers beam specimens containing with and without wire mesh covering. The all beams including control beam made up by utilizing only shear reinforcement and also author used variation of numbers of wire meshes. The observation showed that the torque twist response of ferrocement U-jacketing beams is just seems like that response given by reinforced concrete beams. So they concluded that only introduction of transverse reinforcement is not an effective way of increasing the torsional strength but only increase in toughness is found to be marginal.
Gopal Charan Behera et al. [28] has done the experimentation in that twelve numbers of rectangular beams were casted and tested under pure torsion. The variation in beam casting has been done by keeping variation in longitudinal, transverse and fully reinforcement with and without ferrocement U-jacketing. The study of research is aimed to determine the effectiveness of the using U-shaped wrapping of number of wire mesh layers under pure torsion.. The results concluded that "U" shaped wrap jacketing are found to better contribution in torque carrying capacity under the torsion. The under reinforced concrete beams provide better toughness over other types of tested specimens. Also over reinforced beams showed more torque resistive than the others. The improvement in torsional strength contained with number of mesh layers in ferrocement "U" wrap is minimal.

2.4 Encased Weled wire mesh influenced on shear strength of RCC beams

The considerable work has been done in the utilization of welded wire mesh as shear reinforcement which influenced on shear as well as flexural strength of RCC beams. The study of this topic showed that WWMF can use as shear reinforcement of the replacement of conventional stirrups. However as per research topic concern there is need to study the effect of encased WWMF in torsional strength of the RCC beams. As per reviewing of concern topic literature till date effect of encased WWMF in torsional strength is not investigated by anyone of the researchers but as per mentioned above that sufficient amount of research is available on the welded wire mesh allotted a good shear strength to RCC beams. It is well known that the torsional capacity of RCC beams is totally depends upon shear reinforcement and not on flexural reinforcement. So here is an attempt to study the behaviour of RCC beams under shear load mentioned as below.

M. A. Mansur et al [39] studied the anchorage of U shaped welded wire fabric as shear reinforcement in the beams. Seventy numbers of pull-out tests were made to investigate the influence of various parameters that affect the anchorage. Also four numbers of simply supported overhanging beams were tested to study their cracking behaviour and ultimate strength. Test results indicate that welded cross wires can provide adequate anchorage with respect to their relative size and spacing of these wires and the beams can attain the desired shear capacity for the same. They were utilized the plain and deformed welded wire for experimentation purpose. The use of deformed welded wire fabric significantly improves the cracking characteristics of a beam with comparison of an equivalent amount of smooth welded wire fabric. On the basis of the investigation the conclusive remarks has been drawn by the authors that Stirrups can be adequately anchored by using welded cross wires instead of the conventional way of providing a bend or a hook. However, a decrease in the diameter of cross wire decreases its effectiveness. As a result, cross wires of the same diameter as the main wires can provide equally effective anchorage.
When two cross wires are used, the ratio of the diameter of cross wire to that of stirrups should be at least 0.8 for both smooth and deformed welded wire fabric. The 90° bend showed the marginal improvement in the anchorage than 45° and 135° respectively. The results also showed that the performance of an anchorage of welded wire mesh has significantly improved with an increase in the grade of concrete. Also deformed welded wire fabric as web reinforcement in beam provides a significant improvement in the control of diagonal cracking than an equivalent amount of smooth welded wire fabric.

Xuan et al [40] tested a total six pre-tensioned prestressed T-beams with identical flexural reinforcements and carious shear span to depth ratio statically up to failure to investigate the effectiveness of welded wire fabric as shear reinforcement. The tested beams contained one beam without shear reinforcement and remaining five beams with different types of shear reinforcements. It included conventional double-legged stirrups, single-legged stirrups, and three different types of commercially available welded wire fabric. They studied the experimentation with various factors like Crack widths, stiffness, ductility and ultimate shear strength of the beam. The results indicated that the effectiveness of WWF as shear reinforcement is just like the same as that of conventional stirrups under static loading conditions. The contribution of the shear reinforcement based on the ratio of the difference between measured Ultimate Vu and corresponding cracking load Vcr to the yield strength (Av.fy) of the stirrups is compared. As per showed in Fig.2.1 the values of mentioned ratio confirm the fact that the shear-carrying mechanism is not as simple as assumed by the 45 deg truss analogy according to the ACI Building Code. However, the consistency of the results indicates that the effectiveness of WWF as shear reinforcement is similar to that of conventional stirrups but improvement in the distribution of the diagonal cracks. The Crack widths observation concluded that these are essentially the same for all types of shear reinforcement configuration up to the initiation of major diagonal cracks. However, beyond that, the slight differences in the crack widths were developed with respect to shear reinforcement and not by the type and configuration of shear reinforcement. Also observed that the stress concentration created due to tack-welds and limited ductility of the cold-drawn wires does not influence the effectiveness of WWF as shear reinforcement. The additional horizontal wire at the mid height of WWF had no significant influence on crack pattern, crack width, and the stiffness of the beam. However, it could enhance the ductility as well as the ultimate shear strength of the beam.

Hence the welded wire fabric used as shear reinforcement should exhibit adequate ductility to insure the overall ductility of the member.

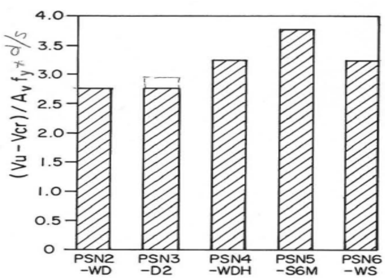

Fig.2.1: *Measured contribution of shear reinforcement*

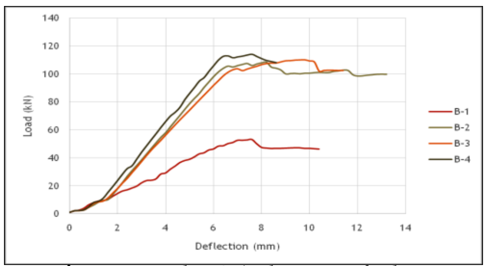

Fig.2.2: *Load vs Displacement for beams*

M.P.Sridhar et al [41] studied shear performance of RC beams specimens containing with and without welded wire mesh. They used variation of shear reinforcement like beams with stirrups alone, only using of wire mesh and combination of both wire mesh and stirrups. The wire mesh proportion has been taken with respect to weight with stirrups. To achieve better performance of concrete in workability, placing and even to achieve good compressive, tensile strength the high rage water reducing agent (HRWRA) is used in the concrete mix. In the experimentation there were four numbers of beams specimens casted. The results showed that utilization of welded wire mesh increases the shear capacity compared with others. The specimen contains only wire mesh as a shear reinforcement observed well in ductility as compared to conventional stirrups beam. Also there is considerable effect can be observed on crack patterns by using of wire mesh. The observed effects are increase in numbers of cracks, delaying in cracks and reduction in cracks width etc. Fig.no.2.2 showed the load vs displacement graph of the readings obtained from the testing of specimens. The results also showed that the performance of beam using only wire mesh and beam using combination of stirrups and wire mesh are similar in nature which failed due to flexural failure. Balasubramanian and Radhakrishnan[44] studied structural behavior of welded wire reinforcement in reinforced concrete beams which has been divided into two aspects: the effect of different types of reinforcement grids in rectangular beams and the effect of structurally performing grids in T – beams. In the first aspect, all the models with normal strength concrete (4500 psi), and the effect of different types of reinforcement grids (B1RC, B2WWR, B3WWR, and B4WWR) and strength (60 ksi and 80 ksi) has been evaluated and in the second aspect, T-beam specimens have been subjected to a four point bending test. Concrete and steel properties are kept the same for all models subjected to the four points bending test and uniformly distributed loading. They checked the beam behavior with respect to various parameters like moment capacity, shear capacity, Maximum strain and ductility etc. Also they carried out non-linear finite element analysis performed using ABAQUS for both the control beam (B1RC) and the WWR beam (B4WWR) which behaves similarly in load and strain patterns.

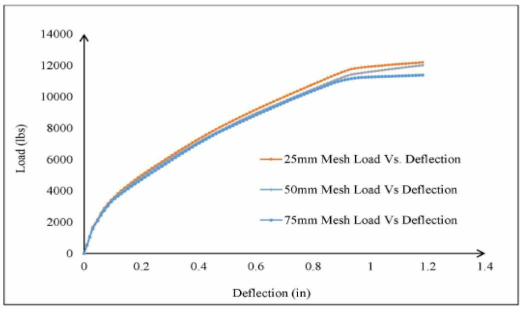

Fig.2.3: *Load Vs Deflection Graph for control Beam B1RC*

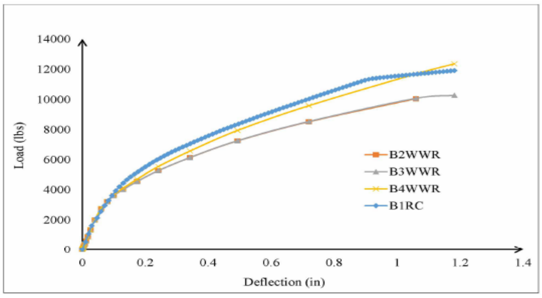

Fig.2.4: *Load Vs Deflection Graph for for Rectangular Beams*

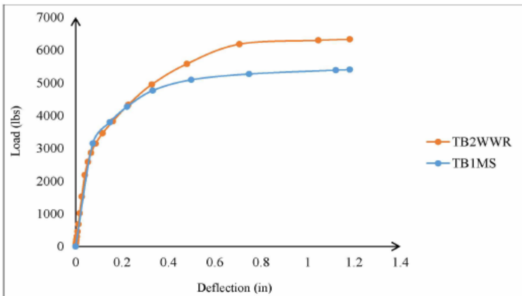

Fig.2.5: *Load Vs Deflection Graph for for TB1MS, TB2WWR*

Above figures showed the load verses deflection curves of the mentioned types of beam specimens. WWR beams B2WWR and B3WWR follow the same pattern of load versus deflection behavior, but being reinforced with 50% of the flexural reinforcement and the percentage difference in the load carrying capacity between the two beams is minimal. B2WWR and B3WWR have a 21.94% decrease in moment capacity when they were compared to B1RC beam. The ductility increase was 16.55% between B2WWR, B3WWR and B1RC when subjected to a four point bending test. B2WWR and B3WWR carrying 50% of flexural reinforcing on the tension side have a 3.44% decrease in moment capacity and a 17.19% increase in shear capacity when compared to B1RC beam subjected to a uniformly distributed load. Based on the mentioned comparison, WWR beam B4WWR can be used as an alternative for the control beam B1RC. Being reinforced with 75% of flexural reinforcing of TB1MS beam, there is a 42.93% increase in moment capacity between TB2WWR and TB1MS beams. According to the results of the present study, it can be concluded that WWR (80,000 psi) can be a better alternative over traditional reinforcing bars (60,000 psi). Welded wire reinforcement grids have a highest flexural capacity with less reinforcing area and with smaller diameter bars, which enhances load transfer mechanism.

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III. Conclusion

3.1) Steel Fiber Reinforced Concrete

After observing the literature about SFRC various researchers has been study well about said subject and carried out in the form of cube ,split tensile and flexural strength means not directly correlated with fiber mechanical properties. However Narayanan and Kareem Palanjian who laid their theoretical investigation on the basis of space truss analogy with separate contribution of torque carrying capacity by steel fibers. They proposed that the increase in torsion strength is linearly depends upon the percentage increase in volume of fiber. After that Pant and Parekar carried out experimentation and comparison with previous results of researcher and concluded that torsion strength by SFRC is non-linearly with fiber percentage and also concluded that chances of producing balling effect of fibers due to excessive percentage of fibers in the concrete body.

3.2) Polymer and ferrocement Concrete jacketing

After studying the literature review retrofitting techniques can be classified in two groups 1) Retrofitting by polymer fiber jackets 2) Retrofitting by Ferrocement jackets.. The first group contains various materials like carbon reinforced polymer, fiber reinforced plastics/polymer, glass reinforced fiber polymer and aramid fibers etc and ferrocement wire meshes can be available in various sizes. Researchers considered from both categories has investigated well and some of them has formulated theoretical analysis in the form of FEM models and one of researcher developed softened truss model which is based Hsu model with material properties modification. Remaining some researcher produced equilibrium and compatibility equations based on elastic theory. fiber polymer jacketing materials showed their good effects in crack arresting mechanism, ductility and in contribution of torque carrying capacity but other hand some specimens get deboned before reaching up to ultimate loads. In case of jacketing done by ferrocement it is observed that ferrocement can be utilized as a replacement of polymer fiber jacketing to avoiding demerits created due to such materials. But ferrocement jacketing cannot achieve by using one layer of wire mesh. There may require numbers of wire mesh layers to acquire considerable enhance in torque capacity of beam specimen. Again there is no exact correlation between the ratio of percentage increase in torque carrying capacity with increase in number of wire mesh layers.

3.3) Encased Welded wire mesh influenced on shear strength of RCC beams.

As per concern of using of WWMF in concrete beams various authors has done well research work for the same .Some of them using of cold-drawn steel wire mesh some of using deformed with same size of main and cross wire and/or different sizes of main and cross wire etc. obviously the shear capacity of welded wire mesh is depends due to its high tensile strength but it should be properly anchored. So in M. A. Mansur's research the 90° bend showed the marginal improvement in the anchorage than 45° and 135° respectively. Also Investigation proved that the utilization of wire mesh made significant effect on crack pattern of the reinforced concrete beams with delaying the crack appearance, increasing the number of crack and reducing the crack width etc. Again some researchers observed that due to the stress concentration created by tack-welds and limited ductility of the cold-drawn wires does not influence the effectiveness of WWF as shear reinforcement. So there is necessary to use the additional horizontal wire at the mid height of WWF which could enhance the ductility as well as the ultimate shear strength of the beam. One of author on the basis his experimentation observed that beams with wire mesh as shear reinforcement and combination of both wire mesh and stirrups exhibited some amount of increase in shear capacity with respect to the beams with stirrups alone as shear reinforcement.

Hence after studying the literature the welded wire mesh gives an effective contribution in shear load carrying capacity of reinforced concrete beam. Also encased WWMF acted as a crack arrester on the surface of reinforced beam which produces micro crack behavior in the concrete.

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A SURFACE EDGE CUTOUT MICROSTRIP PATCH ANTENNA FOR 5G APPLICATIONS

Priyanshu Rani Rajkumar, Ajani Chandani, Jahnavi Deshmukh, Shahid Modasiya

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Government Engineering College, Gandhinagar, Gujarat, India
ranipriyanshu01@gmail.com

Abstract

With internet revolutionizing communication, to the extent that it has become a preferred medium of communication. With these huge demand for high speed cost effective networks so in order to meet these requirements 5th generation networks is required. The primary technologies include: Millimeter bands(26,28,38 and 60GHz) are 5G and offer performance as 20 gigabits per second; Massive MIMO offers performance up to ten times of current 4G networks. In this paper, we have proposed a novel surface edge cutout single patch Micro strip antenna with high gain. The antenna is fabricated on FR4 Epoxy substrate with relative permittivity 4.4 and dielectric loss tangent 0.02. The proposed antenna has compact structure of 28.9mmx28.9mmx1.6mm.The antenna resonates at 5GHz. The proposed antenna has surface edge cutout design which results in high gain and good bandwidth better radiation patters. The formulation is validated by simulation in finite element method- based software, ANSYS HFSS.

Keywords: Slotted Patch, Gain, and Radiation pattern.

I. Introduction

This Micro strip Patch Antenna is low-profile planar antennas mounted at a ground level with di-electric material in-between constitutes a micro strip or patch on the top. They are compact, less expensive and easy to fabricate antennas.

With the advance wireless technology, fast increasing internet speed the requirement for micro strip patch antenna to introduce the high standard of data transfer and low cost of fabrication is made the millimetre wave which is applicable for commercial purpose[1]. Because of the speedy development of wireless communication, the 5G (5th generation mobile networks) technology growth will be necessary to meet the large network demands. The current mobile communication systems cover the band which is below 3GHz. To meet the demands of the 5G, the spectrum from 3-300GHz has been explored [2-3]. The millimetre wave band is a powerful candidate for the next 5th generation [4], but it has the limitation of the transmission distance. Also, although the lower band from 3-6 GHz has much better propagation. An enhancing mobile network performance capability [2]-[5] is a key to facilitate the infrastructure for smart city development. Thus, simple structure antennas which provide wide bandwidth for mobiles and advanced devices will have been continuously receiving great research interests. Over the past decades, significant progress has been made in the development of wideband patch antennas. However, conventional patch antennas suffer from very narrow bandwidth, typically only about several percentages. Many techniques have been extensively investigated to enhance the operating ban [9-13] of patch antennas [6]-[10]. In this paper, we proposed a surface edge cutout design single patch antenna. This in turn validated by the simulation in FEM based general software HFSS.

II. ANTENNA DESIGN AND GEOMETRY

I Design of Simple Patch Antenna

This antenna has a simple structure of rectangular patch operating at 5GHz. The structure and design of the antenna are shown in Figure 1. The antenna has a rectangular patch of dimensions 18.52×13.76mm. In this antenna transmission line feed is used.

II Design of Simple Patch with inset feed Antenna

In this antenna, slots are introduced which has dimensions of 2.5mm × 1mm. The structure and design of the antenna is shown in Figure 2. The length and width of the patch is the same. The rectangle slots are inserted in this antenna.

III Design of Surface Edge Cutout Antenna

In this antenna, edge slots are introduced at the surface to obtain high bandwidth and high gain. The size of the rectangular patch is 18.52×13.76mm. The edge slots have dimensions of 0.8mm × 0.8mm. The structure and design of the antenna is shown in Figure 3.

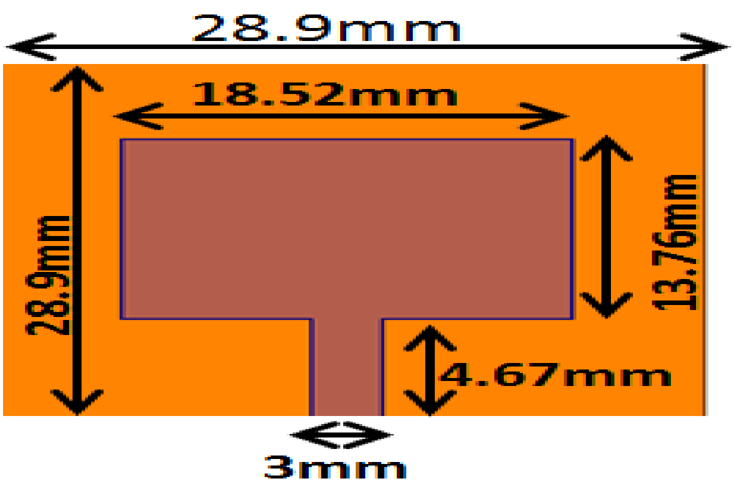

Figure 1: *Geometries proposed of the simple patch Antenna*

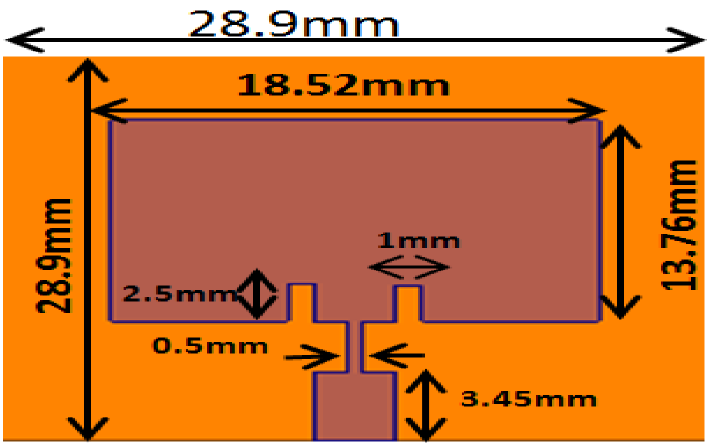

Figure 2: *Geometries proposed of the simple patch with feed Antenna*

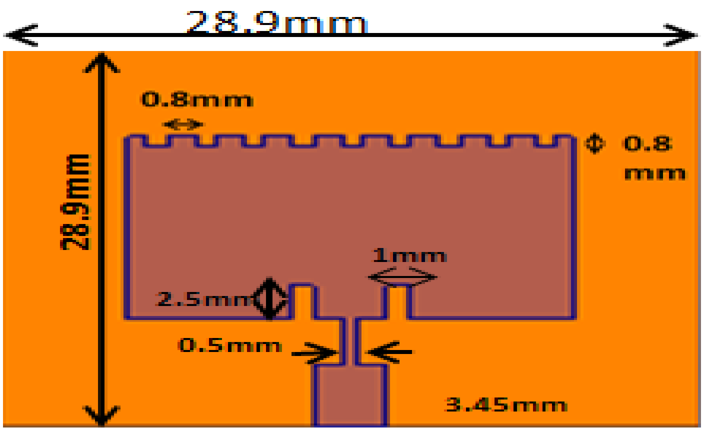

Figure 3: *Geometries proposed of the surface edge cutout Antenna*

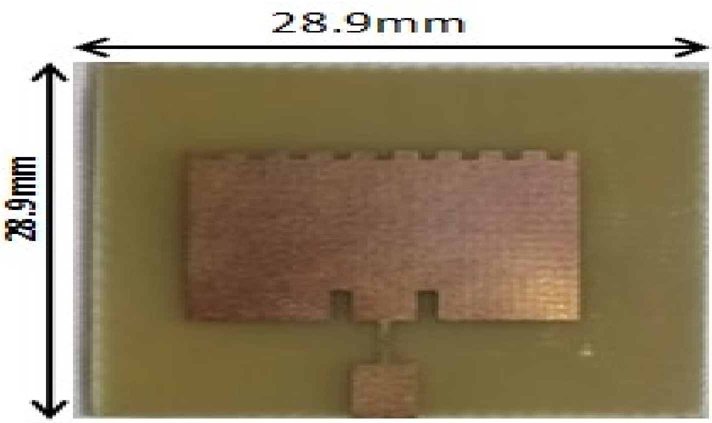

Figure 4: Surface edge cutout fabricated *Antenna*

III. Results

Table 1: *Comparative analysis of different antennas for Return loss, Range and Gain*

Parameters	Antenna		
	Simple Patch Antenna	*Simple Patch with Inset Feed Antenna*	*Surface Edge Cutout Antenna*
Return Loss (dB)	-5.88	-11.88	-15.79
Range	-	4.93-5.04	4.81-5.18
Gain(dBi)	4.56	4.75	4.83

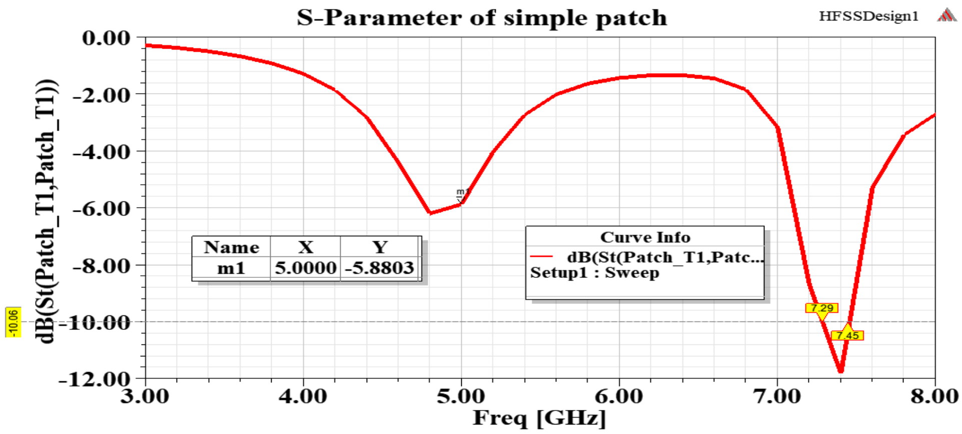

Figure 5(a): *Returen loss of the simple patch antenna*

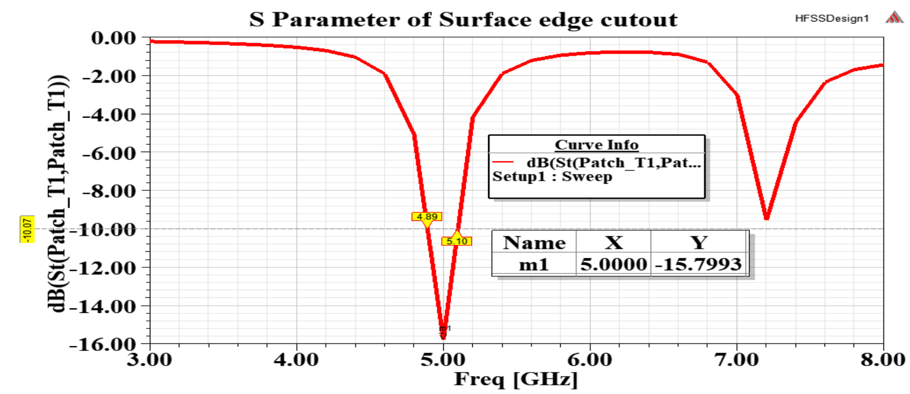

Figure 5(b): *Returen loss of the simple patch with feed antenna*

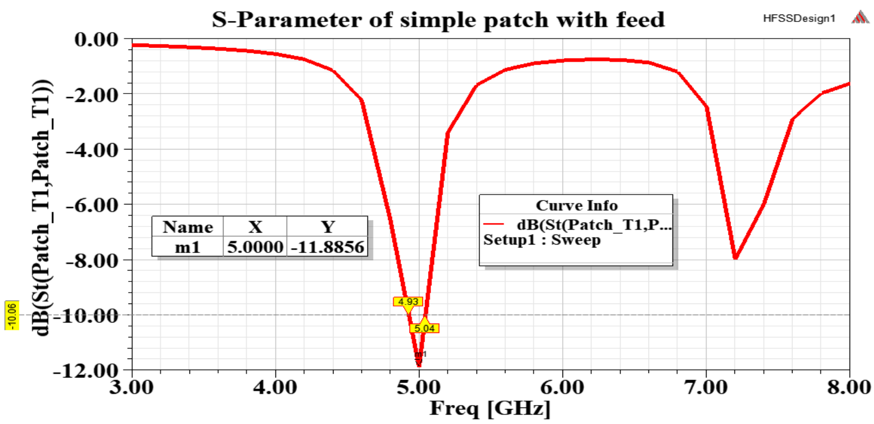

Figure 5(c): *Returen loss of the surface edge cutout antenna*

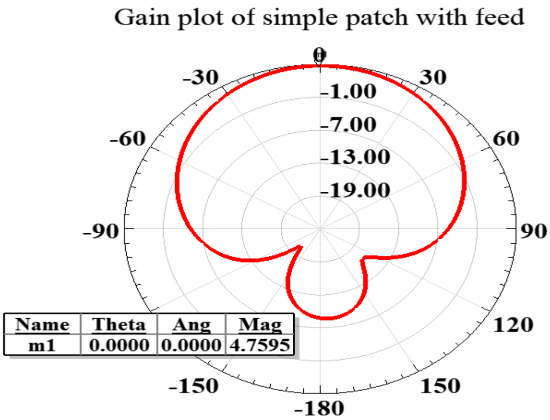

Figure 6(a): *Gain of the simple patch antenna*

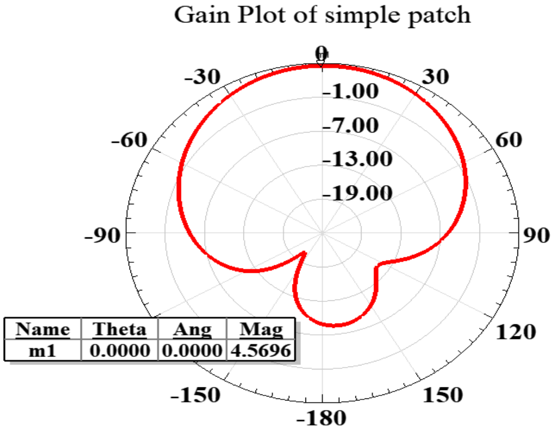

Figure 6(b): *Gain of the simple patch with feed antenna*

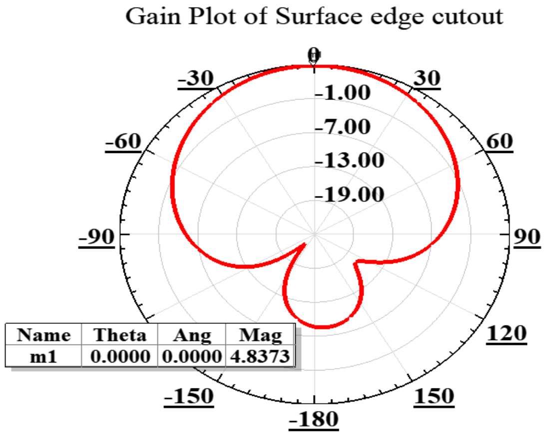

Figure 6(c): *Gain of the surface edge cutout antenna*

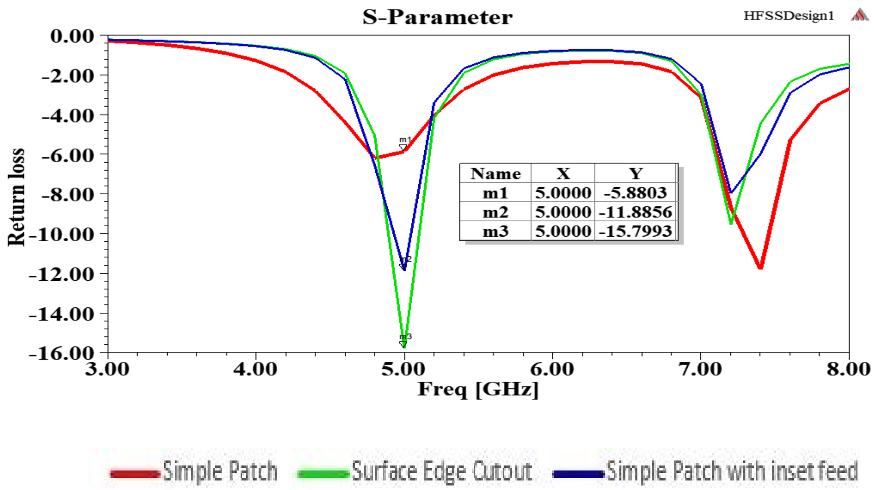

Figure 7: *Comparison of Return loss*

IV. Discussion

The simulation of the proposed antennas is carried out in HFSS software. Three antennas are designed at centre frequency 5GHz. In the simple patch antenna, the return loss obtained is -5.88dB. At -10dB, no return loss is obtained at the centre frequency. The simulated gain is 4.56dBi. In the antenna containing quarter feed with slots, the return loss is -11.88dB. The radiating frequency is 4.93GHz-5.04GHz. The gain obtained is 4.75dBi. The third antenna has the highest gain and bandwidth compared with the other two. The edge cutout at the surface of the patch increases the gain and reduces the return loss. The return loss and gain obtained is -15.79dB and 4.83dBi respectively. The radiating frequency is 4.81GHz-5.18GHz. The return loss in the first antenna is poor because it is a simple patch. With the introduction of inset feed and two slots in the second, antenna the return loss improves relatively to -11.88dBi and in the third antenna we have made slots of equal size with inset feed which has increased the return considerably because with feed there is an improvement in impedance matching hence the results improve. The return losses and gain of the three antennas are given in Figure 5 and Figure 6 respectively. The comparisons of the return loss of the three antennas are shown in Figure 7. The surface edge cutout antenna has the lowest return loss which is -15.79dB. The reason is because of the cutouts at the surface of the antenna which improves the performance. The other two antennas have return loss above -10dB because of the change in design of the antennas.

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CONSEQUENCE OF SOURCE RIPPLE FACTOR IN CONDUCTED VOLTAGE EMISSION MEASUREMENT

Smit Shah, Akhilesh Sidapara, Kalpesh Parikh, Puran Gajera, Dr. Vinod Gupta

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Electrical Research and Development Association, Vadodara, India
smit.454.shah@gmail.com

Abstract

Huge dv/dt and di/dt due to high switching frequency and ripples present in AC-DC converter infallibly introduce unwanted Electromagnetic Interference (EMI) noise voltage through parasitic/distributed parameters of the DC source. In this paper, the entire test setup for conducted emission (CE) is made to measure the conducted voltage disturbance of Equipment Under Test (EUT) due to various DC sources with different percentage ripple factors used to supply. The measurement carried out in the frequency band 150kHz to 30MHz as per CISPR 11 [2]/ CISPR 22 [1]. The dominated DC source responsible for the significant conducted voltage disturbance measurement results are analyzed and to mitigate the conducted emission manoeuvring based on DC source is proposed. Practical measurement are used to validate the mitigation method.

Keywords: Ripple factor, Electromagnetic Interference, DC-AMN, Conducted Emission

I. Introduction

Majority electrical and electronics equipment placed in to the market have to achieve the necessitous requirements of EMC measurement and validation of either European or American EMC Directive and get complies before entering in to the market. When electromagnetic energy in any form generates and conducts through nearby environment, it can interfere to the devices operating in the same environment. Seeing from its production and R&D perspective, it is difficult and cost consuming both to manage electrical noise emission and immunity of the devices. So, it is an essential part of both system and product design. Failure in reduction of emission sources and achieving susceptibility during developmental stage will leads to a time wasting and costly fixes later on.

The DC power supply operated equipment can use either a linear power supply source or switching power supply source. Ripple is an unwanted AC component present in the output of any AC-DC converter. The ripple factor is a ratio of this AC component to the average DC output of converter circuitry and the value of ripple factor is always less than unity. Ideally ripple factor shall be zero in a pure DC source but due to presence of power electronics switches it possesses some AC components. Generally switching power supplies offer high ripple and noise and have decent transient behavior. They are, however, efficient and offers low heat dissipation. They are also compact, whereas the linear DC power supply shows the completely opposite characteristics. But a compromise has to be made between linear and switching power supply sources depending upon source applications, EUT requirements with which they are associated and sometimes with product standard requirements.

Automotive, military and some other standards and regulations are prepared to outline a limit of radiation generated from the commercial electrical and electronics products. Some regulations also defines conducted emission limits applicable to dc power lines. As recent development of products have adopted electronics which are nonlinear loads on the power distribution system. They have input current of non-sinusoidal waveform consisting of harmonics, ripples and switching transients that can have a detrimental effect on the performance of Electrical and Electronics Equipment connected to the same power distribution system. These equipment themselves are not large enough to be an efficient radiator for frequency range below 30 MHz but when the power distribution system is concerned, it can be an efficient antenna. And hence the conducted voltage emission test is performed in laboratories for the frequency band 150 kHz to 30 MHz with the use of DC-AMN according to CISPR22 [1], CISPR11 [2] and other similar EMC standards.

Normally, Differential Mode and Common Mode currents generated from equipment are too small to interfere directly to other products placed in the same surrounding or connected to the same power line but cumulatively all the equipment connected to the same power line possibly generate enough amount of current to cause the power line to become a source of interference, so the measurement was carried out in DM and CM mode as per CISPR.

II. Measurement Technique

The DC-AMN is used for the assessment of conducted voltages disturbance at DC power ports. DC-AMN gives a predefined common mode (CM) 150 Ω termination impedance for the supply port of the EUT during measurements of Conducted Voltage emission at test sites. It is made to provide, in the required frequency range from 150 kHz to 30 MHz and specific termination impedances for symmetric (or DM) and asymmetric (or CM) measurement components.

Differential mode tracks the same path as the input power i.e. from line to line as shown by blue trace in Figure 1, while the common mode has a current path via earth as shown by red trace in Figure 1.

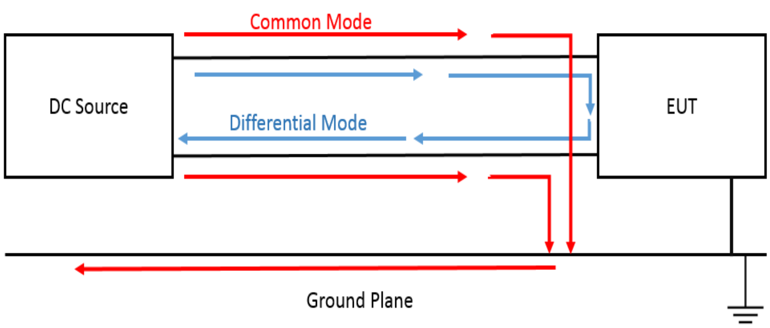

Figure 1: *CM & DM Measurement*

Further, the DC-AMN offers a decoupling network (i.e. an LC-filter) such that adequate decoupling is provided between EUT port input and mains supply, in order to avoid RF disturbances from the laboratory DC power source to actual measurement results, which in turn provides repeatable, valid and reliable measurement results [2].

Measurement of the conducted voltage emission on DC power ports is made by the 150 Ω DC-AMN in UM, DM and CM mode.

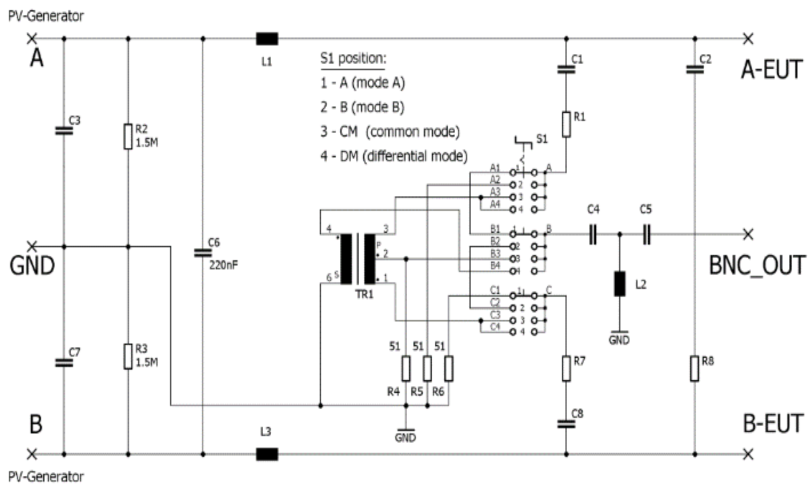

Figure 2: *Basic Circuit Diagram of 150 Ω DC-AMN [2]*

Positive or negative terminal (UM): The unsymmetrical voltage emission is measured from either positive or negative terminals to ground (V-AMN).

Common mode (CM): The sum of voltage emission of positive and negative terminal is measured against ground (T-AMN, asymmetrical voltage).

Differential mode (DM): The symmetrical voltage emission between the positive and negative terminals is measured (Delta AMN).

In these three different approaches of measurement the input impedance and differential impedance seen from the device under test is 150 Ω.

To measure the conducted voltage disturbance for frequency Band B (150 kHz to 30 MHz), FFT based measuring EMI receiver with the reference bandwidth 9 kHz in average mode detector is used. [3]

The measurements was carried out with reference to Figure 3 setup as followed to CISPR 22 guideline. The lamp load (as an EUT) was placed on the electrically insulated table 80 cm above the horizontal ground plane and placed 40 cm away from vertical ground plane, which was bonded with the floor and the EUT was connected to DC-AMN, which was earthed to the horizontal aluminum ground plane.

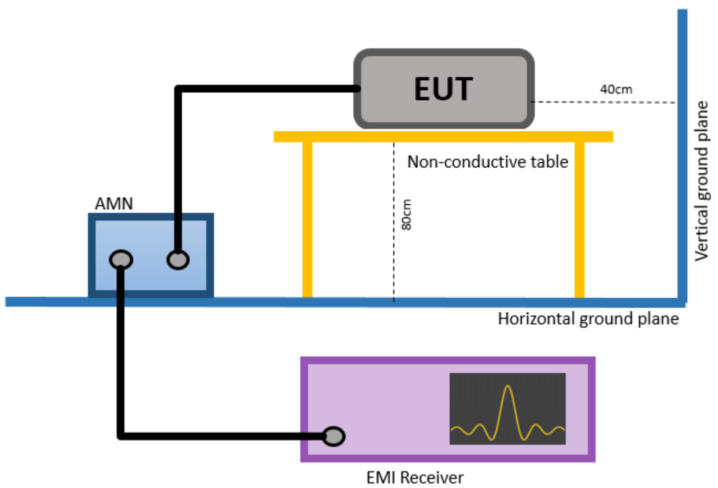

Figure 3: *Test setup block diagram*

III. Measurement

It was comprehended during measurement that UM and CM measurements were representing nearly the same graph patterns. So, the CM and DM measurement in average detection mode was carried out on DC operated EUT with various DC sources having different ripple factors. The measured ripple factor of different DC sources are as stated in TABLE 1.

Table 1: *DC sources' % R.F.*

DC Sour	Type of Source	V_{RMS}	V_{DC}	% R.F.
1	Switching	2.90	24.6	11.7
2	Switching	1.42	24.5	5.79
3	Linear type	0.39	24.0	1.62
4	Battery	0.18	23.7	0.75

The percentage ripple factor was calculated as below:

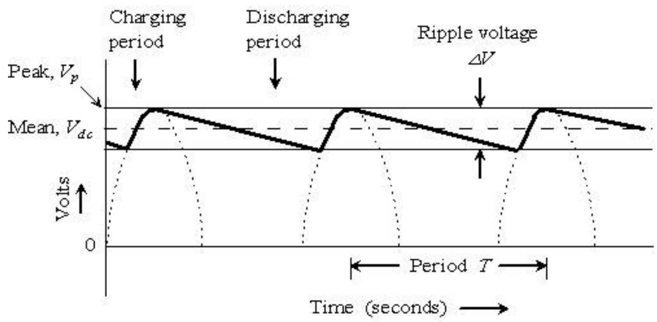

Figure 4: *Generalize output waveform of DC switching power source*

$$\% \, Ripple \, Factor = \frac{RMS \; value \; of \; AC \; component}{\text{Average value of DC output}} \times 100 \tag{1}$$

$$\%R.F. = \frac{V_{RMS}}{V_{DC}} \times 100 \tag{2}$$

The mentioned DC sources have been evaluated for its conducted voltage emission characteristics without EUT and with EUT in order to determine the consequence of ripple factor in actual measurement separately.

I. DC Source - 1 with % R.F. = 11.78%

The DC Source - 1 was switching type power supply. The results of conducted voltage emission in

CM and DM without EUT are shown in Figure 5 & 6 and with EUT in Figure 7 & 8.

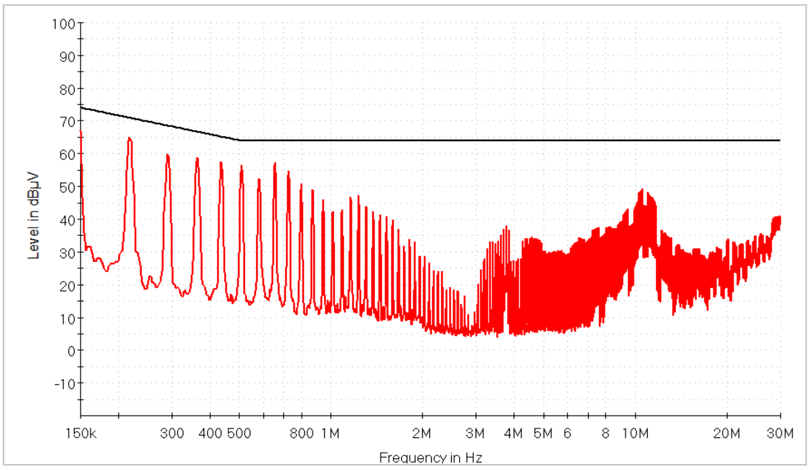

Figure 5: *CM measurement of DC source - 1 without EUT*

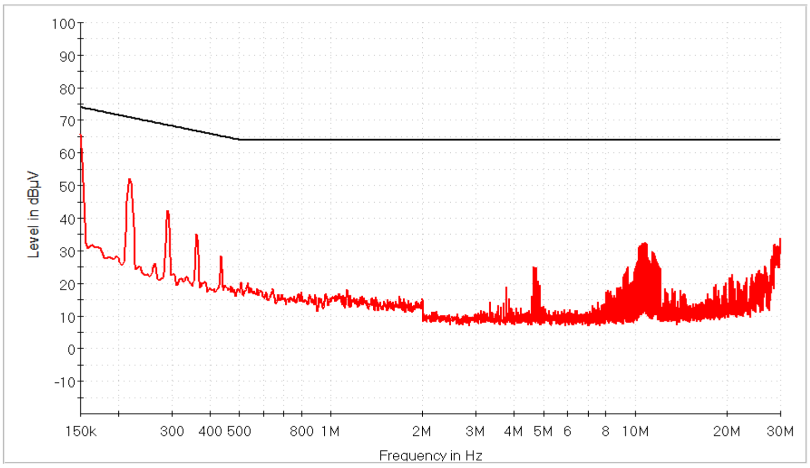

Figure 6: *DM measurement of DC source - 1 without EUT*

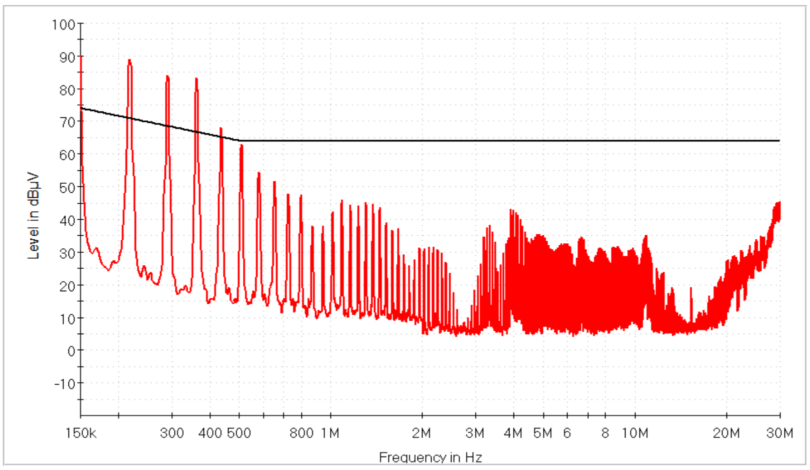

Figure 7: *CM measurement using DC source – 1 with EUT*

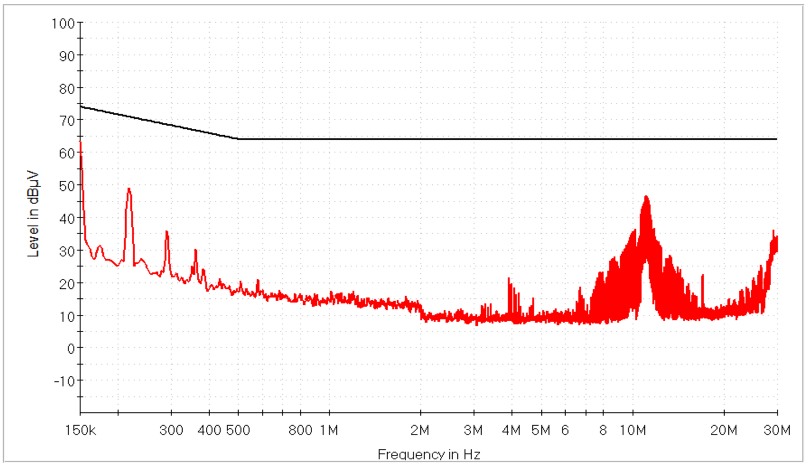

Figure 8: *DM measurement using DC source - 1 with EUT*

II. DC Source - 2 with % R.F. = 5.79%

The DC Source - 2 was switching type power supply. The results of conducted voltage emission in CM and DM without EUT are shown in Figure 9 & 10 and with EUT in Figure 11 & 12.

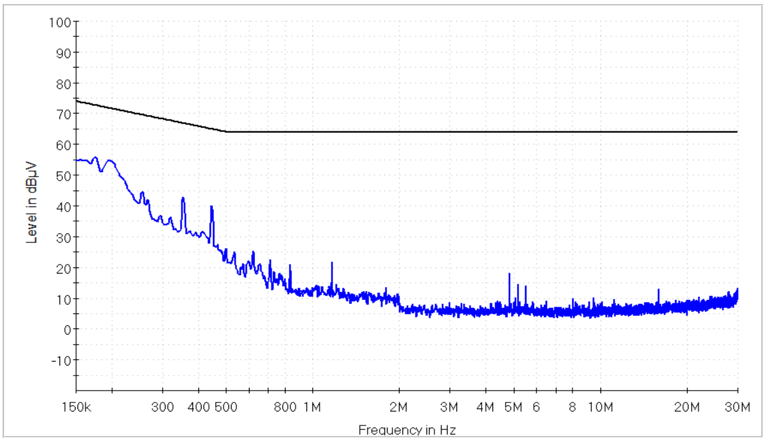

Figure 9: *CM measurement of DC source - 2 without EUT*

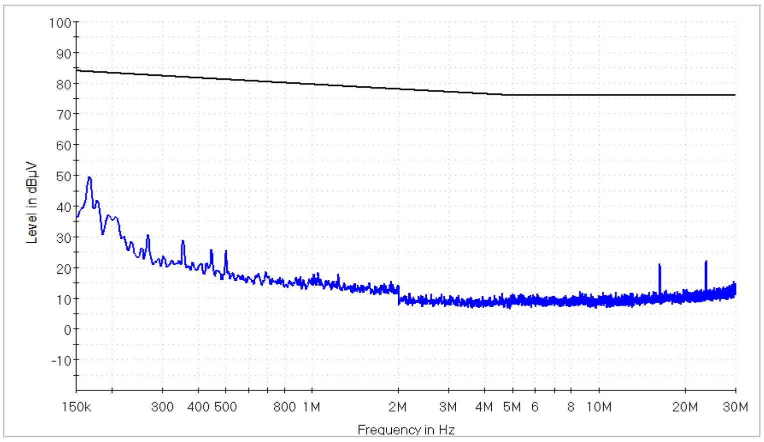

Figure 10: *DM measurement of DC source - 2 without EUT*

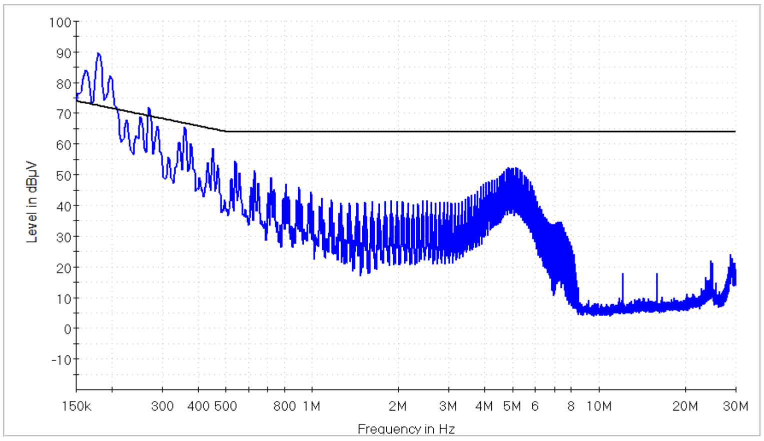

Figure 11: *CM measurement using DC source – 2 with EUT*

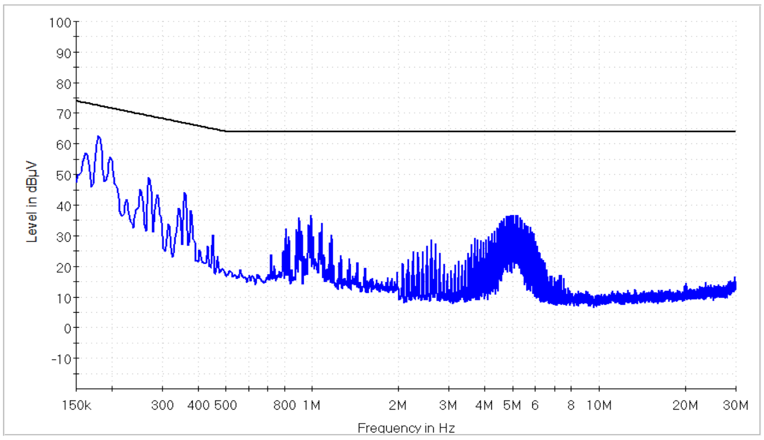

Figure 12: *DM measurement using DC source - 2 with EUT*

III. DC Source - 3 with % R.F. = 1.62%

The DC Source - 3 was linear type power supply. The results of conducted voltage emission in CM and DM without EUT are shown in Figure 13 & 14 and with EUT in Figure 15 & 16.

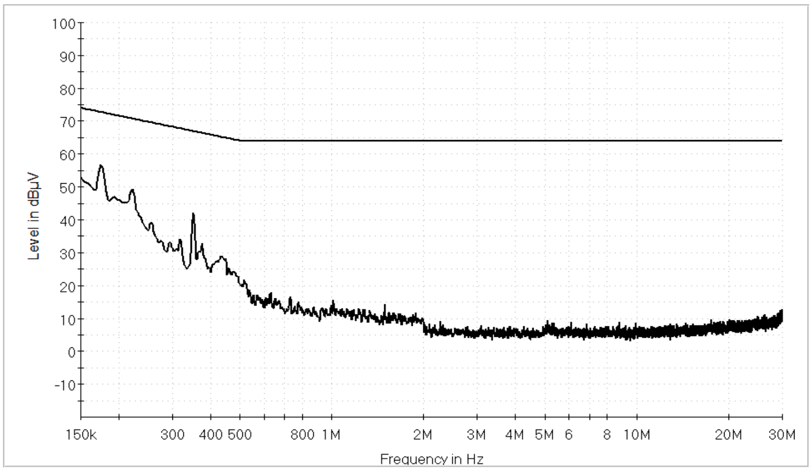

Figure 13: *CM measurement of DC source - 3 without EUT*

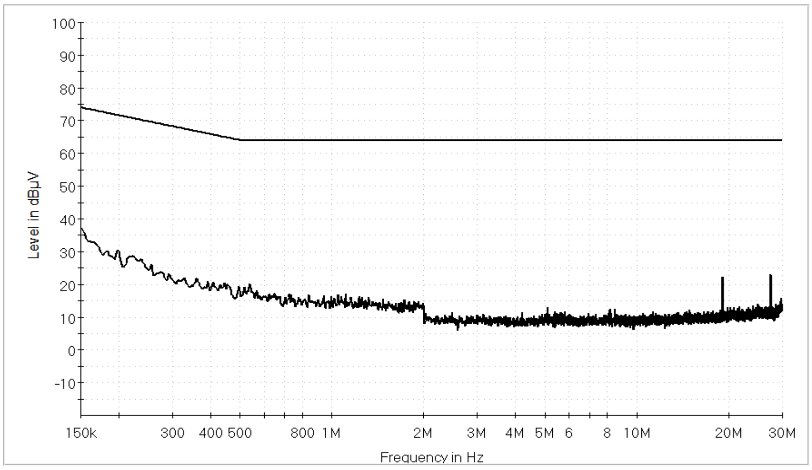

Figure 14: *DM measurement of DC source - 3 without EUT*

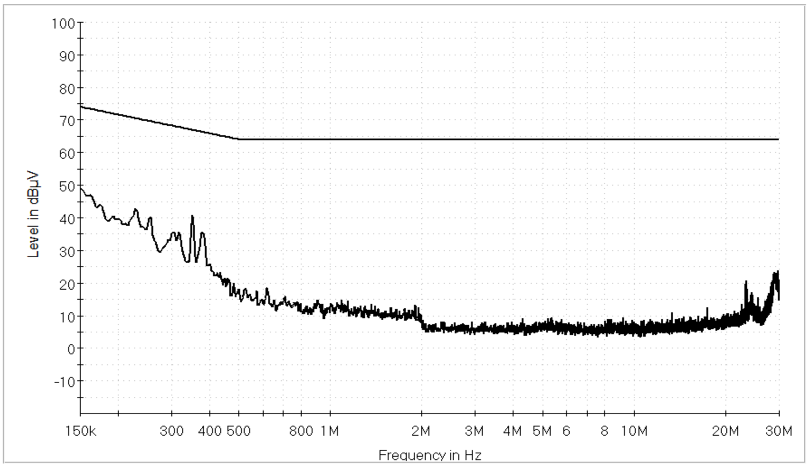

Figure 15: *CM measurement using DC source – 3 with EUT*

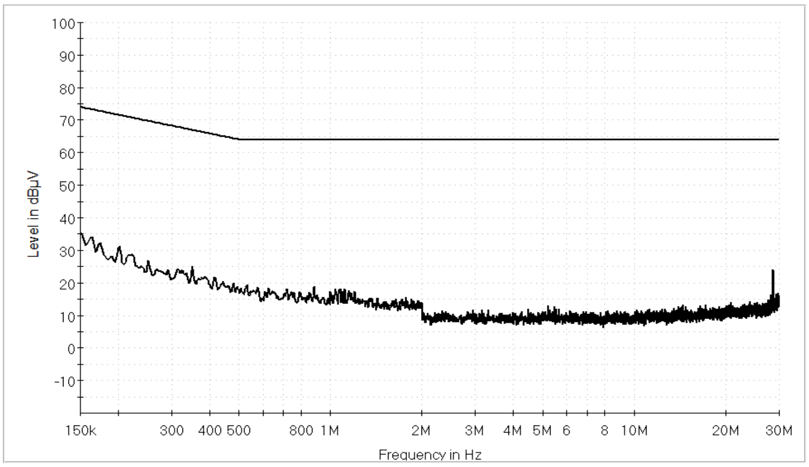

Figure 16: *DM measurement using DC source - 3 with EUT*

IV. DC Source - 4 with % R.F. = 0.75%

The DC Source - 4 was a battery. The results of conducted voltage emission in CM and DM without EUT are shown in Figure 17 & 18 and with EUT in Figure 19 & 20.

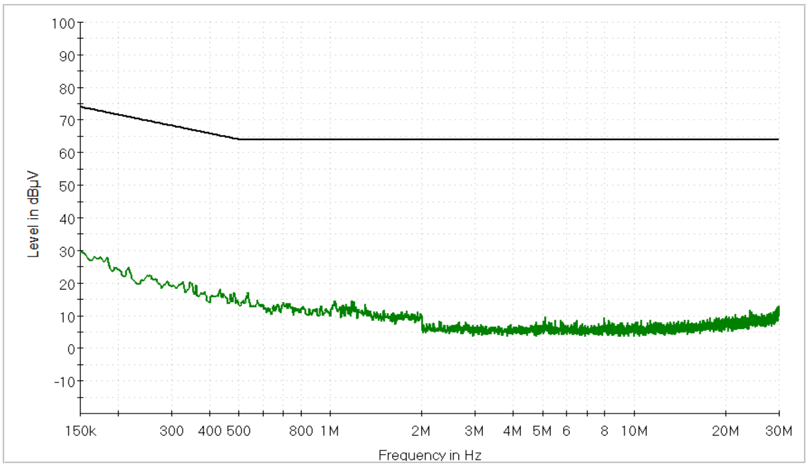

Figure 17: *CM measurement of DC source - 4 without EUT*

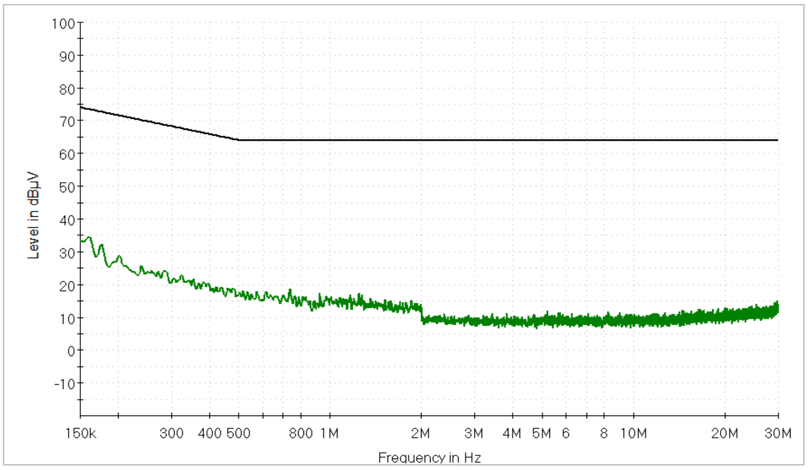

Figure 18: *DM measurement of DC source - 4 without EUT*

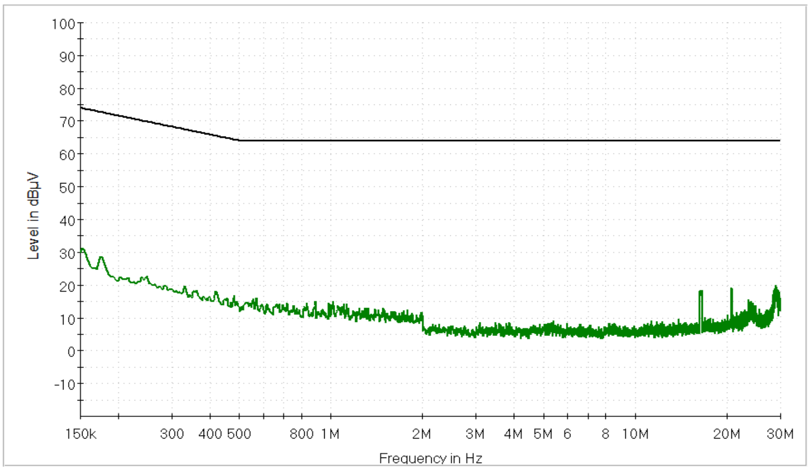

Figure 19: *CM measurement using DC source – 4 with EUT*

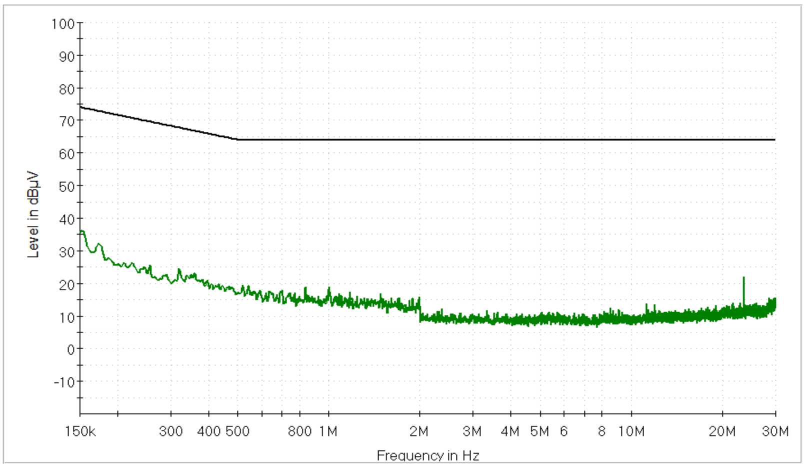

Figure 20: *DM measurement using DC source -4 with EUT*

IV. Observations

From the graph it can be clearly observed that DC Source having higher percentage ripple factor contributes more conducted voltage emission as compared to the source having lower percentage ripple factor.

As evident from Figure 7, 11, 15 & 19; the presence of switching frequencies spikes of switched type power supply sources can inject additional noise in the actual measurement (Figure 7 & 11), however those are absent in a case of linear power supply sources (Figure 15 & 19).

It has been observed that the source having higher percentage ripple factor i.e. DC source – 1, was showing a major change between without EUT (Figure 5 & 6) and with EUT (Figure 7 & 8) traces. While reducing the percentage ripple factor i.e. DC source – 4 had benefited in the traces of both without EUT (Figure 17 & 18) and with EUT (Figure 19 & 20) by showing the same patterns i.e. lesser changes in both traces.

Apparently the variations between with EUT and without EUT results were reduced as value of percentage ripple factor was decreased from DC source – 1 to DC source – 4.

V. Conclusion

In this paper effect of percentage ripple factor of four different DC power sources in conducted voltage emission in the frequency band from 150 kHz to 30 MHz is analyzed. It is observed that linear DC power supply having lower output ripple generates minimum conducted voltage emission, whereas switching DC power supply is not properly designed, having high ripple and it will generate more conducted voltage emission. In switching DC power supply, it is inherent characteristics that it operates at hard switching for several kHz frequency which interferes and generates more conducted voltage emission and hence to mitigate the effect of conducted voltage emission generated by DC source in the test setup linear power supply shall use over switching power supply. Although factors such as the transient response, slew rate, load and line regulation play an important role, it is inferred from this paper that the DC source having ripple factor less than 1.62% shows lesser effect on final conducted voltage emission and complies with the limits specified in CISPR 11.

VI. Acknowledgment

We heartily acknowledge the support received from Director-ERDA, Vadodara and ERDA staff to carry out this experiment.

References

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[2] CISPR 11: IEC International Electrotechnical Commission, International Special Committee on Radio Interference, "Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement".

[3] CISPR16-1-1: IEC International Electrotechnical Commission, International Special Committee on Radio Interference, "Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus".

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WIND SPEED POTENTIAL ASSESSMENT OF SELECTED CLIMATIC ZONES OF ETHIOPIA

Endalew Ayenew[1], Santoshkumar Hampannavar2

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[1]College of Electrical & Mechanical Engineering, Addis Ababa Science and Technology University, Ethiopia
Professor, School of Electrical and Electronics Engineering, REVA University, Bengaluru, India
end_enday@yahoo.com

Abstract

In this paper the wind speed potential assessment of different climatic zones of Ethiopia are proposed. Statistical analysis of wind speed were carried out using Rayleigh and Weibull probability density functions (PDF) for a specific location. Real time Typical Meteorological Year (TMY) data was used for the wind speed potential assessment of three different climatic zones and to plot wind rose diagram.

Keywords: Wind speed assessment, Statistical analysis, Wind Energy

I. Introduction

Wind is one of the globally recognized potential renewable energy source and it is important to have an inclusive knowledge about the wind characteristics for efficient planning and implementation of wind power generation plants. The wind energy assessment is very crucial and draws attention of researchers. Wind resources assessment is a basic requirement for the following reasons: i) wind power is proportional to the cube of the wind speed (10% difference in wind speed leads to 33% changes in wind power), ii) fluctuating wind speed and wind shears. According to the statistics the country has existing wind energy capacity of about 18.7GW with wind speed of 7.5 to 8.8 m/s at 50m height above the ground level. Wind energy is recognized throughout the world as a cost-effective energy plant. It is environmentally friendly solution for energy shortages, i.e. reduce climate change effect, greenhouse gas emission and protection of biodiversity. Wind power plant helps to reduce over three billion tons of CO_2 emissions annually [1- 6]. As per the advanced scenario as shown in Table 1 the wind power could reach nearly 2,000 GW by 2030 [6].

Wind power could reach 2,000 GW by 2030 and supply up to 17-19% of global electricity [7]. Even though wind potential resource is very high in Ethiopia but still it contributes only 0.06% of wind power generation globally. Global Wind Energy Outlook (GWEO) explores the future of the wind energy industry up to 2050 and according to the International Energy Agency's policies scenario considering World Energy Outlook as a baseline, two scenarios were specifically developed.

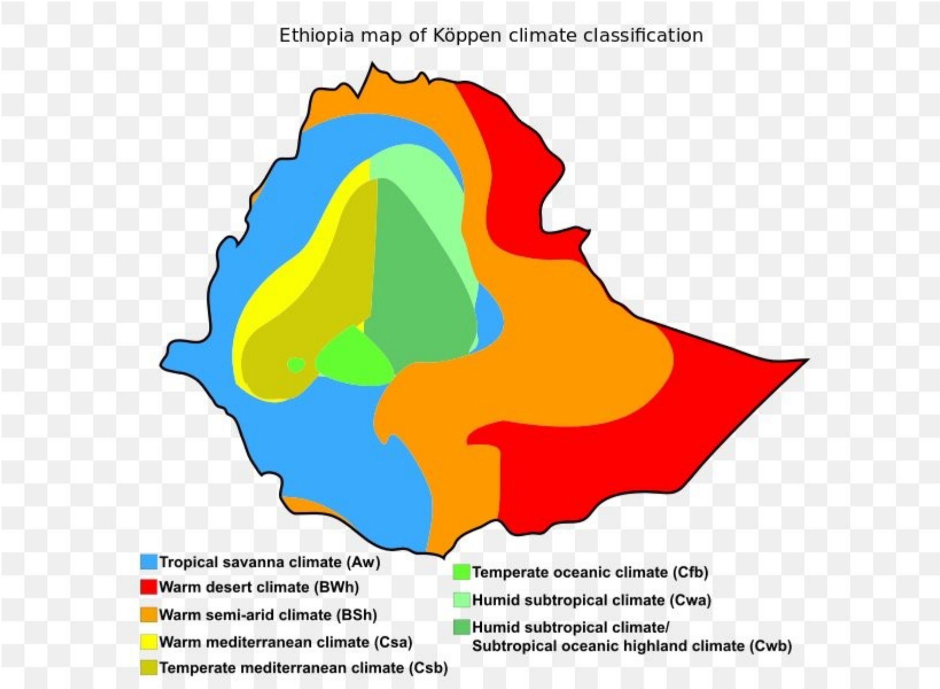

Figure 1: *Köppen Climate Classification Geography of Ethiopia (Source: FAVPNG.com)*

Figure 1. shows the Koppen climatic classification of Ethiopia and it is observed that there are eight climatic zones. Firstly, statistical analysis of one station is comprehensively carried out using Weibull and Rayleigh probability density functions. Secondly, the wind rose diagram is plotted considering Typical Meteorological Year (TMY) data for three different stations located at three different climatic zones.

II. Statistical Models for Wind Speed Assessment

To describe the wind speed distributions, many probability density functions (PDF) have been used such as beta, gamma, lognormal, Rayleigh and Weibull functions. Rayleigh and Weibull models are widely accepted according to the literature studies. Weibull function is preferred due to its flexibility in terms of shape factor and scale factor but suffers from the problem that cannot be used for calm wind speeds [8-14].

Two parameter Weibull probability density function (PDF) is given by

$$f(v)=\frac{k}{c}\left(\frac{v}{c}\right)^{k-1}e^{-\left(\frac{v}{c}\right)^{k}} \tag{1}$$

Weibull cumulative distribution function (CDF) is given by

$$F(v)=\int_{0}^{v}f(v)\,dv=1-e^{-\left(\frac{v}{c}\right)^{k}} \tag{2}$$

where v is the wind speed, k is shape parameter and c is scale parameter [15-18]. The value of the shape factor relates it to other PDF i.e. if k =2 it becomes Rayleigh distribution.

Table 1: *Global wind power scenario*

Total Capacity in MW	2013	2014	2015	2020	2030
New Policies Scenario	318,128	356,322	396,311	610,979	964,465
Moderate Scenario	318,128	363,908	413,039	712,081	1,479,767
Advanced Scenario	318,128	365,962	420,363	800,615	1,933,989

Rayleigh PDF is given by

$$f(v)=\frac{\pi}{2}\left(\frac{v}{v_m^2}\right)e^{-\left(\frac{\pi}{4}\left(\frac{v}{v_m}\right)^2\right)} \quad (3)$$

where v_m is mean wind speed.

Rayleigh CDF is given by

$$F(v)=1-e^{\left(-\frac{\pi}{4}\left(\frac{v}{v_m}\right)^2\right)} \quad (4)$$

Energy pattern factor method (EPF) is used to determine the Weibull distribution parameters. Monthly mean power density (MMD) is given by

$$P=0.5A\rho\sum_{i=0}^{n}\frac{v_i^3}{n} \quad (5)$$

$$MMD=\frac{P}{A}=0.5\rho\sum_{i=0}^{n}\frac{v_i^3}{n} \quad (6)$$

where A is swept area, v_i is wind speed in the sample measured at instant *i*, n represents total days in a month and ϱ is air density
Energy pattern factor is given by

$$EPF=\frac{\sum_{1}^{n}\frac{v_i^3}{n}}{\left(\sum_{1}^{n}\frac{v_i}{n}\right)^3}=\frac{\left(\frac{MMD}{0.5\rho}\right)}{v_m^3} \quad (7)$$

According to the shape factor, Weibull distribution is described as

$$k = 1 + \frac{3.69}{EPF^2} \tag{8}$$

The scaling factor is given as

$$c = \frac{v_m}{\Gamma\left(1 + \frac{1}{a}\right)} \tag{9}$$

For gamma function

$$\Gamma(k) = \int_0^\infty x^{k-1} e^{-x} dx \; and \; \Gamma(1+k) = k\,\Gamma(k) \tag{10}$$

Weibull power density is given by

$$\begin{aligned} \frac{P_{Weibull}}{A} &= 0.5\rho v_m^3 = 0.5\rho\left(c\Gamma(1+\frac{1}{k})\right)^3 \\ &= 0.5\rho c^3 \Gamma\left(1+\frac{3}{k}\right) \end{aligned} \tag{11}$$

Rayleigh power density is given by

$$\frac{P_R}{A} = \frac{3}{\pi}\rho v_m^3 = \frac{3}{\pi}\rho c^3 \tag{12}$$

III. Results and Discussion

I. Statistical Assessment of Wind Speed

Real time wind samples were collected for one TMY for Adama, Ethiopia wind site. The data was collected at a height of 10 meter and 40 meter above the ground for which wind speed varies between 6 m/s and 14 m/s; and 12 ms/and 17 m/s respectively. Figure 2 and Figure 3 shows the Weibull and Rayleigh PDFs respectively. Annual average estimated power densities calculated using Rayleigh and Weibull models are 532 W/m^2 and 370 W/m^2 respectively. Rayleigh model provides better power extraction than the Weibull model for Adama wind site.

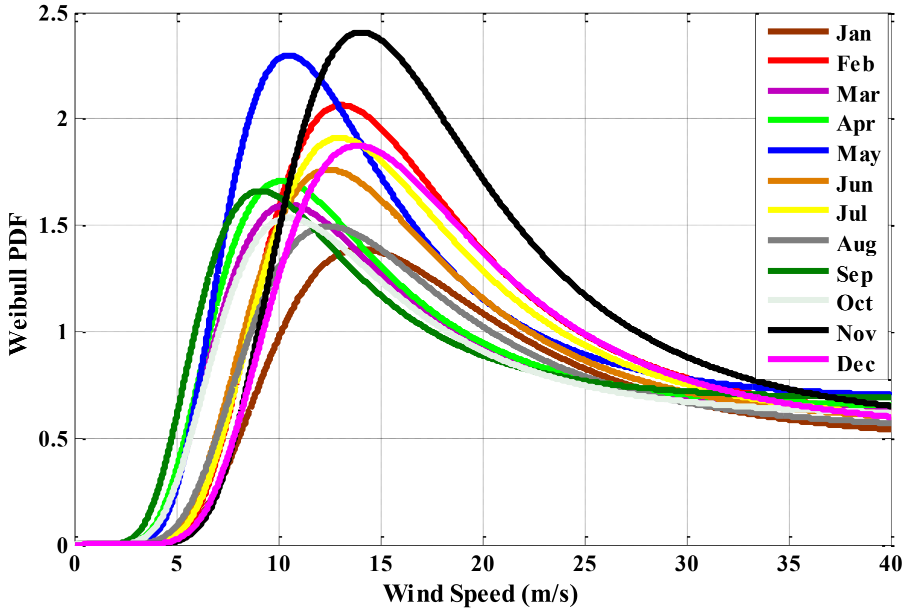

Figure 2: *Weibull Probability Density function*

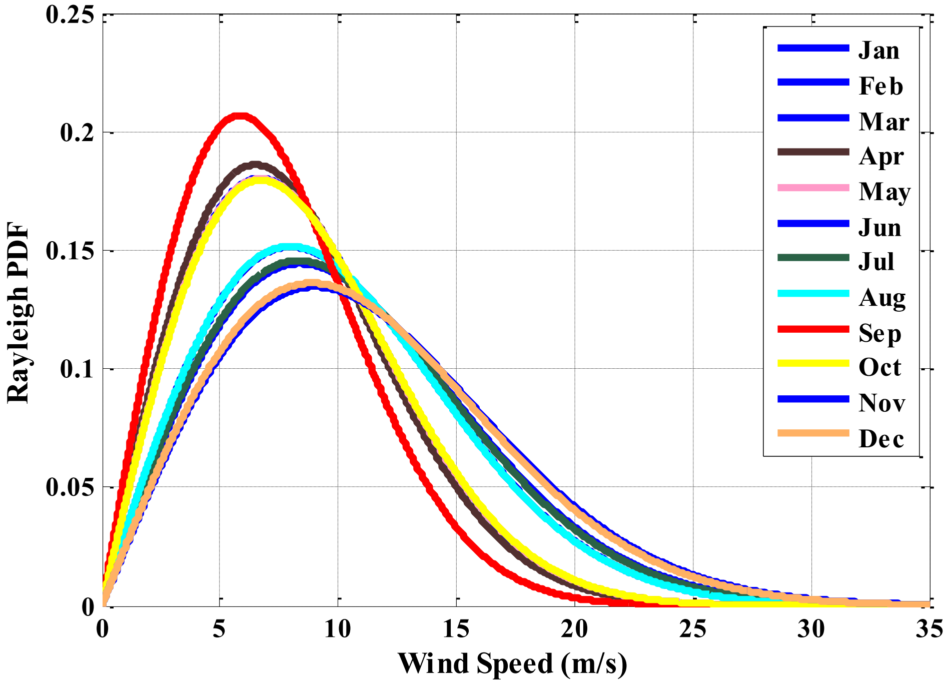

Figure 3: *Rayleigh Probability Density function*

II. Wind Speed Assessment

Wind speed for three different regions (Tropical Savanna Climate, Warm Semiarid Climate and humid subtropical Climate) were assessed by plotting wind rose diagrams. Three cities considered for the assessment are: i) Gondar, ii) Dire Dawa, iii) Addis Ababa (capital city of Ethiopia).

For the tropical savanna climate, Gondar was considered and the wind rose diagram (wind velocity and direction) was plotted using the TMY [19-22] data as shown in Figure 4. The wind blows greater than 8 m/s towards East direction which is around 70%. In the south east direction wind blows at a speed of 4 m/s which turns to be 10% of wind in that city.

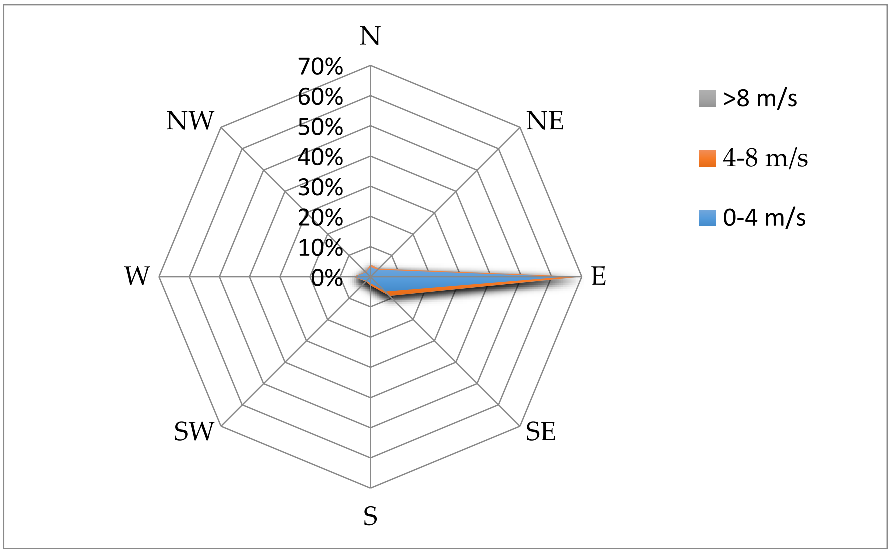

Figure 4: *Tropical Savanna Climate (Gondar)*

For the warm semiarid climate, Dire Dawa was considered and the wind rose diagram was plotted using the TMY data as shown in Figure 5. The wind blows greater than 7 m/s towards West direction which is around 30% and it is interesting to note that the wind blows in East direction at a rate of 4-5 m/s which amounts to 22.5%. Towards North West it is observed that the wind blows at a rate of 4 m/s which turns out to be around 15%.

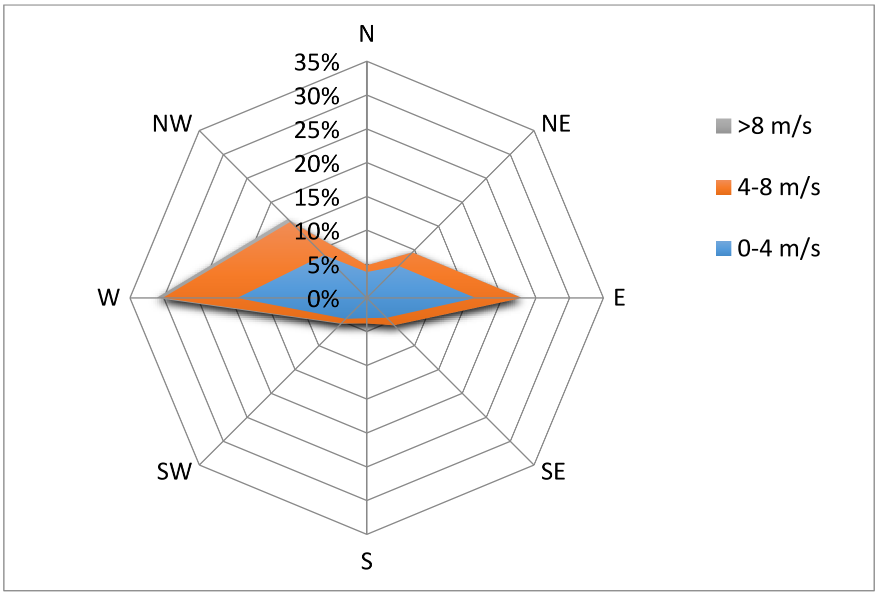

Figure 5: *Wind Rose Diagram (Dire Dawa)*

For the humid subtropical climate, Addis Ababa (capital City of Ethiopia) was considered and the wind rose diagram was plotted using the TMY data as shown in Figure 6. It is depicted from Figure 6 that the wind blows in the North direction at a speed of 8-12 m/s which turns out to be 25% of the total wind in that city. Wind blows greater than 6 m/s in the North West direction and amounts to around 10%. In East wind blows at 4 m/s which is about 6%.

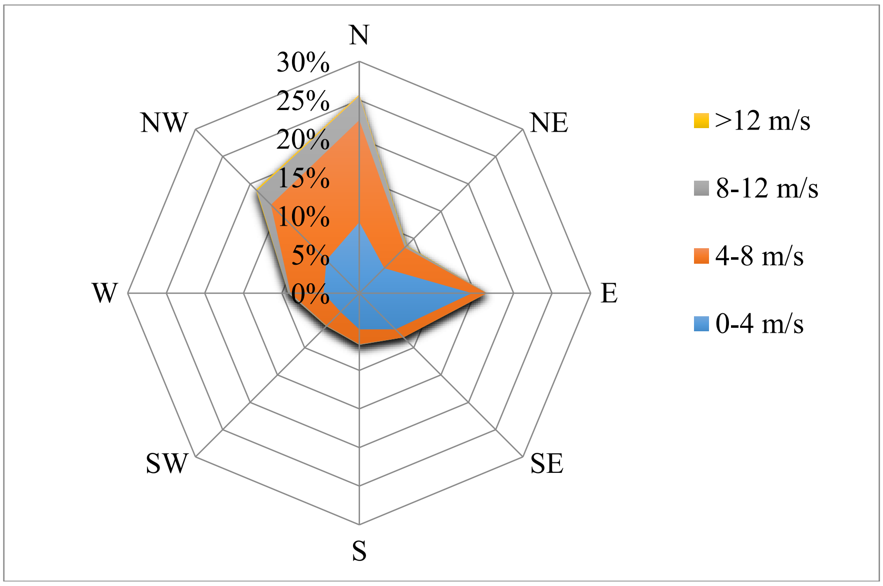

Figure 6: *Wind Rose Diagram (Addis Ababa)*

IV. Conclusion

The wind speed potential assessment of three different climatic zones of Ethiopia were presented. The statistical analysis of wind speed potential of ADAMA was carried out and it is found that Rayleigh PDF is better than the Weibull PDF. The wind rose diagrams were plotted for three different climatic zones (Tropical Savanna Climate, Warm Semiarid Climate and humid subtropical Climate) of Ethiopia. This study will help the electrical utility companies for possible future expansion plans or to start new projects.

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EFFECT OF VARIOUS PARAMETERS ON THE PERFORMANCE OF HELICAL COIL HEAT EXCHANGER- A NUMERICAL INVESTIGATION

Makarand Patil, Balwant Bhasme

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University of Mumbai
m.makarand.m@gmail.com

Abstract

A Heat exchanger is a device that is used to transfer heat from one fluid to another fluid through direct or indirect contact. In this paper, the double pipe helical coil heat exchanger is studied numerically under four conditions at outer wall of heat exchanger which are: constant heat flux, constant wall temperature, insulated, and having heat transfer coefficient of 4000 W/m2K for square and circular shape of tubes. The inner diameter of the inner tube is kept 8mm with the thickness of the inner tube is 0.5 mm. The outer tube inner diameter is 17mm.The inverse of the curvature ratio for this study as 10, 15, 20 and 25 with a number of turns 2. The curvature diameter is varied. The velocity of hot fluid flowing inside the inner tube is varied while, the mass flow rate of cold fluid flowing through the outer tube is kept constant as 0.512105Kg/sec. The primary motives for this work are to find out the optimum curvature ratio and Reynolds number to get the maximum heat transfer rate with minimum pumping power, which increases because of increase in number of turns for a coil. This, work incorporates computational analyses and their validation. In the present work, the objective is to find out the effect of providing various outer boundary conditions on thermal properties of flowing fluid, curvature ratio and Reynolds Number. From the present work it is noticed that Nusselt Number varies directly with the pitch of the helical coil for the constant height of the helical tube. The Optimum value of Reynold's number is increasing with an increase in curvature ratio for constant heat flux condition of the outer tube for both cross-sections

Keywords: Curvature Ratio (d/D), Helical coil heat exchanger, Secondary Flow, Nusselt Number, Prandtl Number

I. Introduction

Helical Coil Heat Exchanger (HCHE) are the simple heat exchangers used in industries. These heat exchangers are compact in a structure that helps to improve the performance of the heat exchanger. Thus, make a good choice for small industries. Two tubes or pipes having different diameters are placed concentrically, the smaller pipe inside the larger one. Heat transfer is taking place between them. The reason behind giving a high heat transfer rate is the secondary flow which causes the centrifugal forces. HCHE has two vertices perpendicular to the axial flow direction. Thus, the mode of heat transfer in HCHE is by means both conduction and convection. But the heat transfer using convection is more as compare to conduction. These heat exchangers give high heat transfer area per unit volume. HCHE used in Nuclear power plants, various processing plants and in Cryogenic application for liquefication purposes of the gases. Also, used to heat crude heat oil to distill into many separate components and in food and beverage industries for pasteurization of liquid food items and store them at their required temperature. They have a wide range of applications in petroleum industries. Due to the use of HCHE in various applications, it becomes necessary to study the parameters like pressure drop, pumping power, and heat transfer characteristics. And which geometrical and flow properties are affected more on heat transfer and pressure drop as the presence of secondary flow which is the responsible parameter for heat transfer increase. As Nusselt Number increases with an increase in Reynolds Number as velocity are increases keeping geometrical parameters constant but correspondingly there is the increase in pressure drop that means pumping power increase which increases the cost of the system. There is a point where we get the maximum value of Nusselt Number with minimum pumping power that point is the optimum value of Reynolds number. Kanungo [1] has done a numerical analysis to optimize the heat transfer rate of the tube-in-tube helical coil heat exchanger. Results show that the LMTD difference increases with Reynold's number at steady-state rate. Jayakumar J.S et al. [2] had done numerical and experimental work on a helical coil heat exchanger. Results are obtained by CFD it helps to develop a relationship that uses for calculating heat transfer rate and can be applied for a different configuration. A. B. Korane, et al. [3] has studied numerical analysis on two geometries square and circular coiled pattern. He has made an empirical correlation for circular and square helical coils for the case of laminar and turbulent conditions. From his numerical work, he has found that the friction factor is more for circular compare to the square. Kharat Rahul et al. [4] has done the experiments to study the heat transfer rate on a concentric helical coil heat exchanger. He found that the major heat transfer coefficient is affected by varying the tube diameter, coil diameter, etc. From this, he had made some conclusions that the heat transfer coefficient decreases with the increase in the coil gap. And with an increase in tube diameter the heat transfer coefficient increases. Rennie Timothy J. et al. [5] had done the numerical analysis on a double-pipe helical heat exchanger. From this, he concluded that thermal resistance is the limiting factor for heat transfer, and heat transfer increases by increasing inner tube diameter. The studies show that the Nusselt number correlated with the modified Graetz number. The heat transfer coefficient and Nusselt number were plotted by using Wilson plots. T. N. Mishra [6] has done a numerical analysis of the tube in the tube helical coil heat exchanger. He has found the heat transfer coefficient by equating the conduction heat transfer rate and convection heat transfer rate. Correlation used for calculating Nusselt number for constant heat flux is given by

$$Nu=0.085Re^{0.74}Pr^{0.4}(d/D)^{0.1} \tag{1}$$

To find out friction factor the following correlation is used for double pipe helical coil heat exchanger whether it is the inner or outer friction factor given by

$$f=2.552Re^{-0.15}(d/D)^{0.51} \tag{2}$$

He has found that shear stress at the wall of the inner pipe is more as compared to the shear stress at the wall of the outer pipe. Aly Wael I. A. [7] has done a numerical study to optimize the flow and heat transfer in Coiled Tube-in-Tube Heat Exchangers under Turbulent flow Conditions. This study was used to investigate 3D turbulent flow. He found that 3D realizable k-epsilon model with enhanced wall treatment is robust and sufficient to simulate the turbulent flow. He has found that the friction factor decreases with an increase in the inner dean number. He showed that by using Taguchi method for counterflow configuration with a lower coil diameter and a higher flow rate in the annulus and tube, can enhance the heat transfer rate. He also showed that with increase in the inner Nusselt number inner dean number increases. In the literature discussed above it can be seen that there is a scope to do further work on effect of various parameters on the performance of helical coil heat exchanger. In the present work, the effect of providing various outer boundary conditions at outer wall such constant heat flux, constant wall temperature, insulated heat transfer coefficient kept as 4000 W/m2 on the thermal properties of fluid, curvature ratio and Reynolds Number numerically.

II. Problem Specification

All the numerical simulation is carried out using CFD software ANSYS fluent in a 3D configuration. The flow domain consists of two inlets, two outlets, and the wall. The inside (d) and an outside tube diameter of the inner tube for the circular section is 8mm and 9mm respectively. The outer tube diameter is 17mm with the height of the helical tube is 60mm with a number of turns as 2. And the curvature diameter(D) considered are 80mm, 120mm,160mm and 200mm respectively. For the comparison purpose, the hydraulic diameter for both the section is kept constant. The inside and outside hydraulic diameter for the inner tube of the square shape is 8mm and 9mm. The outer wall is kept at different boundary conditions. The inlet temperature of the hot flowing fluid (water) inside the inner tube is 355K while, cold flowing fluid (water) is 290K respectively. For finding out the effect of outer boundary condition on various parameters the velocity of hot fluid is varied and that for cold fluid is kept constant. [1]

The governing equations used for the simulation are as described:

1. Continuity equation:

$$\frac{\delta \rho u}{\delta x}+\frac{\delta \rho v}{\partial y}+\frac{\partial \rho w}{\partial z}=0 \tag{3}$$

2. Momentum equation:

X-momentum:

$$u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}+w\frac{\partial u}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial x}+v\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}+\frac{\partial^2 u}{\partial z^2}\right) \tag{4}$$

Y- momentum:

$$u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}+w\frac{\partial v}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial y}+v\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}+\frac{\partial^2 v}{\partial z^2}\right) \tag{5}$$

Z- momentum:

$$u\frac{\partial w}{\partial x}+v\frac{\partial w}{\partial y}+w\frac{\partial w}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial z}+v\left(\frac{\partial^2 w}{\partial x^2}+\frac{\partial^2 w}{\partial y^2}+\frac{\partial^2 w}{\partial z^2}\right) \tag{6}$$

3. Energy equation:

$$\frac{\partial}{\partial \mathrm{x}}\left(\mathrm{k}\frac{\partial \mathrm{T}}{\partial \mathrm{x}}\right)+\frac{\partial}{\partial \mathrm{y}}\left(\mathrm{k}\frac{\partial \mathrm{T}}{\partial \mathrm{y}}\right)+\frac{\partial}{\partial \mathrm{z}}\left(\mathrm{k}\frac{\partial \mathrm{T}}{\partial \mathrm{z}}\right)=0 \tag{7}$$

III. Boundary Conditions

Cold fluid domain:

Table 1. *Boundary conditions for cold fluid domain*

Cold inlet	Mass flow inlet
Cold outlet	Pressure outlet
Inner pipe cold fluid interface wall shadow	Wall

Hot fluid domain:

Table 2. *Boundary conditions for hot fluid domain*

Hot inlet	Velocity inlet
Hot outlet	Pressure outlet
Hot fluid pipe wall interface wall	Wall
Hot fluid pipe wall interface wall shadow	Wall
Inner pipe cold fluid interface wall	Wall
Sidewalls inner tube domain	Wall
Outer pipe cold fluid interface shadow	Wall
Outer pipe outer wall	Wall
Sidewalls outer tube	Wall

The analysis is done in Ansys software for the study. Initially, the geometry is created by using the sweep command to generate a helical shape for both sections giving input as a number of turns as two. And by using Add Frozen option the different properties are assigned to the flowing fluid. Then the extra material and parts removed by using Boolean operators. In free meshing, relatively coarser mesh is generated. It contains both tetrahedral and hexahedral cells having triangular and quadrilateral faces at the boundaries. Later, a fine mesh is generated using edge sizing. In this, the edges and regions of high pressure and temperature gradients are finely mesh. For both the sections, the smoothing is kept medium with a grow rate 1.2. Skewness for both sections meshing is 0.9.

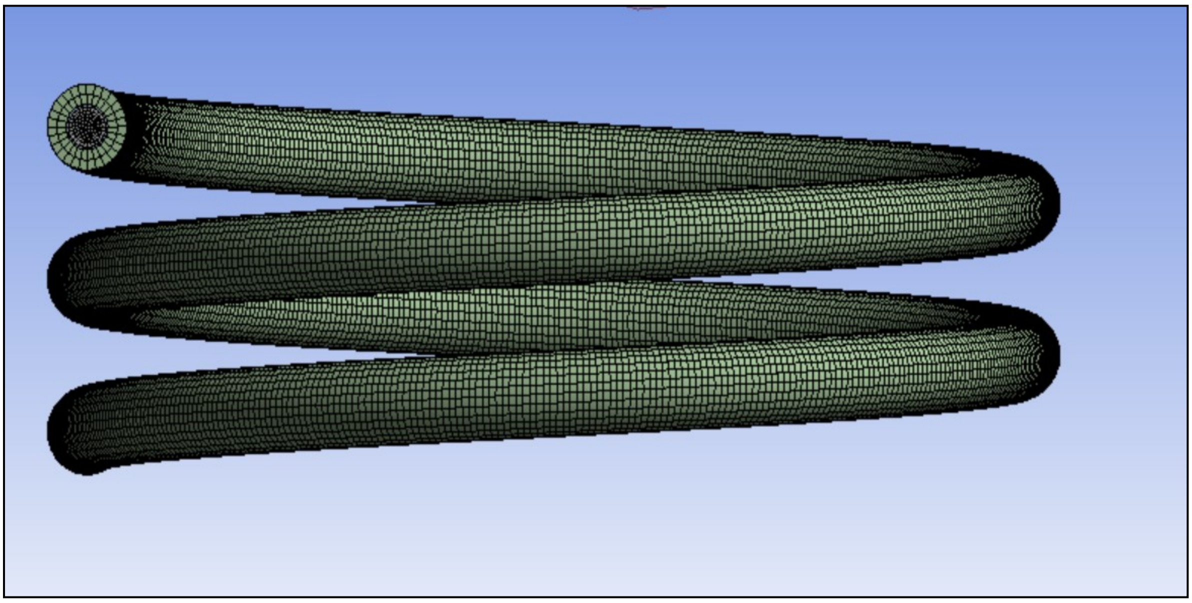

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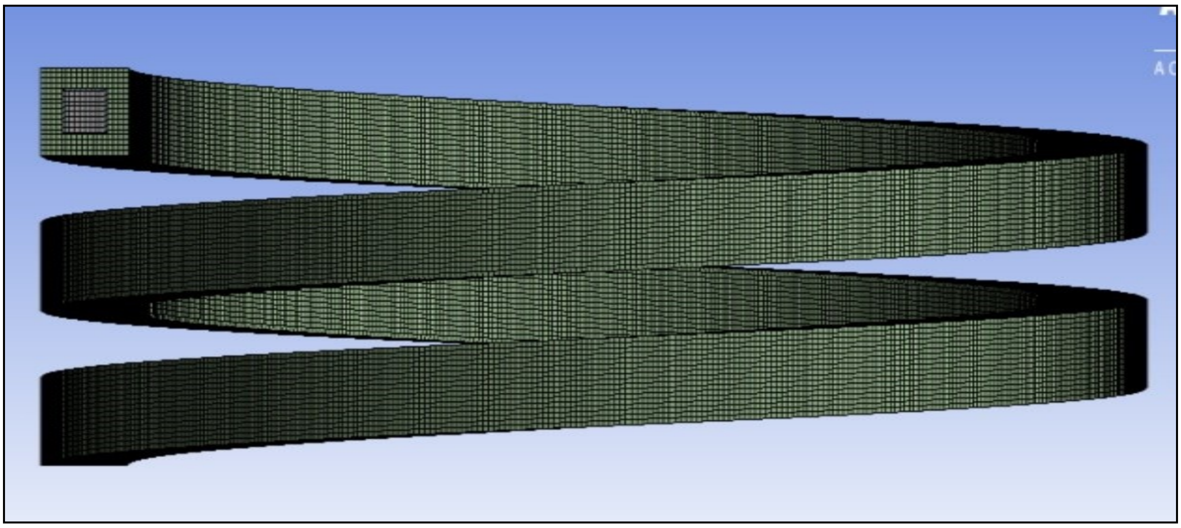
Fig.1 *Mesh Model for circular HCHE*

Fig.2 *Mesh Model for square HCHE*

Solver Details:

The governing equations are used are as a continuity equation, energy equation, and momentum equations. And the k-epsilon model as the flow is turbulent. Pressure velocity coupling is done using the COUPLED algorithm. Second-order upwind algorithm for pressure and momentum discretization of these equations while first-order upwind for turbulent kinetic energy and turbulent dissipation rate. For energy second-order upwind algorithm is used. The convergence criteria are 10^{-5} for continuity, velocity, k, and epsilon, and that for energy is10^{-8}.



IV. Results and Discussion

In the present CFD investigation, the results are obtained at various curvature ratio, velocity of hot flowing fluid and outer wall boundary conditions. The simulations are validated by comparing the results of friction factor for the flow through the helical coil with the numerical and experimental work done by the researchers.

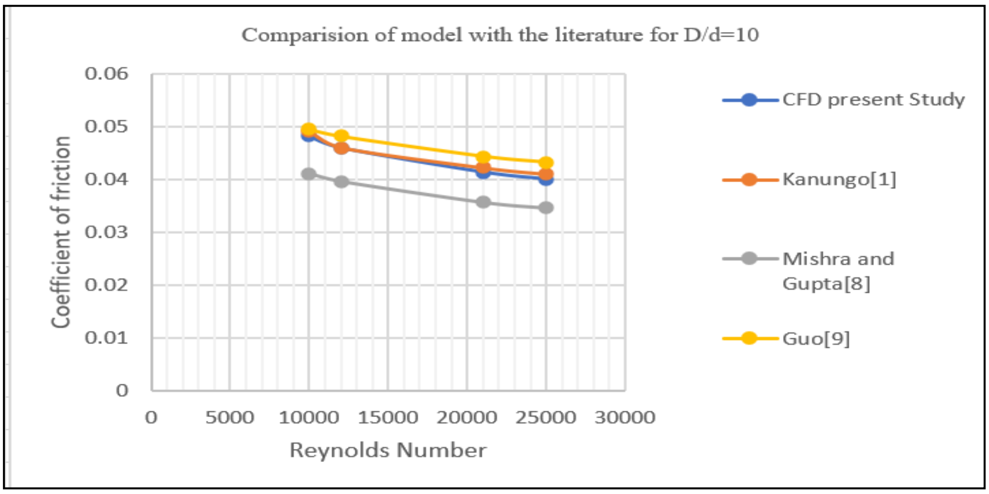


Fig.3 *Comparison of present results with the literature results*

Fig-3 shows that the comparison between the present CFD study and the Numerical work done by Kanungo [1] and experimental work done by Mishra and Gupta [8], Guo [9] for the case of an insulated outer wall for curvature ratio as 0.1. The points almost lie in the range of data points as proposed by the researchers. Thus, we can say that present numerical scheme is validated with that in literatures. To study the heat transfer characteristics of a double pipe helical coil square shape heat exchanger it is necessary to understand what is the effect of the outer boundary condition of the thermal properties of the flowing fluid. In this paper to study its effect, four outer wall boundary conditions as constant heat flux (60000W/m^2), constant wall temperature (330K), insulated condition(q=0W/m^2), and outer convective heat transfer coefficient of 4000W/m^{2}K [1] are considered.

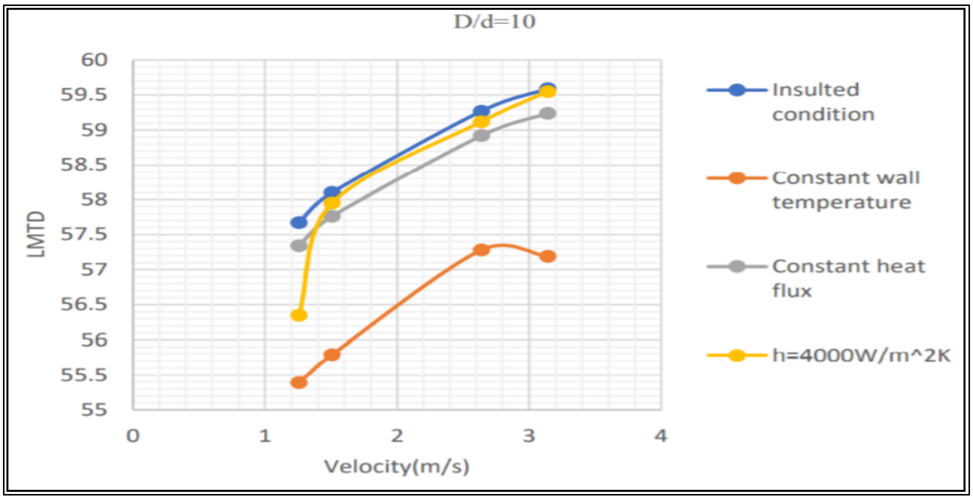


Fig.4 *Variation of LMTD with velocity for D/d=10 (Square section)*

Fig 4, 5, 6 and 7 shows the variation of LMTD with the velocity of the fluid flowing in the inner tube for four different boundary conditions and curvature ratios 0.1, 0.06, 0.05 and 0.04 respectively. In this paper, the thermal property considered is temperature. The values of LMTD are calculated by varying the velocity of inner fluid while the mass flow rate of outer flowing fluid in the outer tube is kept constant. The results show that the insulated boundary condition gives the maximum value of LMTD while constant wall temperature has the lowest value among given boundary conditions. The maximum value of LMTD is 59.59 for the D/d ratio as 10 with inner

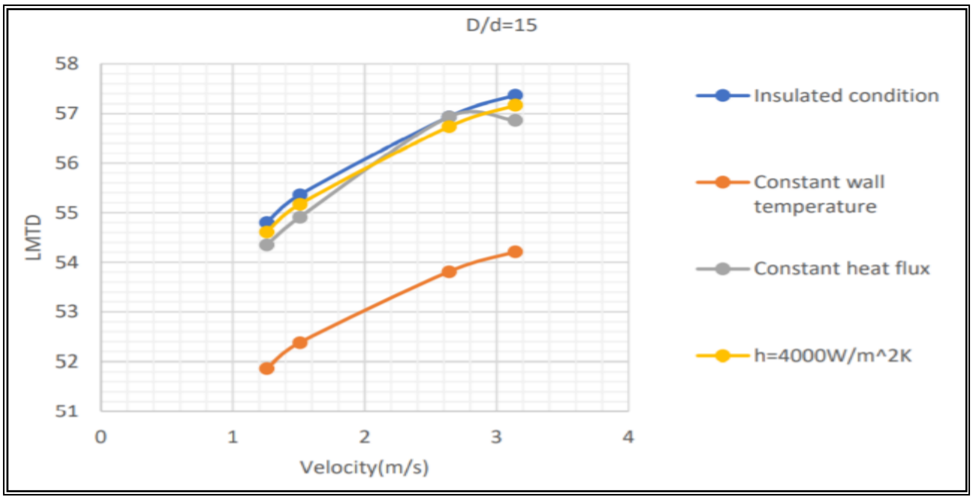


Fig.5 *Variation of LMTD with velocity for D/d=15 (Square section)*

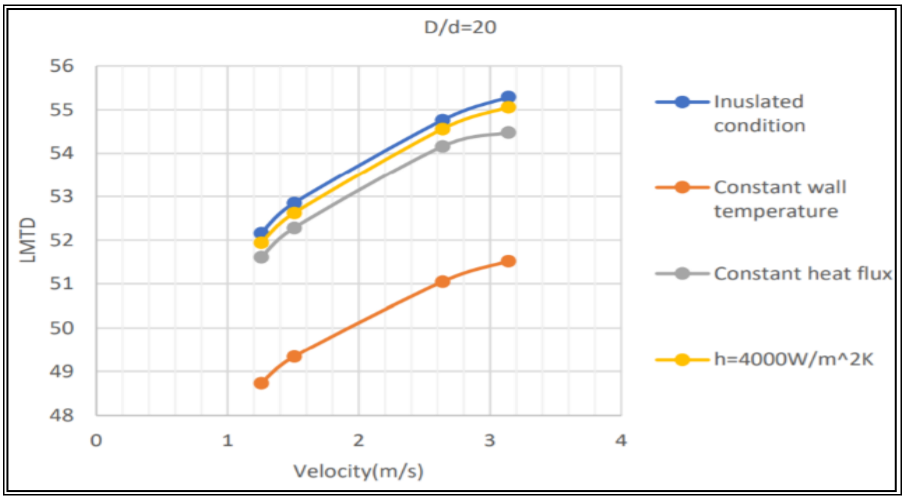


Fig.6 *Variation of LMTD with velocity for D/d=20 (Square section)*

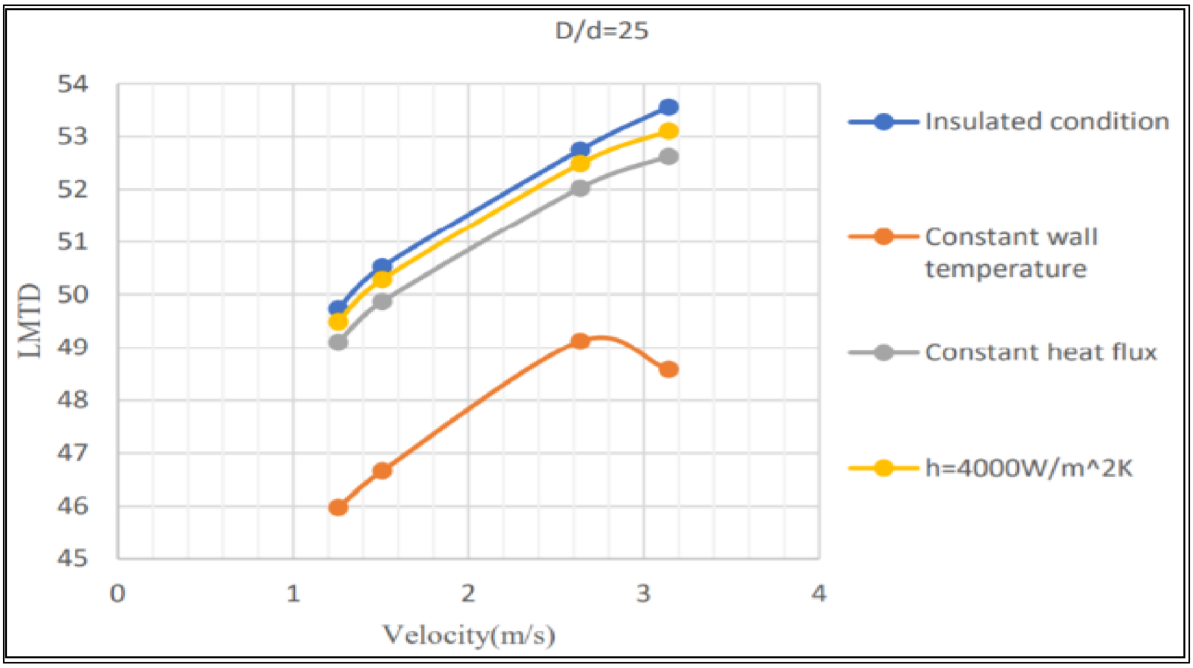


Fig.7 *Variation of LMTD with velocity for D/d=25 (Square section)*

fluid velocity as 3.14002m/s. For the curved pipes and channels, the Non-dimensional Dean number and the Colburn factor plays an important role in the flow and heat transfer characteristics. So, it is necessary to find an optimum value of curvature ratio by using these two non-dimensional parameters for the case of constant heat flux and constant wall temperature condition.[1].

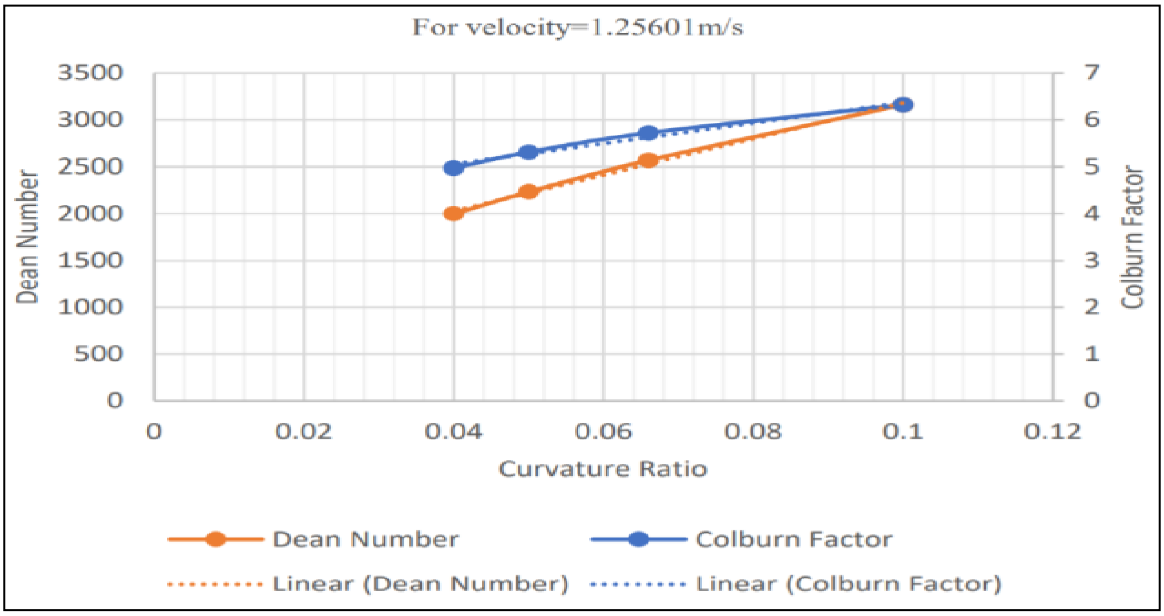


Fig.8 *Optimum Value for Curvature Ratio for constant heat flux (Square section)*

Fig 8 shows the variation of Dean number and Colburn factor with the curvature ratio for the velocity of 1.25601m/s for constant heat flux boundary condition. As seen from Fig. 8 for both circular and a squares section with increase in curvature ratio the dean number is increases. While Colburn factor is the dimensional less quantity which is the product of Stanton number and Prandtl number is also increases. If the dean number is increases which causes a pair of dean vortices to be stable which indicates primary dynamic stability. So, to avoid such condition there is a need to find out the optimum value for the curvature ratio. For the circular section, the optimum value of curvature ratio for the inner fluid velocity of 1.25601m/s is 0.073 and that for the square section it is 0.093 for constant heat flux condition. Similarly, the optimum value for curvature ratio is found for circular as well as a square section for the case of constant wall temperature.

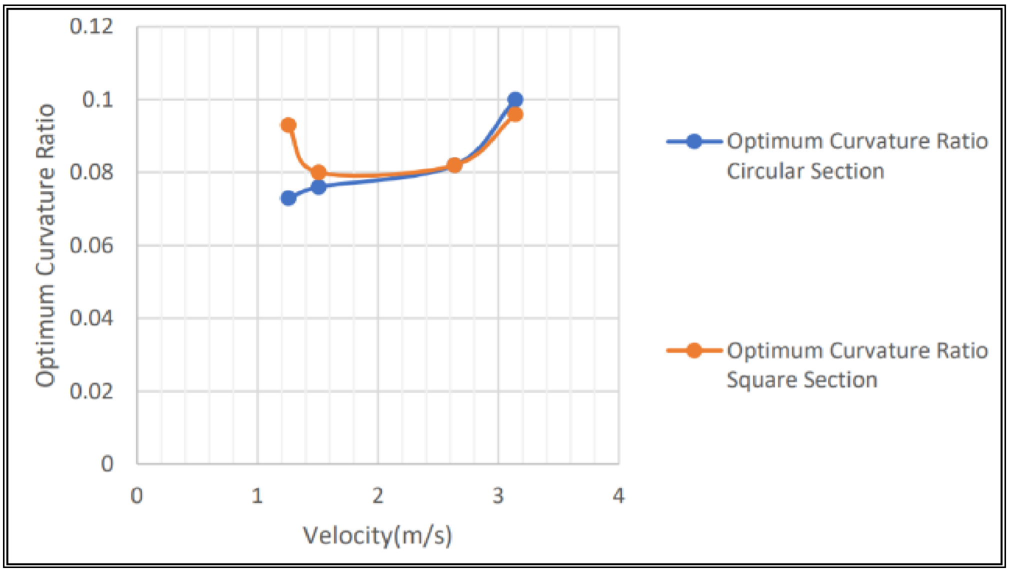


Fig.9 Variation of optimum Value for Curvature Ratio with velocity for constant heat flux

Fig 9 shows the variation of the optimum value of curvature ratio with the velocity of hot fluid flowing inside the inner tube for both sections for the case of constant heat flux condition. The optimum value of curvature ratio for both circular and square section increases with an increase in velocity of fluid flowing inside the inner tube. The maximum value of the optimum curvature ratio for circular and square section is 0.1 and 0.096 for constant heat flux and that for constant wall temperature is 0.104 and 0.108. The Fig. 10 is for variation of optimum curvature ratio with a velocity of hot flowing inside the inner tube for constant wall temperature.

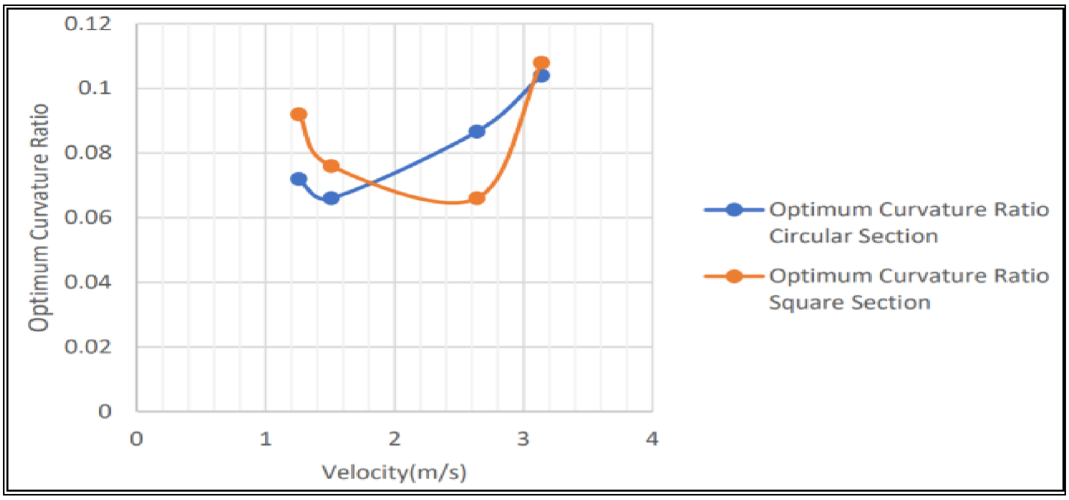


Fig.10 *Variation of optimum Value for Curvature Ratio with velocity for constant wall temperature*

Not only the velocity of flowing fluid but also the curvature ratio plays an important role in designing the helical coil heat exchanger. As curvature ratio increases correspondingly the value of dean number increases which increases in the of pressure drop as seen from fig 11. Also, if the velocity of flowing hot fluid increases which increases in value of Nusselt number but correspondingly the value of pressure drop is also increased. An increase in pressure drop causes an increase in pumping power which increases of cost of the system which is not acceptable. So, there is a need to find the optimum value of Reynolds number at which we get the maximum Nusselt number with minimum pumping power which reduces the overall cost of the system. The intersection of the lines on the graph is the optimum value of Reynolds which gives a high heat transfer rate for minimum pumping power.

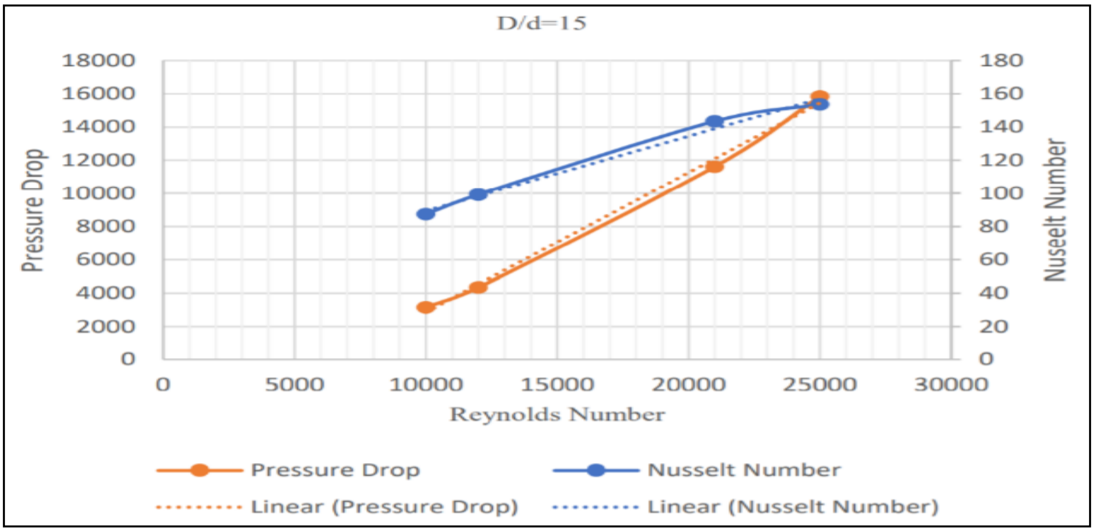


Fig.11 Optimum Value for Reynolds Number for constant heat flux (Square section)

Fig 11 shows the variation of Nusselt Number and Pressure drop with Reynolds number for D/d=15 for the case of constant heat flux condition. Similarly, for the circular and square section for the case of constant wall temperature is also studied. The maximum value of optimum Reynolds number for the circular section is 27100 for the D/d ratio as 20 for the square section is 25000 for D/d ratio as 10 and 25.

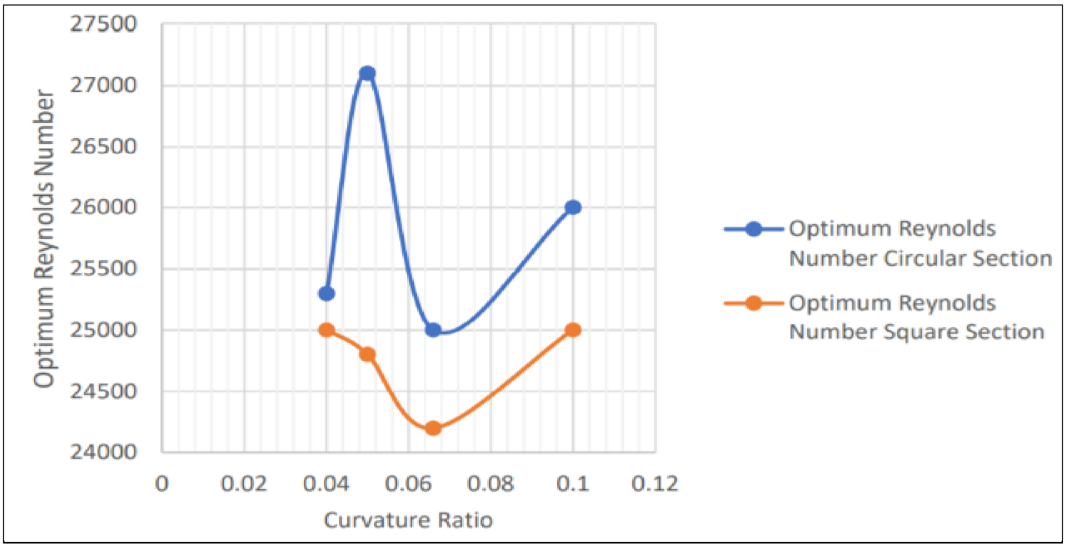


Fig.12 *Variation of Optimum Reynolds number with curvature ratio (Constant heat flux)*

Fig 12 shows the variation of the optimum value of Reynolds number with the curvature ratio for the circular and square section for the constant heat flux condition. The nature of the plot is the same for both the cross-section. Depending upon the application shape can be chosen. Similarly, for constant wall temperature is shown in fig 13.

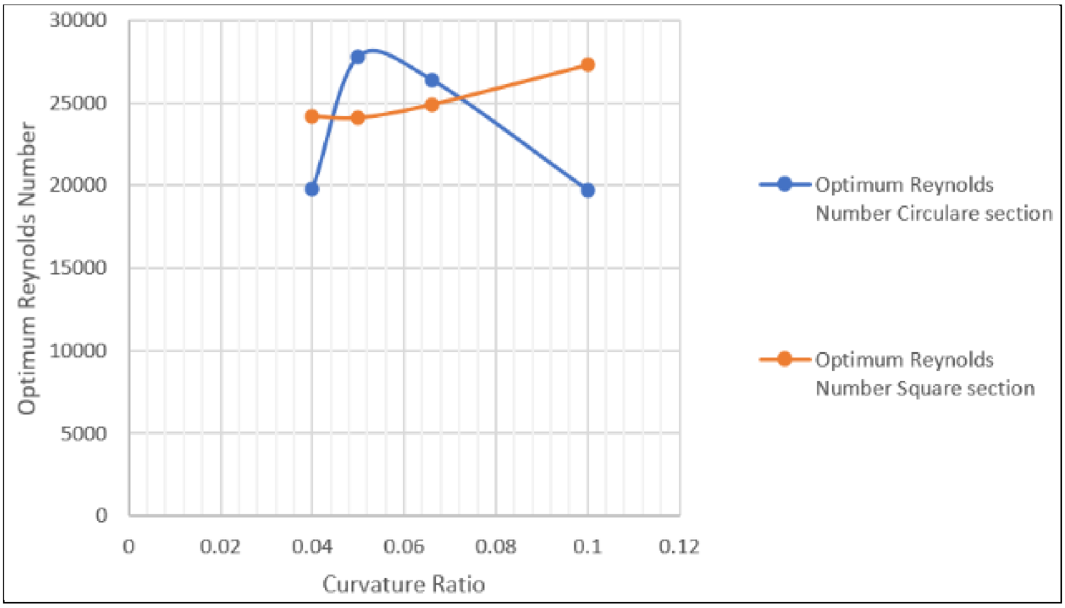


Fig.13 *Variation of Optimum Reynolds number with curvature ratio (Constant wall temperature)*

The maximum value of the optimum value of Reynolds number for the circular and square sections is 27800 and 27300 for D/d ratio as 20 and 10 respectively for constant wall temperature. Like inner flowing fluid velocity, some geometrical parameters affect the heat transfer characteristics of a double pipe helical coil heat exchanger. So, it is necessary to study the geometric parameters like the pitch of the coil, tube diameter, number of turns, and the length of the helical pipe. In this study, the effect of the pitch of the coil on the Nusselt number that is heat transfer characteristics of the helical coil heat exchanger is studied. The velocity of inner flowing hot fluid is kept constant and the pitch of the coil is varied by keeping the number of turns as 2. The height of the helical coil changes according to the pitch of the coil. The curvature ratio is 0.1 and pitch value varied is 20mm, 30mm, 40mm, and 50mm.

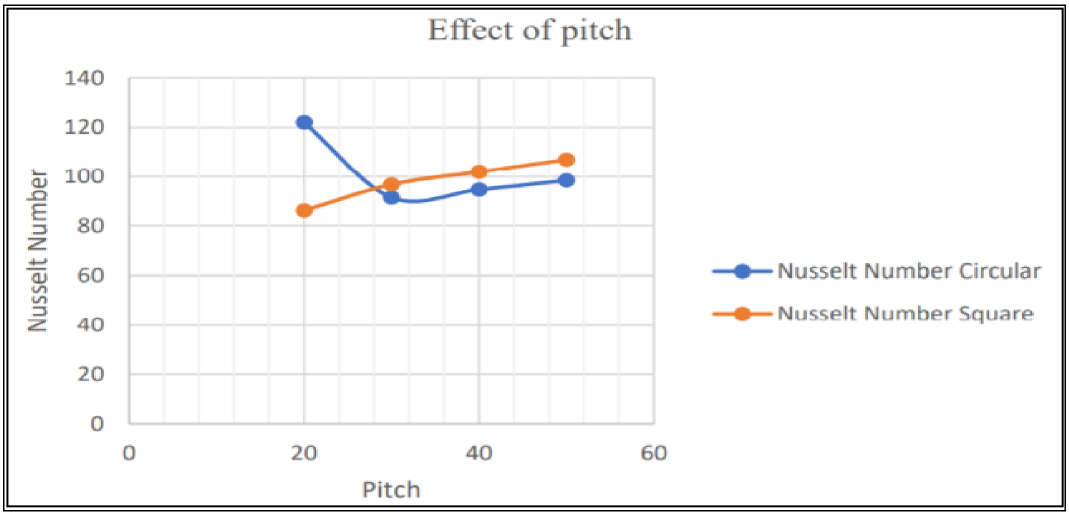


Fig. 14 *Effect of pitch on Nusselt Number*

The Fig 14 shows the variation of Nusselt Number with the pitch of the helical coil. As the length of the coil is directly proportional to both pitch and number of turns. If the pitch increase by keeping the height of the helical tube constant the length of the helical tube coil is decreased. The above fig 14. is drawn at inner fluid flowing velocity as 1.25601m/s and keeping the curvature ratio as 0.1 for both circular and a square section for constant heat flux condition. As the length of the helical coil decreases the corresponding value of the heat transfer coefficient is decreased. So correspondingly the value of Nusselt Number decreases as shown in fig 14.

Fig. 15 shows the temperature counter for a velocity of flowing hot fluid as 1.25601m/s for the case of constant heat flux 60000W/m^{2}K with curvature ratio as 0.1.

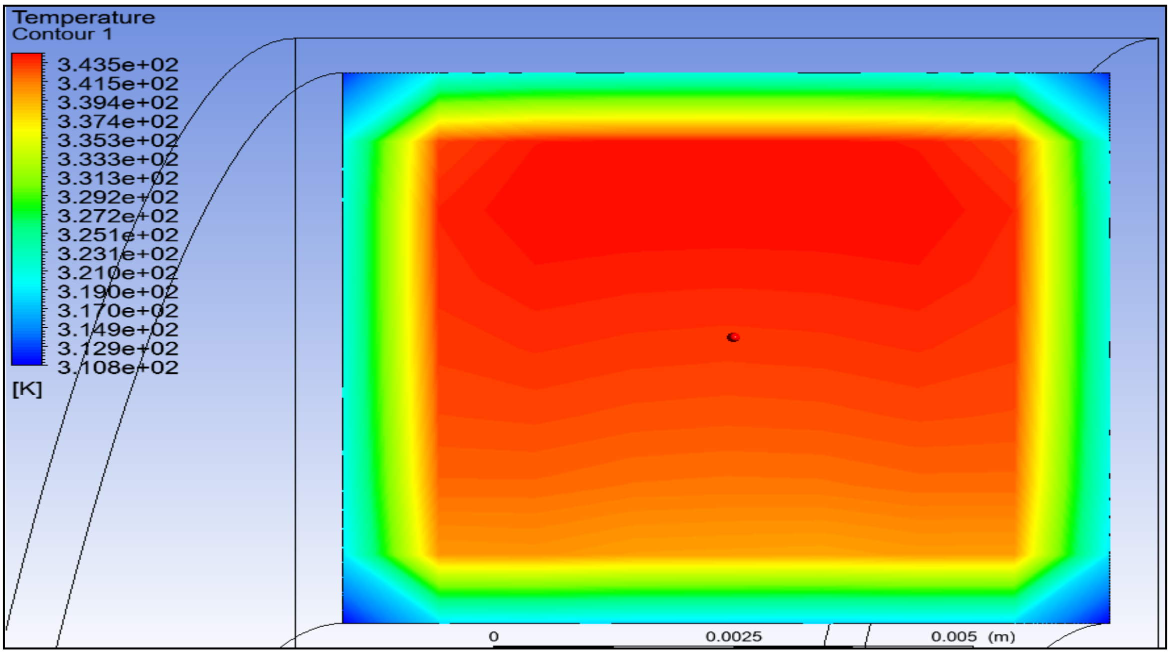


Fig. 15 *Temperature counter for D/d=10 for V=1.25601m/s for hot outlet*

Similarly, the temperature of hot fluid outlet for constant heat flux and for various D/d ratio and for the various velocity of inner hot fluid is shown in the table 3,

Table. 3 *Hot fluid outlet temperature for various D/d ratio and velocities (Constant heat flux)*

D/d	Velocity of Hot Fluid(m/s)	Max. Hot Outlet Temperature
10	1.25601	343.5
15	1.25601	338.9
20	1.25601	334.7
25	1.25601	331
10	1.5072	344.4
15	1.5072	340.1

20	1.5072	336.2
25	1.5072	332.6
10	2.6376	347
15	2.6376	343.7
20	2.6376	340.6
25	2.6376	337.7
10	3.14002	347.7
15	3.14002	344.7
20	3.14002	341.9
25	3.14002	339.2

From the table 3 it has been seen that with an increase in velocity for constant D/d ratio the outlet temperature of hot fluid increases. Because an increase in velocity of hot flowing fluid the time available for heat transfer is decreased. In this study the mass flow rate of the cold fluid is kept constant while, the velocity of hot flowing fluid is varied so, hot fluid flow past the inner tube with high velocity and not find enough time to transfer heat to cold fluid. The outlet temperature of hot fluid for D/d=10 is more as compared to others for the same velocity. Similar nature is observed for both cross-sections for the case of constant wall temperature. The pressure distribution for curvature ratio 0.1 and for velocity of hot flowing fluid 1.25601m/s for the case of constant heat flux condition is shown in fig. 16

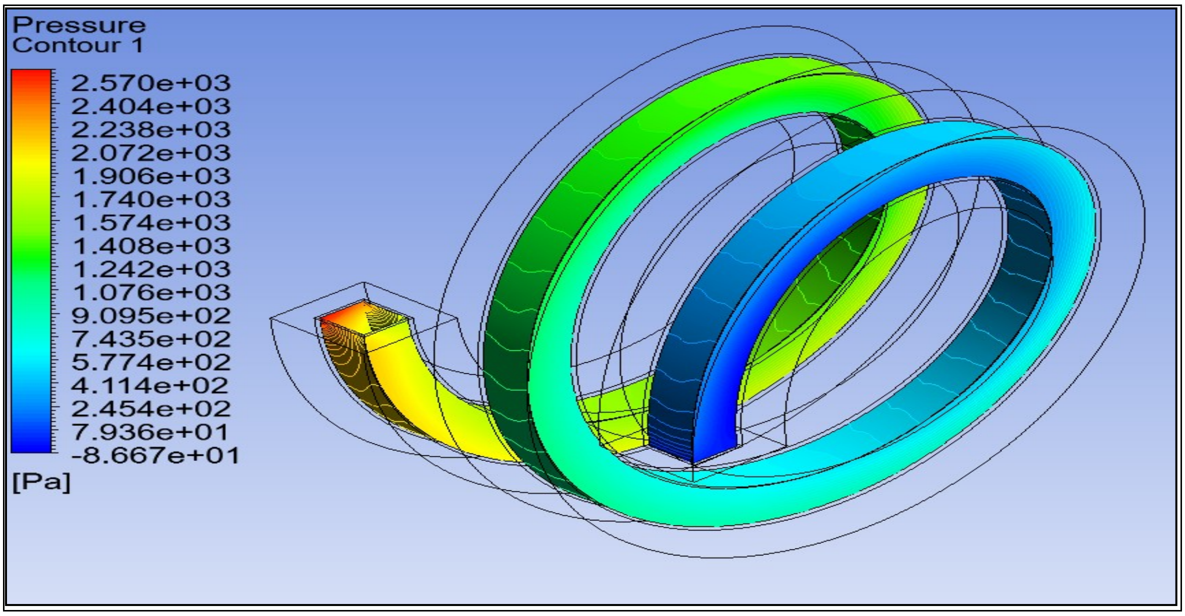


Fig. 16 *Pressure variation D/=10 for V=1.25601m/s (Constant heat flux)*

Table.4 *Pressure Drop for various D/d ratio and velocities (Constant heat flux)*

D/d	Velocity of hot fluid(m/s)	Pressure Drop
10	1.25601	2652.76
15	1.25601	3154.04
20	1.25601	3791.17
25	1.25601	4475.54
10	1.5072	3660.58
15	1.5072	4336.12
20	1.5072	5204.99
25	1.5072	6141.1
10	2.6376	9849.31
15	2.6376	11617.4
20	2.6376	13879.2
25	2.6376	16399.6
10	3.14002	13599.1
15	3.14002	15833.1
20	3.14002	18883.6
25	3.14002	22213.6

Table.4 shows that the variation of pressure Drop for different D/d ratio and velocity of flowing hot fluid. With an increase in velocity of hot fluid the pressure Drop increases. When the flow is more turbulent more energy is lost due to the conversion of pressure energy to kinetic energy. With an increase in D/d ratio pressure loss increases because increase in D/d ratio the length of pipe increases and with an increase in length losses are more. Similar nature is to observe for the circular sections and both sections for constant wall temperature.

V. Conclusion

Numerical simulation has been carried out for tube in tube helical coil heat exchanger with coil shape as both circular and a square section for the various boundary conditions. Boundary conditions used was constant heat flux, constant wall temperature, insulated wall and wall applied with heat transfer coefficient of 4000 W/m2K. Curvature ratio, LMTD, Friction factor, Pressure drop parameters are are studied. It can be seen from the LMTD results the insulated boundary condition gives the highest heat transfer while; the constant wall temperature condition gives the minimum heat transfer among given boundary conditions. In present investigation the optimum curvature ratio is found for various velocities of inner fluid for constant heat flux and constant wall temperature outer wall conditions. It is found that for both of these conditions the optimum value of the curvature ratio for circular as well as square section first decreases and then increases with an increase in velocity of inner fluid. It can also be concluded from present study that with an increase in the pitch of the helical coil by keeping the height of the helical coil tube constant, heat transfer increases

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USER AUTHENTICATION AND CRYPTOGRAPHY USING BRAIN SIGNALS – A SYSTEMATIC REVIEW

Vaibhavi Lakhani, Vraj Baxi
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Department of Computer Engineering
G H Patel College of Engg. & Tech.
Gujarat Technological University
vaibhavilakhani1999@gmail.com

Abstract

Human brain cells communicate with each other through electrical impulses and this electric field is measured by an electroencephalogram (EEG). These signals are individually unique and non-trivial to collect and henceforth it has emerged as a powerful and most reliable amongst the other biometrics due to its profoundly unique nature, which makes it impracticable to steal or mimic. The brain waves or signals can be utilized as biometric authentication to provide a secure and robust data exchange. In this paper, analyzing the active portions and the various states of the human brain to generate the cryptographic keys from brainwave signals are reviewed to provide better security to the data. This review also facilitates the user-authenticating ability of an EEG-based person authentication (EBPA) system when clients are in a variety of brain states during performing mental tasks to login.

Keywords: EEG; Brain Wave Signals; Authentication; Cryptography; Crypto-biometric System; Biometric System

I. Introduction

The interaction between humans and computers is at the periphery of a great leap forward with direct contact via a brain interface. Brain-based Computer Interface (BCI) is a fast-growing, emerging technology with applications in Virtual Reality, health tracking, medicine, mobile cloud computing, and robotic control. One of the major topics in this field is to ensure security and privacy when humans and machines are communicating digitally with brain signals. Brain-computer interface (BCI) and brain-machine interface (BMI) systems are systems that "*give their users communication and control channels that do not depend on the brain's normal output channels of peripheral nerves and muscle.*" [1].

BCI technology helps its users to communicate without physical force but through brain movements with computerised controls [2]. Personal privacy and security issues need to be highly valued when attempting to interact with a brain interface. Therefore, continuous authentication and on-demand authentication in the field of biometrics are proposed. Brain-computer interfaces can be classified into three main groups: Non-Invasive, Semi-Invasive, and Invasive Invasive [3]. In invasive techniques, special devices have to be used to capture data (brain signals), these devices are inserted directly into the human brain by a critical surgery [4, 5]. In Semi-invasive, devices are inserted into the skull on the top of the human brain. In general, non-invasive are considered the safest and low-cost types of devices [4, 5]. However, these devices can only capture "weaker" human brain signals due to the obstruction of the skull. The detection of brain signals is achieved through electrodes placed on the scalp [3, 4, 5].

There arenumerous ways to develop a non-invasive brain-computer interface referred to as neuroimaging [6], such as EEG (electroencephalography), MEG (magnetoencephalography), or MRT (magnetic resonance tomography). An EEG-based brain-computer interface is the most preferred type of BCI for studying. EEG signals are processed and decoded in control signals, which a computer or a robotic device comprehends readily [6]. The processing and decoding operation is one of the several complicated phases of building a good-quality BCI [6-7]. EEG along with BCI allows a person to control external devices or the neuroprosthetic applications (it helps disabled patients to control prosthetic limbs by thinking about the movements).

This paper is divided into several sections: Section 1 is the introduction; Section 2 describes the study related to types of brainwaves; Section 3 comprises the description of EEG and analysis of its data collection; Section 4, we understand the method of user authentication followed by biometric cryptography in section 5, while Section 6 explains the benefits and drawbacks of the crypto-biometric systems that are discussed extensively in this review; Section 7 concludes this paper followed by references.

III. Understanding the Brain

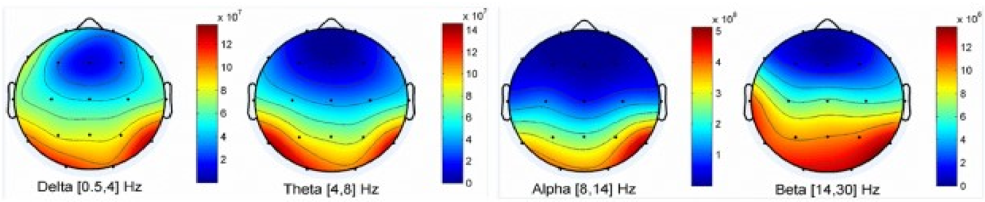
1. Different Types of Brainwaves

Brainwaves are generated by synchronized electrical pulses from masses of neurons communicating with each other. Brainwaves are detected using sensors placed on the scalp. These electrical activities vary on what a person is doing. There is much difference between the brainwaves of a sleeping person with the brainwave of a person is wide awake. The mental state of a person can be examined by observing a brainwave pattern [9].

For extreme anxious people produces high beta waves, while a person who has ADD/ADHD produces slow alpha/theta waves. According to [9], the bands of frequencies are the ones responsible for defining each rhythmic activity and are divided as follows:

- Delta: (0.2Hz-3Hz) refers to deep dreamless sleep
- Theta: (3Hz-8Hz) represents the light sleep and extreme relaxation.
- Alpha: (8Hz-12Hz) refers to an awake person but relaxed.
- Beta: (12Hz-27Hz) refers to the wide awake.
- Gamma: (27Hz-higher) represents a high level of focus and concentration in the individual.

On the another hand, the mental state of the object plays an essential role in defining the frequency, which leads to giving a wave classification that is highly related to the state of mind of the subject [9]. An example of a human brain electrical scan can be found in Figure 1 [11] where the image illustrates the more active parts of the brain in red for different waves (clockwise starting from top left: Delta, Theta, Beta, and Alpha) [11].



III. Analysis

Figure 1: *Brain electrical activity by wave type [11].*

2. EEG Analysis

Electroencephalogram (EEG) records the brain's electrical activity by measuring the voltage fluctuations on the scalp surface with the simple placement of the electrodes on the skin [14]. Those signals can be influenced by mood, stress, and mental state of the individual [6] which makes them very difficult to be obtained under force and threat. Besides, brain signals are related to the subject's genetic information, making them unique for every individual and stable over time [15]. Hence, brain signals are more reliable and secure and have been proposed as an identification and authentication biometric [16].

EEG-based identification and authentication have been examined often and these preliminary works have demonstrated that the EEG brainwave signals could be used for individual identification and authentication. There are two main approaches used for the analysis of EEG data; these approaches define when and how the data should be analyzed. First is *Event-related Potential Based Technique.* In short, event-related potentials (ERPs) are neural activities that occur as results of stimuli, responses, or decisions. In general, ERPs are used to study neural activities as a response to various stimuli, both physical and mental, and are investigated in many different research fields [12]. Second is *Resting State-Based Technique.* A resting-state EEG recording is a recording obtained when using a device to monitor someone's brain when he/she is not reacting to any kind of stimuli, and it is usually acquired when the subject is not moving or thinking of anything in particular [13].

3. Data Collection and Analysis

The EEG dataset used in this study of [2] was gathered at Pace University. The experiments were conducted with 32 volunteers ranged in ages between 20 and 35, and had a college degree. 13 of the participants were female and 19 were male. All of the participants had normal or corrected to normal vision. Over 70% were daily consumers of caffeine; either from coffee or black/green tea. Before the experiments, participants were required to have a good sleep the night before (at least 5 hours). The average amount of sleep was 7.14 hours.

The EEG signals were measured using 8-channel EEG sensors and 2 Cyton board reference sensors to receive the data. The EEG sensors were placed at the Fp1, Fp2, C3 , C4, Cz, Pz, O1, and O2 channels. The measurement data were measured at 200Hz for a 60-second resting state with eyes closed for 30 seconds, then eyes opened for 30 seconds. A 2-minute length video was started after the resting period. The streaming of EEG data was captured using the OpenBCI GUI application. After data streaming ends, a text file is often created containing float (converted from analogue signals) 8-channel data along with millisecond (ms) timestamps [2].

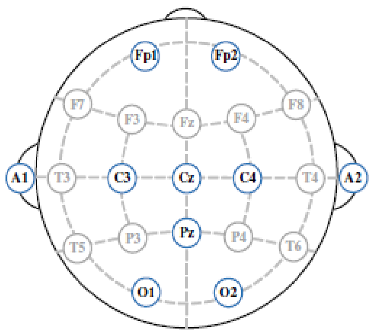


Figure 2: *Chosen Electrodes Locations on OpenBCI Headset [2]*

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IV. User Authentication

1. Authentication Model

The brain biometric authentication system typically has two parts: the data acquisition part and the decision part. Fig. 3 [2] illustrates the general approach of an authentic brain biometric system. In the data acquisition stage, EEG sensors capture brain electrical activity, while the user engages with some protocols, such as resting, pass-thought, visual stimulation, or imagery. Data are transferred for digitization and decision-making; this can occur wirelessly or with wired sensors. Once the data are digitized, the decision-making stage begins. The first step in decision-making often involves signal preprocessing to enhance signal quality [26]. Then various computational features are extracted. When the feature set has been determined and confirmed, the biometric computations are performed. These may be simple statistical analyses or more complex machine learning approaches (e.g., Neural Network [NN], Support Vector Machine [SVM]). When the system is performing authentication, its output will be a binary acceptance/rejection [26].

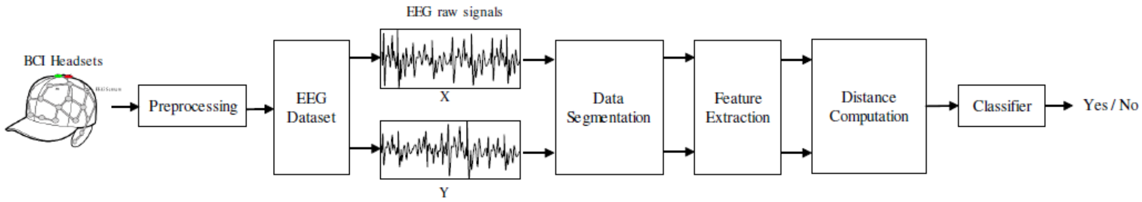

Figure 3: *EEG authentication model [2].*

2. Authentication

Today, multiple companies have a dataset containing some biometrics, which is used to track an employee's work hours and prevent unauthorized people from entering the company's premises. A good biometric for authentication should minimally achieve the following requirements [17]: Universality, Distinctiveness, Permanence, Collectability, Acceptability, Performance, and Anti-circumvention.

Table 1 is a shorter version of a table presented in Jain Ross and Prabhakar [17], which presents a comparison of different biometric identifiers based on the requirements listed above. [18] added “Cost” because the price affects the popularity of the biometric. “L” means several hundred dollars, “M” means several thousand dollars, and “H” is over $10,000 (“NA” means that to the best of our knowledge, there is no such system available) [18].

Using EEG signals for authentication purposes provides distinctive benefits such as requiring the clients to be alive when recording, being unintrusive and impossible to mimic [19] As a result, an EEG-based person authentication (EBPA) system includes merits of both password-based and biometric-based ones but excludes their disadvantages. Due to those interests, a variety of EEG modalities, different features, and classification algorithms have been proposed [20]. [21] proposes an EBPA system in different brain states as illustrated in Figure 4 in order to speculate on how different affective states impact on this system. In the enrolment phase, each user’s brain-wave is elicited by stimuli when that user is in a variety of brain states, namely like, dislike, familiar, and unfamiliar.

EEG data corresponding to those experienced states are first processed and then features are extracted. These features are then utilized to train the models for that user.
During the verification phase, EEG signals corresponding with different brain states of each user are recorded, processed, and features are extracted similarly to the enrolment phase. Then the extracted features are provided to the classifier as different testing datasets to calculate matching scores. Based on those scores, the system decides to accept the true client or reject the imposter. This decision is used to evaluate the influence of various human affective states on the performance

of an EBPA system.

Similar to like and dislike brain states, the longer epoch data are used, the lower EER value the authentication system can obtain with the unknown affective state. The performance of an EBPA system is judged by Decision Error Trade-off (DET) curve, in which the x-axis presents False Rejection Rate (FRR) and False Acceptance Rate (FAR) is shown on y-axis [21]. When the system has multiple DET curves corresponding with different brain states, the value at the point where FAR and FRR are equal, so-called Equal Error Rate (EER), is used to manage the smaller EER value or the lower DET curve, both meaning a better system.
The data of the three typical sub-bands, namely alpha (4-12Hz), beta(12-30Hz), and gamma (30-45Hz) were filtered, extracted features, and then separately fed into the classifier.

Identifier	Universality	Distinctiveness	Permanence	Collectability	Performance	Acceptability	Anti-Circumvention	Static/ Dynamic	Cost [ab]
Ear	M	M	H	M	M	H	M	S	L
Face	H	L	M	H	M	H	L	S	M
Finger-print	M	H	H	M	H	M	M	S	L
Hand geometry	M	M	M	M	M	M	M	S	L
Iris	H	H	H	M	H	L	H	S	L
Voice	M	L	L	M	L	H	L	D	L
DNA	H	H	H	L	H	L	H	S	NA
Retina	H	H	H	M	H	L	H	S	L
Mouse move-ment	L	M	L	H	M	H	H	D	NA
Hand-writing	L	M	L	L	M	H	H	D	NA
Key-stroke dynamics	M	M	L	H	M	M	H	D	L
Brain-waves	H	M	L	M	H	M	H	S/D	NA

Table 1: *A* Comparison of Biometric Identifiers (L/M/H) [18]

Gui et al[16] proposed a general framework for EEG- Based User authentication. They used a single noise channel for noise reduction by ensemble averaging and low pass filter. Wavelet packet decomposition was used for feature extraction and then a neural network was adopted for classification. Four different scenarios were discussed to emulate different cases in the authentication. The SCENARIO I of identifying all the 32 subjects had the worst accuracy ranging from 5.75% to 10.68%. The hidden layer of 25 neurons had the best accuracy and increasing the neurons did not help improve the performance. SCENARIO II using the side-by-side method showed better performance at identifying all the 32 subjects. The accuracy for 32 sub-models varied from 28.71% to 36.27% and 40 neurons got the highest accuracy of 36.27%. When using fewer neurons, the accuracy decreased to about 31% to 33%. SCENARIO III was the case of identifying one specific person from others. The hidden layer of 45 neurons had the best average accuracy of 94.04%. Increasing or decreasing the neuron number did not change the accuracy too much. SCENARIO IV was testing the case of identifying a small group of individuals from others. The 496 cases were to identify the specific 2 persons from the other remaining 30 subjects. With 20 neurons in a hidden layer, the accuracy was the highest of 90.03%. The minimum accuracy was 70.06% and the maximum is 99.2%. They concluded that the side-by-side method improved the performance of identifying all the subjects as mentioned in Fig. 6. Due to the improvement in the training datasets, the classification rates reached about 33% and 47% and was about 5 times the accuracies of identifying all the 32 subjects.

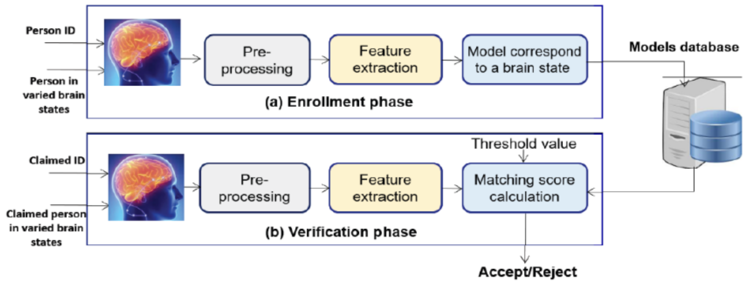

Figure 4: *exhibits the performance of the authentication system in different brain states for each brain wave band [21].*

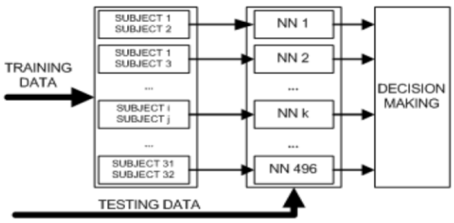

Figure 6: *General Structure of Side-by-Side Method [16]*

V. Cryptography

1. Cryptography Model

To perform key generation some sort of tasks are given to the sender and analyzing the brain signal based on input tasks. After analyzing the brain waves finds out dominant waves generate binary value equivalent. At the receiver side, the same activity will be used for checking analyses of brain waves which is passes to the signal to the binary converter and produces a key. That key will be used for decrypting the ciphertext. So none other than the sender can retrieve the secret information [9]. This cryptographic scheme will be applicable when any confidential data stored in the central database can be secured using a brain signal as a biometric. In the novel approach [9] fig 7(a) entitles about the security of saving cryptographic keys by using the key binding technique with the help of brain waves generated from neuron actions in the brain.

After binding key with brain signals which will be stored as a secured template. The secured template will be further analyzed for the verification phase. In verification phase inputting brain waves and features are extracted from the input opposite of key binding called key releasing will happen reproduces the correct key if the inputting brain wave will be valid, otherwise error key will appear and it will cause an error while the decryption process. Fig 7 (b) [9] represents a biometric key generation from brain waves of different mental activities of the same person. In this approach initially, brain signals are captured using sensors then it is given to the feature extraction stage. Here relevant features are extracted and those extracted features were responsible for the generation of brain biometric key [9].

In terms of computer science and information security, cryptography is usually associated with the process of making plaintext (ordinary processable data) into ciphertext (encrypted unreadable data) and vice versa. Several methods of generating, binding, and storing private keys using biometrics have been developed. These cryptosystems are called crypto-biometric systems [22]. The first example of an EEG-based cryptosystem was created in 2007 [23]. It used an EEG scan performed with 61 electrodes to generate a 61 bit key to randomize a Huffman tree, which was then used to encrypt the data. The recording was done while the subject was focusing on a picture containing black and white stripes. This experiment was conducted with 10 subjects, and 40 EEG scans were extracted at various times. The true positive (correct decryption by the genuine subject) rate was 82.05–100%, and the true negative rate (correct decryption by the impostor subjects—not the one whose scan was used for encrypting the image) was lower than 27.22%, but the most important feature of this encryption is that each EEG recording is one second long. For encryption key generation, recorded signal is converted into filtered signal and the energy is computed from the signal which is normalised for further use.

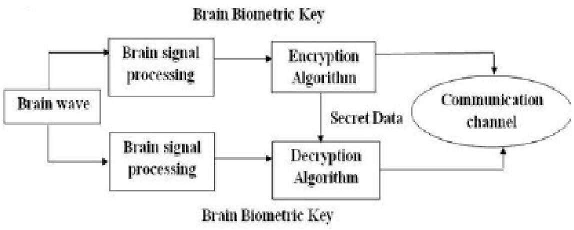

Figure 7(a): *Key binding using brain waves [9].*

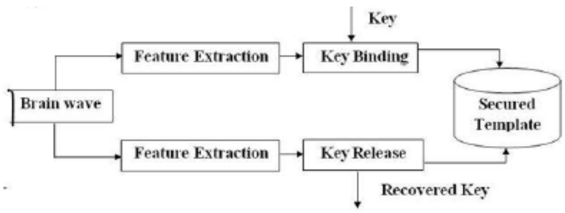

Figure 7(b): *Biometric key generation from brain waves [9].*

Bajwa and Dantu [24] suggested a key generation method using EEG scans for user authentication and encryption, but they didn't conduct an encrypting experiment. They also showed promising results, using a single key for both authentication and cryptography, and provided a discussion about the trade-offs between accuracy and complexity.

Tuiri et al [25] proposed two symmetric cryptographic algorithms that are considered to fulfill the unique biometric sequence. They used two key generation techniques such as Diffie-Hellman based key exchange and AES based key generation scheme. The system applied SVM as a classifier for accuracy and ability to separate the classes using the concept of hyperplane separation to the data, mapping the predictors onto a new, higher-dimensional space in which they can be distributed linearly. False Acceptance Rate (FAR): is the measure of the likelihood that the Neuro key system will incorrectly accept the derived key from an unauthorized user. False Rejection Rate (FRR): is the ratio of the number of times the Euro key system will incorrectly reject the derived key of a genuine user to the total attempts. As for increasing the accuracy and decreasing the amount of data to work on, a spectra based electrode selection is performed for each subject. In subject classification measurements, the F-measures and the ROC res are calculated using Support Vector Machine and Bayesian Network; the experiment has achieved an accuracy of 97.5% for the SVM classifier, and 95.6% for the Bayesian Network. The Diffie-Hellman exchange generated key has given an HTER (half total error rate) mean rate of 3.4% averaged over the subjects and the electrodes. As for the AES base biometric crypto-key, the rate was higher, 4.1% for the same activities.

VI. Benefits and Drawbacks

Crypto-biometric systems have several unique advantages as compared to other conventional biometric systems used today. First of all, to able to produce EEG signals, one has to be alive and in a conscious state. However, biometrics such as DNA, fingerprints, face can be preserved after several hours of death. Secondly, electrical brain operations are taken into account by calculating the voltages that decrease significantly over the distance. Hence, the electrodes must either be on or near the consumer to calculate the voltage. So, the key password created by the user cannot, therefore, be used without user awareness. Thirdly, EEG signals are very sensitive to the state of mind mentioned in the above-discussed sections. Therefore, any attempt of oppression that could trigger the user into discomfort will invalidate the crypto-biometric. Finally, a consumer cannot reveal a biometric feature unless they are not aware of it. Thus, high-precision identification with the non-volatile EEG feature can be achieved. These crypto-biometrics, given many such advantages mentioned above, have the potential to be used for authentication and security.

Despite the many proponents, these are still not commonly accepted because extensive research still needs to be carried out. As the brain is continuously active, many background signals of interest may superimpose each other when the neurons are responding to a variety of tasks. So, the difficulty may arise in finding the location of the origination of these response signals. Also, as the signals generated are weak on the scalp hence the acquisition of EEG signals is very sensitive to endogenous and exogenous noise. Hence a much detailed understanding of frequency localization, optimal sensor location depending on employed acquisition protocol, and discriminative information are required. They may also pose some drawbacks in user acceptability in which there are some worries related to "mind-reading" and emotional analysis by the data controller. This may make the user uncomfortable. While using EEG biometrics, the target response from the brain needs to be outlined by using specific protocols. A major limitation of the EEG signal is when people wear a gaming headset that uses EEG. In this scenario, if an individual is performing a bank transaction and the hackers may monitor the bank password, then the money can be credited into the hacker's account. Thus, while Brain signal based authentication has many benefits, the utmost care should always be taken to stay safe from various potential attacks. Furthermore, one of the most important limitations is the user inconvenience when a number of electrodes are placed on the scalp of the user. Hence minimization of the number of electrodes is a critical factor to be considered for user convenience.

VII. Conclusion

In this paper, we presented a survey of brain biometrics, which possess some unique characteristics and advantages over conventional biometrics and thus have gained increasing attention in the community. Initially, we learned the essential knowledge about the brain and how it emulates the electric signals that can be used in various areas. After then, we also examined the different states of the human brain that can affect and influence the behavior of the frequencies and biometric cryptosystems. Furthermore, we learned a brief description of the EEG and its related data collection and analysis. Moreover, there is a profound account of the user authentication models and methods to make the system robust for data transmission. We progressed through many literary works and studied the results for better support. In the following section, we learned about the cryptography of brainwave signals using different techniques such as AES, DES, Huffman tree, etc. Further, there is an overview of the bio-cryptographic system which leads to an easy understanding of the security through brainwave signals. Overall, in the aforementioned review, we examined all the aspects needed for developing a crypto-biometric system for user authentication and security of the data.

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GEO-TAGGING OF AGRICULTURAL PRODUCTS USING MOBILE APPLICATION IN REMOTE AREAS

Rushi Sheth, Keyur Brahmbhatt

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Information Technology Department, Birla Vishvakarma Mahavidyalaya
rushisheth98@gmail.com

Abstract

Geo-Tagging is a popular term in the market nowadays. Be it a blog post or a status update on social media, things are getting geotagged. If a person adds a new post on social media giants like Instagram, Facebook, Snapchat he enjoys features like adding location to the post which is an instance of Geo-Tagging. Geo-Tagging substantially means adding crucial geographical information like longitude, latitude, altitude to the metadata of photos, video files, audio, etc. In a country like India where agriculture accounts for about quarter of GDP and employs about 50% of Indian work force, the concept of geotagging can fulfill wide range of objectives. Various laboratories in India carry out a timely test on agriculture products to ensure quality, nutrition efficiency and pesticide residues, hence sample collectors go for collecting different agriculture products. However, to verify whether the samples are collected from the same place as claimed or not is quite difficult. In this paper one such solution is proposed which can be used by laboratories to carry out sample collection by capturing picture of sample in a mobile application, fetching latitude and longitude in background to geotag each sample, hence maintaining the authenticity of the sample.

Keywords: Geo-tagging, Mobile Application, GPS, Agriculture

I. Introduction

Laboratories carry out Agricultural products testing in order to ensure the quality of products and decide whether they are suitable for consumption or not. To avoid frauds and malpractices verification of collected sample[1] is of utmost necessity. Whether the samples originated from the same place as it is claimed or not, any malpractices were performed while sample collection, all these things have to be checked before test are conducted on samples in laboratories. These samples could have been collected from farmers or local vegetable vendors. Testing of this sample is much important as it stands for how well the hygiene standards and quality of agricultural product is maintained. But what if the sample was not collected from the place as it is been claimed, it would lead to big compromise of whole procedure. The current practice followed by the sample collector is where they manually enter data of the samples in register and on the other hand they click pictures of samples in geo tagging devices. Due to this practice, they have to maintain separate data sheets for samples taken as well as their photos and manually link them while entering data on software. While, the solution suggested in this paper would change scenario of sample collection, as

[1] Sample- Agricultural Product

there would be no need of manual entry in register and once the entry is done digitally in mobile application, data would be automatically uploaded to the server upon sync without need of any manual entry on the server DB.

This paper suggests preparing a mobile application which would help capture photos of these Agricultural samples, fetch latitude and longitude in order to geotag these photos of samples collected. The data of sample collected would be stored in local database i.e. SQLite[2] as samples are also to be collected from rural and remote areas of the country where there is poor internet connectivity. From regions with such poor network connectivity, sample collectors would be unable to send data, hence this application would take care of that problem by making use of local database like SQLite. When the network connectivity would be available, the sample collector would be able to send data or sync data to the server with one tap on mobile screen.

II. Literature Survey

Since last decade a trend of geotagging photos, blogpost has been quite popular among social media users. But there is a lot more to the concept of geotagging which techno geeks are realizing with the time passing. Geotagging has made its way to the classrooms, where its increasing importance for student field work is quite noticeable [1]. Students are being taught history with geotagged photos. In the recent happening, officials in COVID'19 war room of India used geotagging app called 'Sahyog' which helped them identify the entry and exit points of containment zone, so that they can carry forward necessary procedures [11]. This instance clearly demonstrates the potential of Geo-tagging technique and its wide range of applications. Data analyzers have used the geotag data in order to generate heat maps and gather further inferences from it regarding user pattern and behavior [3][4][6]. Tourist behavior has also been under the observation for their response to geotag data on social media, which led researchers to identify and categorize hotspots for tourist [5]. In 2017, Ministry of Agriculture had signed a MoU with the ISRO under Rashtriya Krishi Vikas Yojna for geotagging of agricultural assets which would lead to better land management, inventory management, claim settlement and verification, soil quality check after natural calamities [8]. Prime Minister Modi himself emphasized on the need for online recording and monitoring of assets to check leakages. This MoU has somewhat shifted the focus on a point that Geotagging might play an important role in agriculture sector for asset management and the solution proposed in this paper fulfills that expectation. Under the scheme of MPRNL i.e. 'Monitoring of Pesticide Residues at National Level' 31 laboratories all over India has been assigned with a herculean task of sample analysis from different parts of India to carry out analyses of pesticide residues. A total of 1,81,656 samples were collected within a span of 10 years to undergo the analysis, out of which 2.1% were above MRL[3] as prescribed under Food Safety Standard Authority of India (FSSAI), Ministry of Health and Family welfare [10]. The volume of sample collected under MPRNL Scheme and the objective of the scheme clearly signifies need of a geo-tagging application for collection of agricultural products from remote areas. Some applications have been made in past for observation on agricultural land system i.e. ALS but they served different objective than the problem identified here [2]. In Philippines, under rural development project funded by World Bank, they are using geotagging to effectively supervise, manage and monitor numerous of infrastructure projects [9].

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[2] SQLite – a type of Relational Database Management System
[3] MRL – Maximum Residue Limit

"The beauty of geo-tagging is that one does not have to be an engineer to learn it. Anyone can learn the ropes"

Arnel de Mesa

Engineer and Deputy Program Director, Rural

III. Solution Development

The solution includes development of a geo-tagging application in cross platform framework flutter in order to complete the desired purpose. An ASMX .net Web Service or any other Rest API[4] could be developed in order to send the data to the server from local device, once the network connectivity is available. Data could be sent in JSON format and JSON serialize class can be used in order to enter data into the server database.

A. Modules of Application

There are four main modules proposed for the application to be developed, in order to geotag photos of samples collected.

- Data Entry- This module would be used for entering data of different agricultural products i.e. samples for instance, maize, wheat, cauliflower, ladyfingers collected from farmer or local vendor, by the sample collectors. The data and details of the sample inserted by the sample collector would be stored in local database (SQLite). In this module the sample collector would be able to enter detailed description of samples for instance, pesticides details, certification details etc. When there would be network availability, sample collector would able to send data to central server through sync module. Data Entry could be further divided into three sub modules:
    - Farm- For adding data of samples collected from farms.
    - Market- For adding data of samples collected from markets from local vendors.
    - Party[5] Registration- For registering new farmers and vendors. Each sample collected would be registered against a particular farmer. Here contact number of party would be used as a primary key in order to avoid duplicate entry of the farmer/vendor.
- View Entries – Sample Collectors would able to view entries of samples and parties they have registered. They would also be able to delete entries before data is sync with the server. They would also be able to see the sync status for the particular entry.

- Sync - This module would enable the sample collector to send data on the server when the network connectivity is available. The sample collector would able to send data of party i.e. farmer or vendor registered by him. He would be able to upload data of samples collected by him along with its photos. This module would also have functionality of party master

[4] API – used to define interactions between multiple software intermediaries
[5] Party- Farmer or Vendor

sync which would enable sample collector to sync the data of party with the central server, hence a party when registered by another user, sample collector would get the data for same.

- Registration - Sample collectors would be able to register themselves with the help of this module. Every entry in the database of the sample would be done under the User Id of the sample collector in order to avoid malpractice. Application active users would only have access to this application in order to perform geo-tagging i.e. only authorized persons would be able to do data entry of the samples in this application.

B. Plugin[6]

Various plugins are used in flutter application in order to enhance the capabilities of the application, these plugins are important part of flutter eco system. Few such plugins which can be used for above application are as follows:

- GeoLocator (Flutter Plugin) – This plugin is used to get the location data of the device through different methods defined in this particular package.
- SQLite- This plugin is used in flutter in order to maintain local database and perform dB operations like insert, update, delete. It also supports transactions and batches.
- Camera- This plugin is published by flutter developers and has features like live preview of camera widget, capturing snapshots and saving it to files, it also adds access to the image stream from dart and record video.
- path_provider – This plugin is used to locate any file, directory on the file system of local device. In order to access DB file this plugin would be useful, it would also help store image files of samples when registered.

IV. Implementation and Results

I. Dashboard

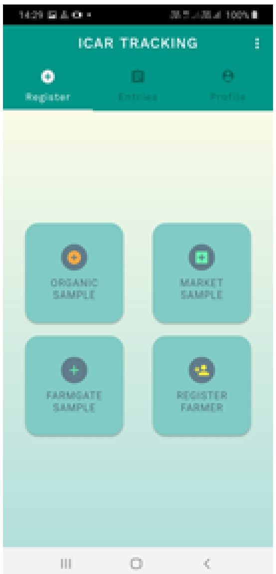

Figure 23: Dashboard

Figure 1 demonstrates the Dashboard of the application which would be used by the sample collector in order to make different type of entries. He would be able to navigate to different entry forms to enter relevant data regarding samples collected.

[6] Plugin- Used to perform Functions like native apps in flutter

II. Entries

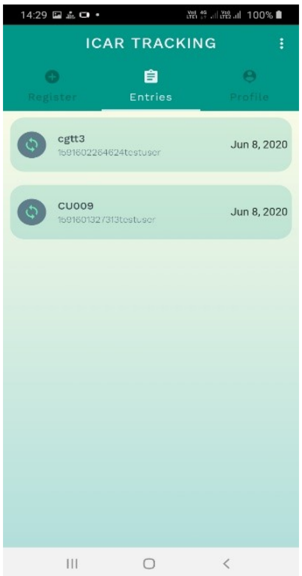

Figure 24: View Entries

Figure 2 reflects how entries can be viewed in the application once sample data is added. The sync icon on the left of each entry denotes that the data pertaining to this particular sample has already been synced with the server. The date on the right reflects on which date the sample was registered for testing.

III. Profile

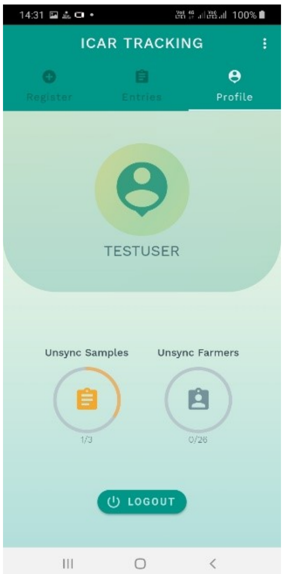

Figure 25: Profile

Figure 3 shows profile screen where sample collector would be able to know about number of unsync samples and unsync farmers. With the help of this data he would know whether the data was uploaded or the sync failed to perform in background.

IV. Party Registration Form

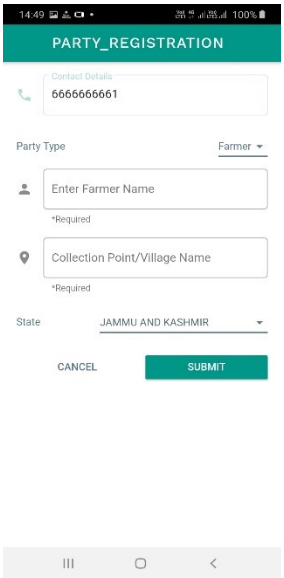

Figure 26: Party Registration Form

Fig. 4 demonstrates party register form and how data would be entered by the sample collectors where contact details for each party is kept unique in order to avoid duplication of data and maintain consistency.

V. Future Scope and Limitation

This solution has wide **scope** in future which can cover numerous of objectives in agriculture and other field.

- On the basis of geographical data, Farmer can be suggested what nutrients are needed by his crop based on the topography of the land. Amount of water required by the soil for the nourishment of the crops. Hence, farmer module can be included in future to this application for their guidance.
- This solution can also help in geo fencing of field in future in order to identify agricultural land in one's possession. This would help in different government schemes as accurate data of the land and area of land would be known to the Government.
- Recently MoU[7] was sign between Ministry of Agriculture and Nation Remote Sensing Center of ISRO[8] under Rashtriya Krishi Vikas Yojana for geo-tagging of agricultural assets. Government would use the same for land management and verification of claims in case of crop damage etc. This would help promote transparency in data regarding agricultural assets [8].
- Inventory management of Agricultural Goods would become easy by using the above solution with slight modifications. Bulk data could be easily sorted rather than keeping manual records in registers.
- Soil Health assessment could be carried out easily with this kind of application in future at times of natural calamities.

The only **limitation** of the proposed solution is that the mobile would require a SIM card in order to get the GPS location i.e. latitude and longitude, for performing geo-tagging.

[7] MoU-Memorandum of Understanding
[8] ISR0 – Indian Space Research Organization

VI. Conclusion

In a nutshell, the proposed solution of geotagging agricultural products using mobile application clearly seems to be a better alternative than the current practice followed by sample collectors of manual entry in registers. Geotagging of samples would also help in avoiding mal practices and would maintain the authenticity of the sample collected. As the data after digital entry would get sync to central server on one tap at screen, lots of time and manual work could be saved. Analytics of sample data would be easily available as the data would get sync on the central server. In a country like India, where, Agriculture accounts for 17-18% of GDP employing about more than 50% of Indian work force, this solution seems quite viable [7]. On the other hand, this solution is not limited to this particular problem, but as mentioned above it might be handful in tackling other agricultural issues.

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AN ANALYSIS OF DIFFERENT COMPUTER SCIENCE ALGORITHMS WITH THE GRAPH THEORY OF MATHEMATICS

Prof. Jayna Donga[1], Prof. Priyank Bhojak[2], Prof. Kanu Patel[3], Dr.Vatsal Shah[4]
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[1] MBIT, [2,3,4] BVM Engineering college, Gujarat.
jdonga@mbict.ac.in

Abstract

The field of mathematics plays an important role in different domains.one of the important concept of mathematics is the Graph theory which is most commonly used in area of computer science to design computer algorithms. The well-known problem in mathematics which represents graph theory is the Travelling salesman problem. The travelling sales man problem is the problem in graph theory needs to find optimal path (i.e. minimum total distance) to traverse all the cities with the constraint to returning back to the initial state (city). There is no general solutions available to solve this problem but there is similarity between the travelling sales man problem and minimum spanning tree.so, this problem can be implemented with the help of minimum spanning tree which also focus on finding minimum distance for each nodes with the constraint of not to form any cycle. In this paper we have presented few computer science algorithms which are implemented using graph theory of mathematics and also tried to analyze their differences and applications.

Keywords: Graph, Computer Science, Algorithm, Graph Theory, Shortest Path, Minimum spanning Tree

I. Introduction

The Theory of graphs is a sub branch of discrete mathematics. Graph Theory analyzes are named graph theories and are mathematical structures used to describe the pairly relationship between various artifacts. The graph theory is used in several applications of research and technology. To model the relationship of various classes between any physical scenarios, the Graph is an essential tool. The graph is used to represent several real world issues.in short, the vast utilization of graphs in computer science algorithms to provide the problem solutions because it provides an effective idea prior to implementing it on real platform. [2][3].

The problems can be divided into two categories:
1) Classical Problems 2) Application Problems.
Using graph theory, the traditional problems are described as connectivity, routes, streams, color and empirical studies of graph drawing [3].the application problems mainly focuses on experimental research and to implement technical algorithms with the help of graph theory.

Graph theory history:[1]
In 1735, the Graph theory is formed by the Swiss mathematician L. Euler which is based on the issue of Konigsberg. In the European continent, a small town located is Konigsberg.in the Konigsberg, there were a big river and there were two deltas. Euler had studied the issue of Konigsberg Bridge and constructed a graph structure to solve the problem which is known as the Eulerian graph as shown in figure-1(b).

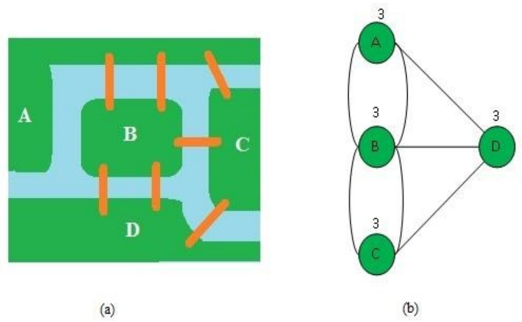


Figure-1: a) Konigsberg Bridge b) Konigsberg Bridge representation in graph [1]

Evolution of Graph Theory
Throughout the year 1840 A.F. Mobius introduced the Compete Graph concept and the Bipartite Graph concept. Kuratowski has shown complete graph and bipartite graphic recreational problems. In 1845, Gutsav Kirchhoff embraced the idea of a tree, a connected graph without cycles and also introduced the theoretical graphic ideas such as how to calculate current in electrical networks or circuits. Thomas Guthrie had presented the well-known four-color problem in 1852, while after a century Kenneth Appel and Wolfgang Haken had proved this. Thomas, In 1856. P. Kirkman and William R. Hamilton introduced polyhedral analysis of the intervals.In 1913, a puzzling problem was presented by H. Dudeney.

Basic Terminology [4]
Before going to analyse applications of graph theory in computer algorithms let us understand the basic terms related to graph theory.

Graph: A Graph G can be represented as an ordered sequence of (V, E), where V(G) signifies the set of vertices and E(G) signifies the edges connecting a pair of vertices.

Undirected Graph: In an undirected graph, the edges have no directions attached to them.it means that if an edge between vertices A and B can be crossed from both sides, such as A to B or B to A. Refer undirected graph in figure-2 (b).

Directed Graph: In a Directed graph G as per Figure-2 (a), The edges create a pair of ordered vertices. If node 1 to node 2 is an edge, then there is a direction from 1 to 2 but not from 2 to 1.

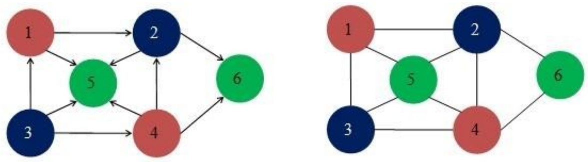
Chromatic number: The chromatic number of a graph G is the minimum number of colors needed to color all the vertices of a graph G.

Adjacency matrix: An adjacency matrix is used to represent graphs in sequential form into computer memory.an adjacency matrix indicates weather two nodes are adjacent or not that is they are called adjacent if there is an edge connecting them. As an example of adjacency matrix refer Figure-2.

The Degree of a vertex: in undirected graph, the degree of a vertex A, deg(A) indicates the total number of edges connected with that node A. If deg(A) =0 that means A does not belongs to any edge and such node is called isolated node. In directed graph the node is having In-degree and Out-degree. The In-degree of a vertex A, represented indeg(A) which is the number of edges that entering to A. The Out-degree of a vertex A, represented outdeg(A) which is the number of edges that originate at A. The degree of a vertex is shown in figure-2.

Sub Graph: The subsection of graph G (V, E) Which is represented by G′ (V′, E′) is called the Sub graph of Figure-3(c) shows the example of Sub graph.

Vertex coloring: The nodes of graph G are colored in such a way so that no two adjacent nodes of G having the same color is called the vertex coloring of graph G.



(a) (b)

(a)

V = {1, 2, 3, 4, 5, 6}
E ={(1,2) (1,5) (2,5)(2,6)(3,1)(3,4)(3,5)(4,2)(4,5)(4,6)}

Degree:

Vertex	In-Degree	Out-degree
1	1	2
2	2	2
3	0	3
4	1	3
5	4	0
6	2	0

Adjacency matrix

-	1	2	3	4	5	6
1	0	0	0	0	1	0
2	1	0	0	0	1	1
3	1	0	0	1	1	0
4	0	0	0	0	1	1
5	0	0	0	0	0	0
6	0	0	0	0	0	0

(b)

V = {1, 2, 3, 4, 5, 6}
E ={(1,2) (1,3) (1,5)(2,4)(2,5)(2,6)(3,5)(4,5)(4,6)}

Vertex	Degree
1	3
2	4
3	3
4	4
5	4
6	2

-	1	2	3	4	5	6
1	0	1	1	0	1	0
2	1	0	0	1	1	1
3	1	0	0	1	1	0
4	0	1	1	0	1	1
5	1	1	1	1	0	0
6	0	1	0	1	0	0

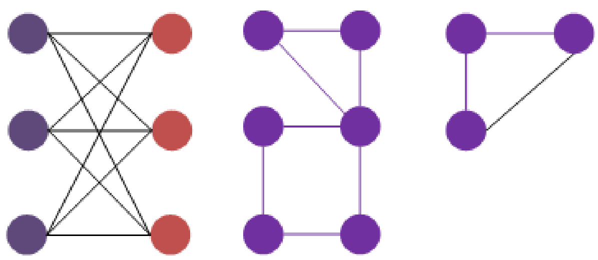
Figure-2: a) Directed graph with a number of vertices and edges, the degree of vertex and adjacency matrix.

b) Undirected graph with of vertices and edges, degree of vertex and adjacency matrix [1]

Isomorphic graph: There are two graph G and H are called isomorphic graph if they construct different forms with the same number of vertices and edges.

Tree: The connected graph G without any cycle is known as Tree T.

Bipartite/Bigraph graph: as shown in figure-3(a), In the Bipartite graph the set of vertices divided into two disjoint sets in such a way so that no two nodes within the same set are adjacent.



(a) (b) (c)

Figure3. a) Bipartite graph b) graph c) subgraph [1]

Spanning Tree: A Spanning tree of a connected, undirected graph G is the subset of G (V, E) which is a tree that connects all the vertices together without forming any cycle.

Applications of Graph Theory in Various Domains

In general, the overwhelming usage of Graph Theory can be used for simulation applications in different fields of information and technology. This is important in chemistry for the study of compounds, bond formation, and atom review. For Biology and activities safeguarding, the principle of graphs is used if a node refers to areas where other forms occur and the edges equate with the way of action. The numbers taken are very significant to the impact of action that impacts various animals by having a gander to foster instances or delegate the propagation of illness, pests and may consider. The graph theory is often commonly used in activity science, examples of which are like the problem of traveling salesman, the shortest spanning tree in a weighted matrix, obtaining an ideal job and people match and discovering the briefest path between two vertices in a circle. This is also helpful to explain communication networks, operation networks and game theory in the same way. The preparation and coordination of large complex tasks is a very well established and productive use of the networks in organizational analysis [4]. Likewise we have shown various applications of graph theory in various fields in figure-4.

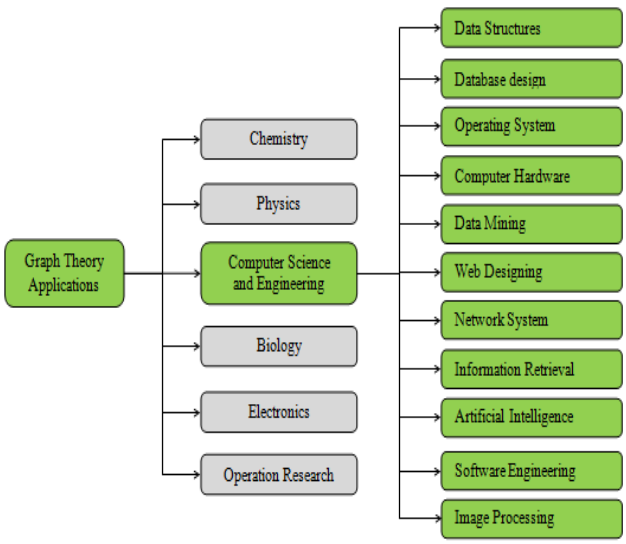


Figure- 4. Graph theory applications in various fields [1]

Applications of Graph Theory in Computer Science

DataStructure: Data structure are nothing but logical organization of real-world data into particular structure.it may be either linear data structure or non-linear data structure. There are some important algorithms to arrange data in non-linear structures are represented by graph. The examples of this is the algorithms like Breadth-first-search, Depth-first-search, shortest path algorithms and minimum spanning tree algorithms which is implemented by graph theory.

Database Design:

The database designing is also done by graphs. [6].Graph database represented using vertices, edges and attributes to represent and store the data. The Graph construct pays vary crucial role in the database designing as gives fast process implementation using different functions and properties.

Image processing:

The information extraction from an image is done by various image analysis approaches and it is done by digital image processing methods. We can use graph theory approaches to enhance these image processing techniques. The segmentation, filtering, Classification and clustering are the graph-based approaches in image processing [10].

Computer Hardware:

The limits of the physical layer can be represented using graph theory concepts [6].a) Register distribution is done by graph colouring technique b) The sequence of instructions can be represented by Adjacency matrix. c) To process instructions simultaneously d) Allocation of process scheduling.

Artificial Intelligence:

In artificial intelligence, the graph theory can be used to solve all kind of problems which are using backward and forward chaining techniques of artificial intelligence. Using the graph theory, one may solve almost all the motion problems in artificial intelligence [11].

Data Mining:

In datamining, the graph theory is used in graph mining which presents relational parts of data. The graph based data mining includes subgraphs, subgraph isomorphism, graph variants, mining measures and solution methods. The datamining models that is represented using graph theory having the capability to catch auxiliary data in writing though they will not consider the semantic relations amongst the words [8].

Software Engineering:

The graph theory is also useful in software engineering as an example of it is during software requirements specification (SRS) the data flow diagrams are used where vertices are transformations and edges represent the data flow.

The graph generation is possible which is based on Abstract syntax tree in class-oriented model [9].

Operating System:

The graph theory can be used in field of operating system for process scheduling, resource allocation applications and deadlock handling. The example of graph application is like graph coloring technique can be used in job scheduling where the processes are assumed as the vertices and the edge between those jobs represents that they cannot be executed parallel.

Web Designing:

Web designing can be modelled through the graph theory where the web pages will be denoted by nodes and the edges amongst them will be the hyperlinks. This model is called a web graph. The important information will be retrieved from the web graph.

Information retrieval system:

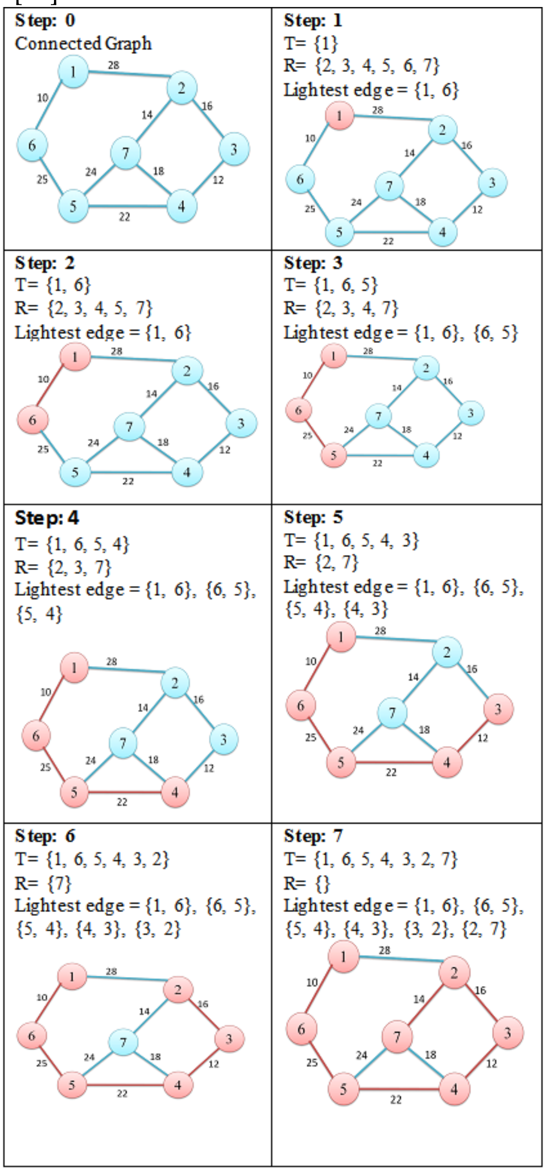
The Computer networks can be described as the environment of components that connected with each other through any wired or wireless medium and they can communicate with each other. The network is technically called as graph where the components are nodes and the wired or wireless medium between them are called edges. Now a days the invariants in graph constructs had been used as a part of bridging ways to deal with information retrieval systems. The graph theory applications are used for various applications inside IP for objects, IR assessment estimations, and re –ranking [10].

Computer Science Algorithms using Graph Theory

The graph theory is very useful in various fields, as we have discussed in earlier sections. In this section we will discuss few computer science algorithms which are using graph theory. For example very well-known mathematics problem is travelling salesman problem which can be implemented using minimum spanning tree. There are two popular algorithms for finding minimum spanning tree from the given graph are Prim's minimum spanning tree algorithm and Kruskal's minimum spanning tree algorithm.

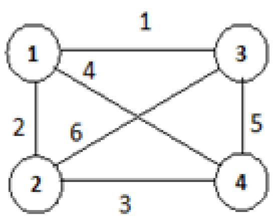
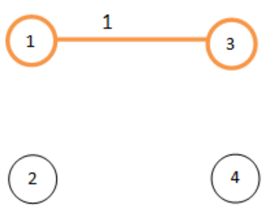
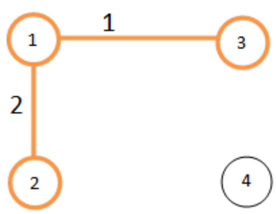
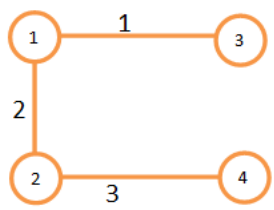
Minimum Spanning Tree: A spanning tree of a linked and undirected graph G is a branch-like subgraph of G that links all the vertices together without having the loop. A graph G can have several potential spanning trees but the minimal spanning tree (MST) is a tree weighing less than or equal to the weight of every other spanning tree [15].

Prim's Algorithm Example [12]:



In this example we have calculated minimum weight for minimum spanning tree using Prim's algorithm is 99 so that the minimum distance path is {(1, 6), (6, 5), (5, 4), (4, 3), (3, 2), (2, 7)}.

Kruskal's Algorithm Example [13]:
In kruskal's algorithm, we are finding all the edges with minimum weight in ascending order in such a way so it covers all the vertices and don't contain any cycle. The weights of edges will be placed into priority queue and then the edge with minimum weight will be selected and put into the previous sub tree.

<table>
<tr>
<td>Step: 0
</td>
<td>Step:1
T={1,2}
R={2,4}
Edge with minimum weight = (1, 3)
</td>
</tr>
<tr>
<td>Step:2
T={1,2,3}
R={4}
Edge with minimum weight = (1, 2)
</td>
<td>Step:3
T={1,2,3,4}
R={}
Edge with minimum weight = (2,4)
</td>
</tr>
</table>

Total Cost of the MST: 1+2+3 = 6

In this example we have calculated minimum weight for minimum spanning tree using Kruskal's algorithm. The minimum distance path is {(1, 3), (1,2), (2, 4)}.

CONCLUSIONS

This paper presents various concepts related to graph theory and its applications.it contains basic terminologies about graphs, history of graph theory and applications in various fields like physics, chemistry, biology, computer science and engineering, electronics, operation research and other fields. It focuses mainly on various domains of computer science which does vast use of graph theory to design their algorithm to solve problems.it also represents some computer science algorithms as an example which shows that how graph theory is useful in computer science domain. We conclude that the graph theory of maths is very important and effective concept which is almost used in all the domains.

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IDENTIFICATION OF ADULTERATION IN HOUSEHOLD CHILLI POWDER FROM ITS IMAGES USING LOGISTIC REGRESSION TECHNIQUE

Ms. Nilam Desai, Dr. Dharmendra Patel

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Smt. Chandaben Mohanbhai Institute of Computer Applications,
Charotar University of Science and Technology, Changa 388 421, Gujarat, India
nilamdesai.mca@charusat.ac.in

Abstract

Adulteration is proof of food quality deterioration with either adventitious or deliberate methods through the production of synthetic mixtures, by-products etc. Within a nation such as India, where the population is enormous, and where the buyer is not noticed, the display of corruption is hardly shocking. Everyday use, such as fruit, spices and milk, is seen as much as our dismissal defiled. Some manual procedures occur in everyday foodstuffs to detect adulteration. Yet human mistakes can make it unreliable. To make this process automatic, we are introducing a novel method to identify adulteration in Kashmiri chilli powder by its images. Here, we are considering adulteration as brick powder mixed chilli powder. We have used 100 pure red chilli powder images and 50 red chilli powder which has been mixed with bricks powder. To classify images, we have used logistic regression and got 82% accuracy in process implementation.

Keywords: chilli powder; adulteration; logistic regression; household spices

I. Introduction

Food is a basic existence necessity. We eat food for various aerobic activities and improve our vitality. Each being requires nutrition to grow, function and sustain forms of life. Different types of foods are available on the market today and we rely on different food sources on a regular basis, including fruits, natural products, kernels, milk products and so on. The lure of money and the general triviality for humanity led adulterants to add food to the more harmful brick powder and boric powder from the tiny pillars of rice.

Food adulteration indicates that poor quality, mediocre, unsatisfactory, useless items are found in food or mixed with them. Adulterated food is harmful because it can be toxic and can impair the well-being of individuals and may refuse essential nutrients for the legitimate development and enhancement. The most popular adulterants that have been identified include some synthetic materials for quicker maturation of organic goods, blending with the largest of decayed goods of the earth, like some ordinary and [1] compound shoppers' colors, blending soil, rocks, stones, sand and marble, grain, beats and different outputs, and cheaper and less mediocre materials.

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The adulterant tests were performed in popular and well-known sources like FSSAI, ISI, AGMARK, BIS and others. During the study, the adulterant items were contained in packaged and unbranded foods. The Indian Food Safety and Standards Authority (fssai) is proposing the formulation of regulations on food safety as well as guidelines on food and toxin and residue, and regulations on food safety, 2011 [2]. FSSAI has also crucified buyers in terms of food deterioration and provided tools like the DART Book to assist them in the domestic identification of food pollution.

Some popular grooming foods include wheat flour, cooked rice, refined fleece meal, bajra, honey, turmeric, red powdered chili, milk, sugar, coffee powder and a lot of other foods [3]. The adulterant is detectable across multiple methods, including manual processes and chemical processes. The key focus in this paper is to detect adulteration by image processing techniques in the Kashmiri chilli powder.

Chilli powder [4]is a dried, crushed fruit of one or more chili type, along with other spices. Chili powder. This is used in cooking dishes as a spice and as a seasoning. Chilli powder is reduced to brick powder, plum solvent salts, Rhodamin B and oil, which can lead to a number of diseases including, for example, stomach, metal hazards, cancer, food poisoning, cardiovascular disease, heart attacks, liver damage, the tumor and many others.

Adulteration in red chili powder is characterized by manual processes. Take 1 tsp [5] of the powder of the chili and pour it into a bowl. This indicated the proximity of brick powders or sand at the point where the build-up was tested and any lumpiness was felt.

We have proposed a new approach for identifying adulterated Kashmiri chilly powder from the digital camera image. We measure color features and logistic regression is performed for training and classification. The following paper is organized. The related work in this area is defined in Section II. The terminologies used in this paper are discussed in Section III. The proposed method and result are defined in Section IV-V. Section VI ultimately presents conclusion.

II. Related Work

The research on chili powder adulterated by means of Sudan I dye was carried out by Haughey, S.A., et al. [6]. With near infrared reflectance spectroscopy and Raman spectroscopy, spectral images were made. Spectral data have been subject to quantitative and qualitative calibration models and statistics. A statistical algorithm was used to calculate quantitative model coefficients, based on the spectral data (NIRS / Raman), and pre-treatment of the data was defined to be 0.891-0.994.

Innovative high resolution mass spectrometry, with a coefficient of variance less than 20 percent was introduced. Simona et al. have proposed a [7] simple screening technique to classify Sudan dyes in adult tomato sauce, chilli powder and palm oil. The technique includes a small preparation for the sample, complete avoidance of fluid chromatography and then identification and identifying by ambient pressure chemical ionization in positive flight ionization mode.

G. Rajakumar et al. have implemented [8] the VLSI Electronic Image Processing Detection based adulteration in food samples. Selected and calculated images are various types of food samples. Such images are compare with regular images stored within the Field Programmable Gate Array (FPGA) with the algorithm of the Distance Matrix in the Very Large Scale Integration (VLSI) implementation.

A. Justin Diraviam et al. have developed a novel method for the identification of food adulteration with a [9] digital camera in selected food products. Chilli powder, black pepper and milk are the foods chosen. Image feathers consisting of average, standard difference, entropy, smoothness and local tetra pattern are measured. Feature data are compared and created based on both the data set food pictures and the input food pictures in the identification of foreign particles in food products.

III. Methodologies

To build a consistent vector, different color features are defined. For analysis of chilli powder pictures, we have used RGB color channel here.

Logistic regression, which is also called a logistics model, analyses the correlation between many separated [10] variables and a category variable and calculates an event 's likelihood by fitting the data to a logistical curve. Two logistic regression models, binary regression and multinomial logistic regression are available. Binary regression is usually used where the dependent variable is inconsistent and independent variables are categorical or continuous. When the dependent variable is not binary and contains more than two types, it is possible to use a multiple regression model.

This research mainly focuses on the detection of the Kashmiri red chilli powder which is mixed with bricks powder, whose color features as listed in the Table1 and Table 2. The other adulterants such as Sudan dye is not considered in this discussion. Here, we have used binary logistic regression as there are only two images classes for classification: pure and adulterated chilli powder, for that we have used label as 0 and 1.

IV. PROPOSED APPROACH

We are performing following steps to identify adulterated chilli powder from it digital images.

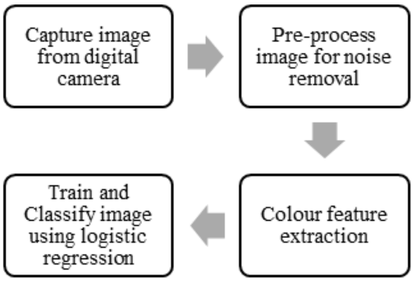

Figure 1: *Block Diagram of Proposed Model*

I. Capture image from digital camera and Pre-processing

Chilli powder images are taken using digital camera (See Fig. 2). Both branded and un-branded chilli powder are considered to create image dataset. To generated adulterated powder image, 15-gram brick powder adulterant added to 50-gram pure chilli powder sample is taken by camera. All the images are taken in such a way that bottom surface appears in white color (see Fig. 3).

II. Pre-process image for noise removal

To remove noise, Gaussian filter is applied so that image looks more smooth and sharp. To remove background, color masking operation is applied after Otsu's Thresholding techniques (See Fig. 4).

Figure 27: Red Chilli Powder

Figure 3: *Red chilli powder mixed with brick powder*

The objective of Otsu's thresholding [11] is to find the threshold value at which the sum of the first and context spreads is minimal.

Figure 4: *Masked image of red chilli powder*

The technique for selecting a specific background color is known as color masking to [12] eliminate false regions caused by color change. The color of the background is the color of the mask. Here, Red color channel is used to separate foreground with background. And black color is applied as mask.

III. Color Feature Extraction

Each channel's mean is measured and used as the image classification parameter. The RGB image consists of three images (one for each channel), in which each image can store discrete pixels between 0 and 255 with typical brightness intensities.

$$\text{Mean(R/G/B)} = \sum_{k=0}^{n} \frac{Rc \text{ or } Gc \text{ or } Bc}{n} \tag{1}$$

Here, mean of each channel (C) which is Red, Green and Blue, calculated by separating each in matrix (see Table 1 and Table 2) and applying logic for dominant color formation so that it presumes actual values as human vision.

Table 1: *Mean of Red, Green and Blue Channel (Mixed Red Chilli Powder)*

Mean of each RGB channel			
Label	R	G	B
Mixed Red Chili 1	81.34967	109.8886	171.901

Mixed Red Chili 2	0.134404	0.194583	0.387035
Mixed Red Chili 3	74.2278	107.012	179.7792
Mixed Red Chili 4	0.064241	0.105532	0.223678
Mixed Red Chili 5	0.038761	0.075368	0.381909
Mixed Red Chili 6	0.032687	0.058498	0.369771

Table 2: *Mean of Red, Green and Blue Channel (Original sample red chilli powder)*

Mean of each RGB channel			
Label	R	G	B
Sample Red Chili 1	81.34967	109.8886	171.901
Sample Red Chili 2	0.134404	0.194583	0.387035
Sample Red Chili 3	74.2278	107.012	179.7792
Sample Red Chili 4	0.064241	0.105532	0.223678
Sample Red Chili 5	0.038761	0.075368	0.381909
Sample Red Chili 6	0.032687	0.058498	0.369771

IV. Training and Classification of red chilli powder images

All the dataset images are trained by its color features. Dataset is divided into 80:20 ratios to generate training and testing data. For creating dependent variable vector, labels are specified as 0 for adulterated and 1 is for pure chilli powder. The model has been built for classification of red chilli powder using logistic regression. In the following, the formulas for logistic regression model are briefly listed for reference.

$$Y = b0 + b1 * X1 + \ldots bn + Xn \tag{2}$$

Here, Y is dependent variable that is label in chilli dataset and X1, and Xn are explanatory variables (colour mean features).

$$P(X) = 1 / (1 + e - (b0 + b1 * X1 + \ldots bn + Xn)) \tag{3}$$

In above equation, Sigmoid function is applied on linear regression, in order to calculate prediction value.

V. Result and Analysis

We have used python programming language for execution and simulation process. After creating and testing classification model, confusion matrix and ROC curve has been generated to analysis actual values and predicted values (see Table 3 and Fig. 5).

This confusion matrix is used to evaluate a model 's efficiency. The confusion [13] matrix is presented in a table with below four values belonging to two predicted and actual categories.

True Positive (TP): Predicted positive and the result is true. Model predicted that the chilli powder is pure, and it is pure in actual dataset also. Here, Model is predicting 85% correct true values for pure data.

True Negative (TN): Predicted negative and the result is true. Model predicted that the chilli powder is mixed, and it is mixed in actual dataset also. Here, Model is predicting 80% correct true values for mixed data.

Table 19: *Confusion Matrix*

		Predicted	
		Pure	Mixed
Actual	Pure	85%	15%
	Mixed	20%	80%

False Positive (FP): Predicted positive and the result is not true. Model predicted that the chilli powder is pure, and it is mixed in actual dataset. Here, Model is predicting 15% incorrect true values for pure data.

False Negative (FN): Predicted negative and the result is not true. Model predicted that the chilli powder is mixed, and it is pure in actual dataset. Here, Model is predicting 20% correct true values for mixed data.

Receiver Operating Characteristic curve (ROC) is a probability curve and AUC represents degree or measure of [14] separability.

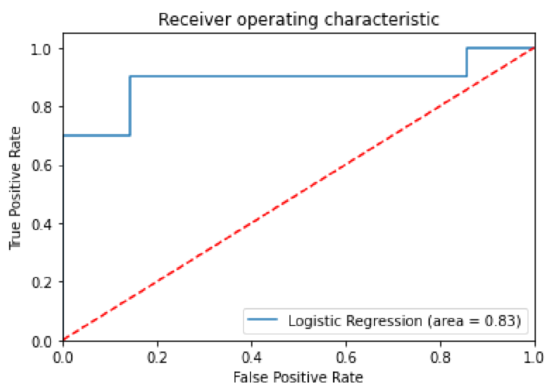

Figure 28 ROC curve for predicted model

It tells how much model is capable of distinguishing between classes. Fig. 5 shows that AUC approximately 0.83 which means the proposed model is 83% skilful of bifurcating between two class labels pure and mixed chilli powder.

We have calculated precision, recall and f1-score value to find accuracy of model. The precision [15] is a combination of the number of positive examples properly classified and the number of positive examples predicted. We got 0.83 precision value. Recall is measure of positive examples labelled as positive by classifier. We got 0.82 as recall value. F1 score is a weighted mean of the recall and precision. We got 0.82 f1-score. This result shows that proposed model is working well to classify pure and mixed powder.

VI. Conclusion

Adulteration is major problem in food industry as it causes many diseases in humans. Red chilli powder is adulterated in many ways and one of the common way is to add bricks powder. Though, there are manual methods are available to identify outside material in chilli powder but automation process is also required for faster and accurate analysis. We have introduced an approach to identify adulterated chilli powder from its images. We have use color feature that s means of each RGB channel and classify the data using logistic regression. After analyzing true – false ratio of prediction data, model give 82% accuracy to predict data that whether image is of adulterated chilli powder or pure chilli powder.

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LOW COST AUTOMATIC FIRE ALARM AND HAZARD LOCATION INTIMATING SYSTEM FOR INDUSTRIAL APPLICATION

B. H. Pithadiya[1], H. N. Parikh[2], H. N. Pandya[3], H. N. Kapse[4]

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[1,2,3] Department of Electronics, Saurashtra University
Rajkot, Gujarat, India
[4]Department of Instrumentation & Control, Institute of Science &
Technology for Advanced Studies & Research
Vallabh Vidhyanagar, Gujarat, India
pithadiyabh2@gmail.com

Abstract

Burn tragedy is a significant hazard to human life and properties. Automatic fire alarm device allows for real-time tracking, monitoring and intimation. Once the fire happens, it gives early warning and helps to the fire loss. It is versatile security and alarm system which can be used by individuals, corporations or industrial establishments. The concept behind this project is to have a quick, easy, accurate and low-cost fire sensing and location-intimating device for users to get support in critical situations. The system can be positioned at any remote location that the consumer can quickly access with the aid of GSM technology. In this it is proposed that NodeMCU acquire signals from different sensors and control to manage communication with property owner. This is carried out by sending SMS immediately to owner in initial stage and to fire brigade in critical stage to resolve fire hazard. Different sensors incorporated within system are smoke, fire and flammable gas sensor. It helps to estimate specific threshold values in hazardous condition and alarms the buzzer accordingly. If in high emergency the system sends SMS consisting of the area and address location to the user / in charge person and fire brigade respectively.

Keywords: Node-MCU (ESP8266), Smoke sensor, Flame sensor, Temperature and Humidity sensor, GSM

I. Introduction

Wherever heat sources and flammable materials share a room, possibilities for fire occur. Many industrial sites contain highly hazardous content which can combust or burst into flames unless adequately handled and processed. An industrial fire is a form of industrial disaster which causes enormous damage to its sector. There are different ways in which this hazard is caused such as electrical fire, flammable liquids, compressed gases, hot work, housekeeping practices etc. The work environments in every industry pose unique fire hazard hence there lies some general issues culminating in a risk of fire or blast in industrial complexes or manufacturing facilities. Prevention ensures that a minor event or a small fire in a trash does not turn into a catastrophic event which can devastate a business or the lives of workers and a community.

Fire prevention is based on various hazard monitoring systems that include: Linear heat detection, Smoke Detection, CO and Combustible Gas detection, Emissions monitoring and many others with technological developments, fire safety issues also have raised rapidly. Few researchers have tried to overcome this hazard monitoring in different ways viz. review of fire-detector types has been carried out by Omar Asif et.al. With development of microcontroller based automated fire alarm system for alerting fire incidents in household or industrial premises [1]. While Chen Thou et al. [2] worked on the early fire detection through image processing. The basic idea behind fire-detection was RGB (red, green, blue) model based chromatic and disorder measurement for extracting fire-pixels and smoke-pixels. Based on iterative checking on the growing ratio of flames, a fire-alarm was given when the alarm-raising condition is met. In other studies an emergency response system for fire hazards was designed with IoT standards for rescue operations for public safety by Ravi K. et.al.[3]. The system to improve home safety by getting immediate response about fire was implemented by Mahzan N. N. et.al.[4] while GSM based fire alarm system is suggested by Mao and Duan [5]. Lian used controller to get remote alarm for fire system [6]. This paper proposes framework of low cost multi sensor and alarm system with intimation of actual hazard location. To take precautionary measure and to avoid fire hazards or destruction especially in industrial setup this system has been developed. This works in two possible steps. First step is to inform the owner about the fire initiating signal so as to alert and to get in action whatsoever required. And the second step is to alert instantly to fire fighters also in case fire broke out exceeding threshold values.

II. System components

I. Node-MCU

Node-MCU is an open-source firmware and development kit that helps to build prototype. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif and hardware which is based on the ESP-12 module. It uses an on-module flash-based SPIFFS file of Systems. It is asynchronous and event-driven. Many functions, therefore, have parameters for callback functions.

The ESP8266 Node-MCU has total 17 GPIO pins broken out to the pin headers on both sides of the development board. These pins can be assigned to all sorts of peripheral duties, including: A 10-bit ADC channel, UART interface, PWM outputs, SPI, I2C & I2S interface, I2S interface etc.

The programmable ROM is programmed on-board via the USB, allowing the programming step to be easily integrated into the product manufacturing and testing process. Maintaining the Integrity of the Specifications

II.SIM900A Modem (GSM)

SIM900A Modem is built with Dual Band GSM from SIMCOM. It works on frequencies 900 / 1800 MHz. The frequency bands can also be set by AT Commands. The baud rate is configurable from 1200-115200 through AT command. It is ultra compact and wireless module and allows connecting PC as well as microcontroller with RS232 Chip. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. It provides facility for audio calls and SMS attend the incoming calls through simple AT commands. This is a complete very powerful single-chip with serial and TTL outputs.

III. Data Acquisition Sensors

There are four different components for acquiring data from the site.

A) Temperature & Humidity Sensor

Ambient temperature and humidity is measured using DHT11 air temperature humidity sensor. The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin. Its fairly simple to use, but requires careful timing to grab data. And new data collected from it once every 2 seconds.

B) Flame Sensor

Flame sensor is a device used to detect the presence of fire in its surrounding. For this system we have used **Infrared Flame Sensor** to detect the fire. It consists of a photodiode coated with black epoxy which makes it sensitive to the infrared radiations having wavelength between 700nm to 1mm and **can detect fire up to distance of 100cm within 60 degrees of angle of detection**. D**etection process is based on** the Infrared (IR) wavelength emitted by the flame.

C) MQ2 Gas Sensor

It is metal oxide semiconductor sensor used for sensing the concentration of gases in the air. It comprises a sensing material whose resistance improves as it comes into contact with gas. This change in the value of resistance is used for the detection through voltage divider network. It can detect Propane, Hydrogen, Methane etc concentrations in the range of 200 ppm to 10000 ppm.

D) MQ5 Gas Sensor

This sensor detects the presence of gas in an area. This module is useful for gas leakage detection of LPG, Natural gas, town gas and or smoke etc. Use the onboard potentiometer to adjust the sensitivity.

E) Relay module

A relay switch is operated by an electromagnet which requires a small voltage for activation which is provided from the NodeMcu. When any one input from the sensor sense above threshold limit, relay switch activates bulb to switch ON. It helps to show emergency status of hazards area. Assembling all these components together makes a system, as shown in block diagram Figure 1

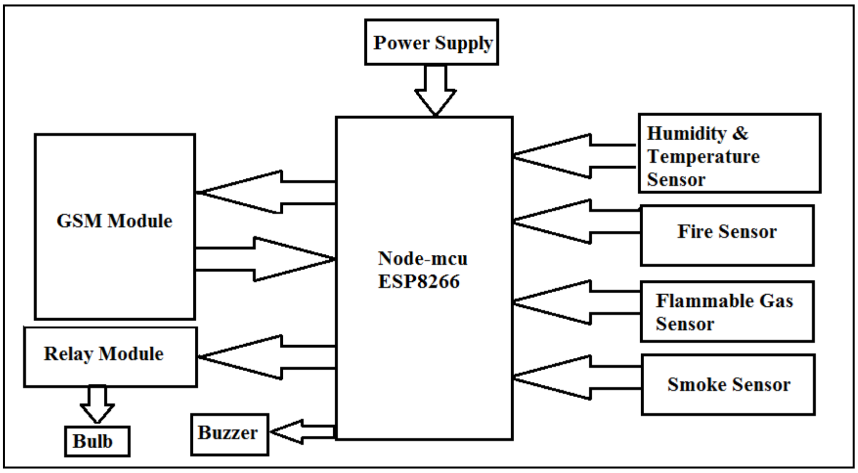

Figure 29 : *System block diagram*

III. System operation

I. Hardware

The actual circuit connection is shown in figure 2. In this circuit two main components are used. One is NodeMCU and other GSM module. Sensors are interfaced with NodeMCU as input devices while the GSM will execute process after getting signal from NodeMCU. The relay circuit will be activated for alarming fire hazard to switch ON bulb and buzzer sounding. The circuit connection shows NodeMCU powered by Boost Buck module. Different sensors for detection are connected through this module for power requirements. The entire sensor devices are interfaced with NodeMCU as input devices. Flame sensor acts as electromagnetic radiation receiver. This sensor uses the infrared flame flash method, which allows the sensor to work through a coating of oil, dust, water vapor. While the smoke detection sensor MQ2 is used to detect the gases like methane, propane, concentrations if any present. This sensor includes a sensing part, primarily ceramic based on aluminum oxide, filled with Tin dioxide, embedded in a mesh of stainless steel. When immersed in air at high temperatures, oxygen is adsorbed on the surface of the sensing material. Instead donor electrons in tin oxide are drawn to this oxygen and hence the present flow is stopped. Such oxygen atoms interfere with the reduction of pollutants, thus reducing the surface density of the adsorbed oxygen when pollutants are present. Current will now pass via the sensor, producing analog voltage values. The quantities of these voltages are calculated to determine the gas concentration. Tension levels are higher when gas production is small. MQ5 is responsible for detecting smoke. The gas sensor module consists of an exoskeleton in steel that houses a sensing device beneath it. By connecting leads this sensing aspect is subject to current. If a gas interacts with this sensor, it is first ionized and then adsorbed by the sensing part. This changes the resistance of the sensing element which alters the value of the current going out of it. This adsorption creates a potential difference on the element which is conveyed to the NodeMCU unit through output pins in form of current. DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. This tests the modified principles of resistance and transforms them into digital shape. This sensor uses Negative Temperature coefficient of thermistor to measure the temperature, which causes its resistance value to decrease with increase in temperature. This sensor typically consists of semiconductor ceramics or polymers to achieve a greater resistance value except with the slightest temperature shift. The messaging GUI is designed for sending warning SMS. Sim900 interacts on UART platform with external device. The default Contact baud rate is 9600 bps. This requires setup and functional AT commands for it. NodeMCU Serial UART is used to interface the communication with sim900. Arduino IDE is used to compile and compose code. In the serial channel initialization feature is initialised. AT commands are sent to GSM in loop function. Note the cell number type to which the SMS must be submitted. The power is kept for ever at the end of the loop process while(1) process. If while (1) is not present, the loop feature runs continuously and SMS are continuously sent to the recipient.

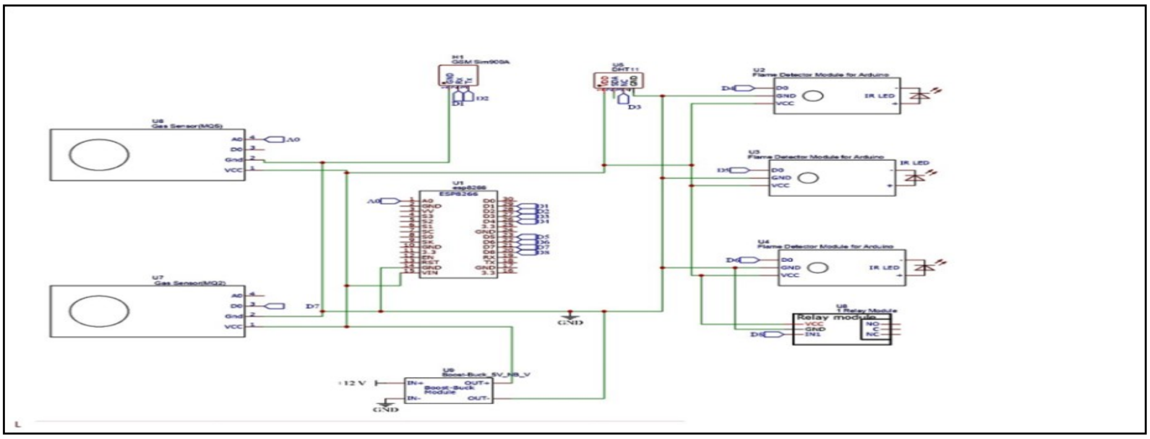

Figure 30: *Circuit Connection diagram*

II. Software

This is preliminary step to begin with programming – need to initiate the system with following steps.

- Connect Node MCU to computer. Need a USB micro B cable to connect the board.
- Open Arduino IDE and Install ESP8266 board. Require at least Arduino IDE version 1.6.4 to proceed with this. Go to File > Preferences. In the "Additional Boards Manager URLs" field, type http://arduino.esp8266.com/stable/package_esp8266com_index.json, and then click OK.

  Then go to Tools > Board > Board Manager. Type "esp8266" in the search field

  The entry "esp8266 by ESP8266 Community" should appear. Click install button.

- Select NodeMCU 1.0: Tools->Board dropdown Config the Board menu and choose the right Port for your device. CPU Frequency : 80MHz, Flash Size : 4M (3M SPIFFS), Upload Speed : 115200, Now the system is ready for coding.

III. Experimental setup and Flow sequence

The figure 3 shows actual experimental set up for the low cost automatic fire alarm and hazard location intimating system for industrial application. The component working is explained in hardware section.

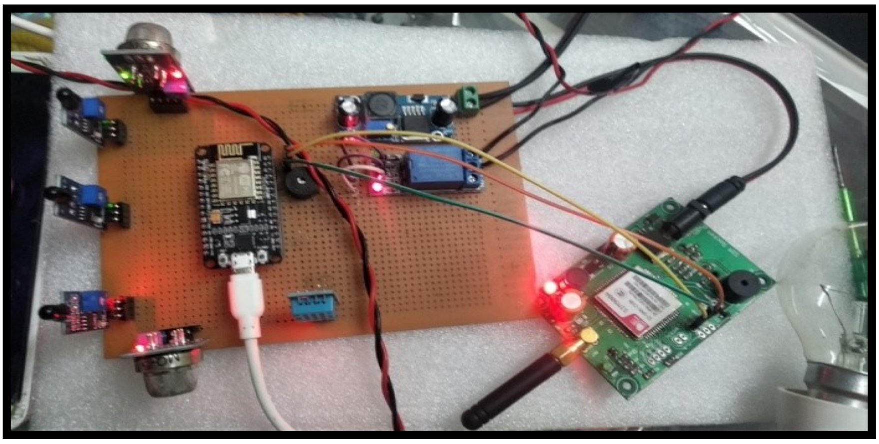

Figure 31: *Experimental setup of sensing system*

The flow sequence of detection and alerting system is shown in flow diagram figure 4.

IV. Flow description

As shown in flow diagram (figure 4) at the initiation, controller checks for interface connectivity. If it finds ok, first SMS about activation is transferred through GSM module to owner's mobile. Each sensor is set to threshold limit. Controller checks the threshold value at preset time interval. Once initiation process is completed Sensor starts its function to detect. It gives logic 1 as output if any threshold limit is crossed otherwise its output remains in logic 0. NodeMCU continuously monitors these logical variations at output pin of sensor.

At any instance if the threshold value exceeds, sensor detects it and signals to NodeMCU. Message is sent to owner and warning indicators are activated, here buzzer and bulb. If more than one sensor exceeds threshold limits NodeMCU performs necessary actions to activate relays for the buzzer and bulb. At the same instant alert message is also sent to user and fire brigade about emergency.

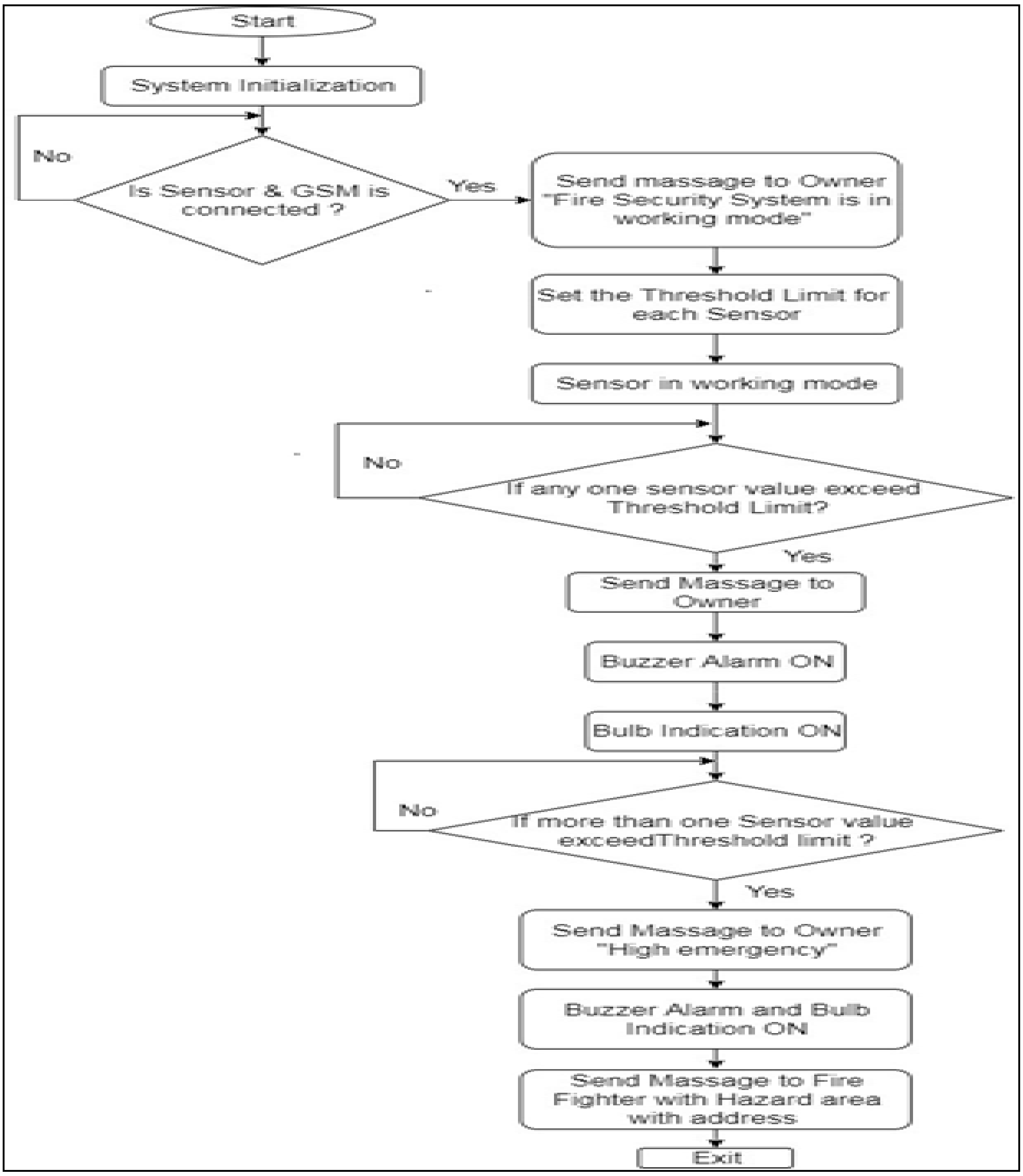

Figure 32 : *Flow diagram*

The beauty of this system is that fire fighter receive message with the address of hazardous area too. This enables them to directly track the spot for preventive actions.

The address is stored in memory of the installed device to avoid major losses in such hazardous conditions by instantly informing fire fighters team.

IV. Result

Tests were performed with differing conditions of smoke, air, and temperature to evaluate the system's efficiency and reaction to adverse fire circumstances. The results of the tests indicate that the program consistently provides appropriate warning responses under different test conditions. Figure 5 shows the experimental setup of the tests, where it indicates the condition of the bulb ON.

And the system responses in the form of SMS under different situations to the owner and fire fighter are shown in Figure 6a & 6b, respectively. Throughout the experiments, the system's transmission period from fire detection to warning message (SMS) via GSM network was on average 15 seconds for the owner as well as the fire fighter, which is fast enough to take the appropriate steps to stop the fire threat.

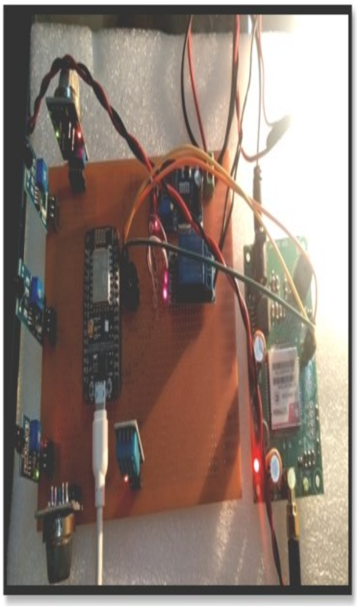

Figure 33: *Indication Bulb ON detecting fire possibility*

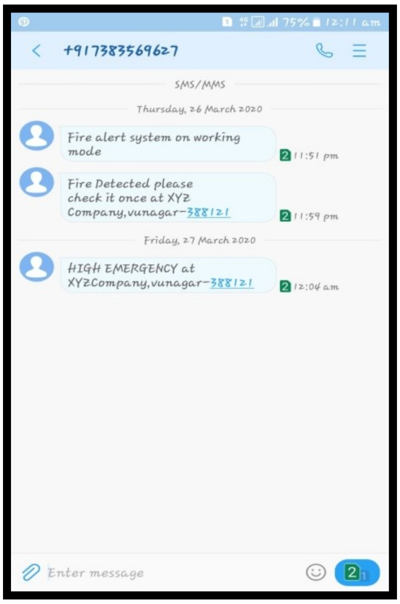

Figure 34a: *Alerting SMS reached to owner*

Figure 6b: *Alerting SMS reached to Fire fighter with location intimation*

V.Conclusion

Fire tragedy presents a great threat to human life and property. In view of this a low cost automatic fire alarm and hazard location intimating system for industrial application is designed and implemented. NodeMCU being the significant controller comes in action whenever signals from sensors are received and act accordingly to communicate with GSM module to send SMS. Also it activates relay module to blow buzzer alarm at the local site area. This system provides an early fire warning which will help to prioritize the immediate rescue operations by owner and or fire fighters respectively so that damages will be reduced effectively.

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DESIGN OF PATH PLANNING ROBOT

Anita Bhatt, Ghanshyam Vaghasiya, Savan Chavda, Rumit Patel, Nimesh Metaliya

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BVM Engineering College, Gujarat, India
anitanbhatt@gmail.com

Abstract

Robot path planning and executing multiple times that task has been focused in this paper. Path planning is a key task in the field of Robotics. This requires embedding intelligence into these robots for ensuring optimal solutions for task execution. The modeling environment and algorithm to find the shortest, collision-free path are the basic issues in the path planning problem of the robot motion planning. Robotic is now gaining a lot of space in our daily life, several areas of modern industrial automation, and cyber-physical applications. Planning a path in a static environment is easy compared to a dynamic environment where the obstacles are moving. There is a need to develop such an effective technique for path planning in a dynamic environment. Thus, a lot of research problems that pertain to robotic applications have arisen such as planning (path, motion, and mission), task allocation problems, navigation, tracking. In this paper, we focused on the path planning research problem and solution

Keywords: Simultaneous Localization and Mapping, Path planning algorithm. Robotics, Embedded system, Encoder motor.

I. Introduction

Moving from one place to another is a trivial task for humans. One decides how to move in a split of a second. For a robot, such an elementary and basic task is a major challenge. In autonomous robotics, path planning is a central problem. The typical problem is to find a path for a robot, whether it is a vacuum cleaning robot, a robotic arm, or a magically flying object, from a starting position to a goal position safely. The problem consists of finding a path from a start position to a target position. This problem was addressed in multiple ways in the literature depending on the environment model, the type of robots, the nature of the application, etc. [3]. Safe and effective mobile robot navigation needs an efficient path planning algorithm since the quality of the generated path affects enormously the robotic application [5]. Typically, the minimization of the traveled distance is the principal objective of the navigation process as it influences the other metrics such as the processing time and energy consumption [4]. This paper presents a comprehensive overview of mobile robot global path planning and map learning. Path planning and map learning has been done using compass sensor and encoder. This data has stored in EEPROM and retrieved when robot is in action.

Nowadays, we are at the cusp of a revolution in robotics. A variety of robotic systems have been developed and they have shown their effectiveness in performing different kinds of tasks including smart home environments. Intelligence must be embedded into the robot to ensure optimal execution of the task under consideration and efficiently fulfil the mission. However, embedding intelligence into the robotic system imposes their solution to a huge number of research problems such as navigation which is one of the fundamental problems of mobile robotics [4]. we have focused on Map learning and Path planning.

II Problem Definition and literature

A service robot can be used for both domestic as well as industrial purpose. Some of the applications include cleaning and housekeeping, museum guidance, surveillance, etc. To achieve these tasks, an autonomous mobile robot must be capable of constructing and maintaining maps of their environment [1]. At the same time, the robot needs to localize itself using this map. This problem is usually referred to as Simultaneous Localization and Mapping (SLAM) and is a highly energetic area of research in the field of robotics [3]. The map-based navigation of a robot involves three processes (a) Map learning (b) Localization (c) Path planning. Map Learning - It is a process of memorizing the data acquired by the robot during searching, in a suitable representation. Localization - It is a process of deriving the current position of the robot within the map. Path planning - It is a process of choosing a course of action to reach a goal, from the current position. Various approaches, algorithms have been proposed for path planning are according to the environment, type of sensor, robot capabilities, etc. [2]. These approaches are gradually toward better performance in terms of time, distance, cost, and complexity. There are many types of algorithms to manipulate and search the data structure used to store the maps of the work area. Designing a code is a difficult part of this project because this project is a real-time application [7].

III System requirements and design

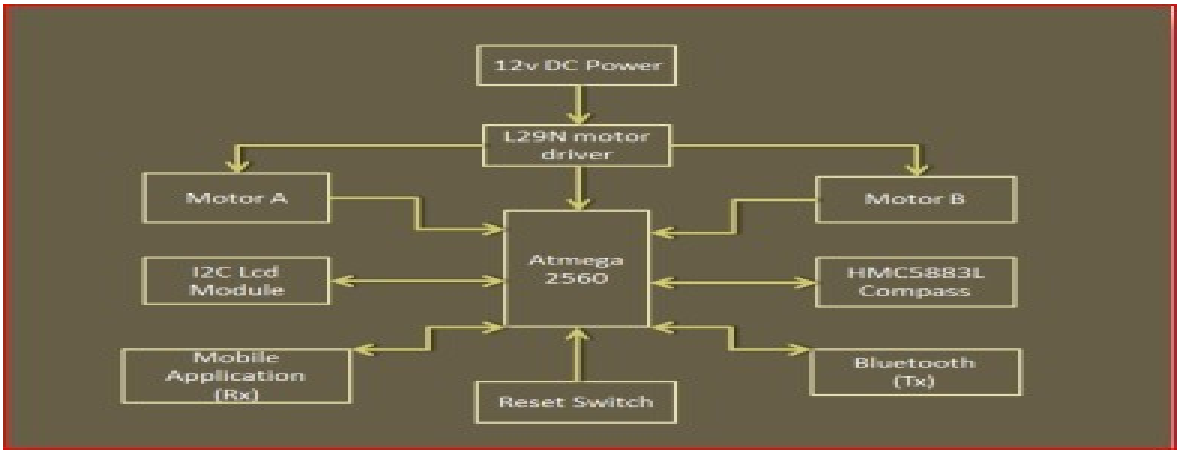


Figure 1 *Block diagram of Path planning robot*

Many hardware, software, and processing techniques are required in designing the proposed system. We have tried to implement an efficient technique for designing the robot. For robot path planning, there are number of sensors that can be used like laser range sensor, IR sensor, encoder, etc. Most widely IR circuits are designed on the principle of distance measurement. A transmitter sends a pulse of IR signals which is detected by the receiver if there is an obstacle and based on the angle the signal is received, distance is calculated. IR transceivers are very useful for distance measurement. But the accuracy of this sensor is lacking, when there is angular turn happens. An encoder is a sensor of mechanical motion that generates digital signals in response to motion [5]. As an electro-mechanical device, an encoder can provide motion control system users with information concerning position, velocity, and direction. We have used the HMC5883LDigital Compass

I Software requirement

Arduino integrated development environment (IDE) is a platform used to program our proposed system. Arduino group has developed this platform with an inbuilt compiler and a tendency to convert byte code into machine code which can be transferred to Arduino based microcontroller. The newer generation has added some new interaction with which we can program our SoC also. Arduino IDE creates a sketch with programming language like C++, it can be written with the help of programming language C also. The second software EAGLE is a scriptable electronic design automation application with schematic capture, printed circuit board layout, auto-router, and computer-aided manufacturing features. We have used EAGLE software for PCB designing.

II Hardware requirement and system working

Its hardware contains AT Mega 2560 is a Microcontroller, which has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 Analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller by simply connect it to a computer with a USB cable or power it with an AC-to DC adapter or battery to get started.
Mathematically equation to find a distance using encoder pules.

Circumference = pi * Diameter

Distance traveled = Wheel rotations * circumference
Distance traveled = (Encoder ticks / 360) * circumference
Encoder ticks = (360 / circumference) * Distance to travel

HMC5883L compass sensor: is a 3-axis digital compass used for two general purposes: to measure the magnetization of a magnetic material like a ferromagnet and to measure the strength. It measures the Earth's magnetic field value along the X, Y, and Z axes from milli-gauss to 8 gausses. Communication with the HMC5883L is simple and all done through an I2C interface. The breakout board includes the HMC5883L sensor and all filtering capacitors. The power and 2-wire interface pins are all broken out to a 0.1" pitch header. Uses the HMC5883Lmagnetometer chip. Supports 3.0V to 5.0V IO levels on I2C SCL and SDA pines.

The first task for the robot is to design the base part. In the base part, we choose the body part for robots and what is suitable for robots. The second task is to check the alignment of the body is right or not. Alignment is perfect then we move forward to the next part to choose wheels for the robot. Choosing wheels for the robot is an essential part and al wheels are the same and also grip and perimeter of wheels are the same

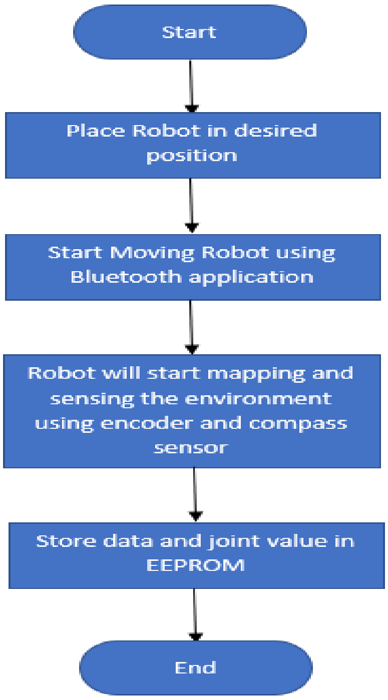


Figure 2 *Map learning algorithm*

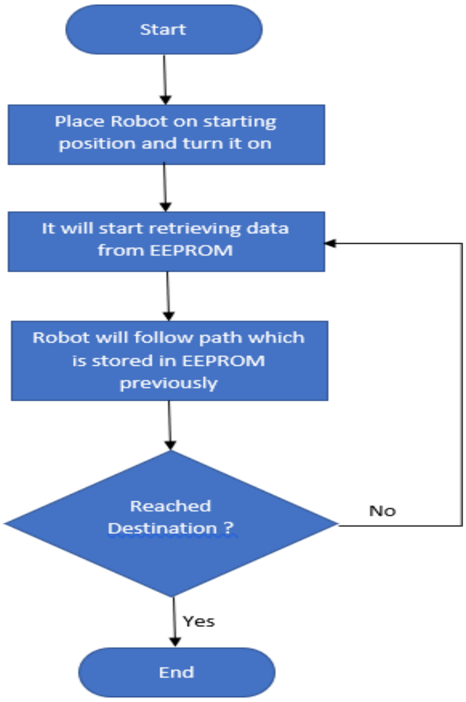


Figure 3 *Path planning algorithm*

Then we choose the DC motor according to our application, checked it if it working or not using a 12V battery power supply and then we connected the DC motor to the wheels. The basic task is completed making perfect body parts that fulfil our application. Then we move forward to the next part.

In this part, we choose components of our robot according to our application and components list below

- AT mega 2560
- L29N Motor Driver
- HMC5883L Digital Compass
- Bluetooth
- I2C LCD 1602
- Encoder motor

Assemble the above list of components and check all components are working or not. We connect all components to the controller. Here, the important part is what logic satisfying our application, and we design code in Arduino software. Write a code is a difficult part of this project because this project is a real-time application and in which sensors and motors outputs are not continuously similar when the 12V power supply battery is not fully charged. We observed that when a battery is not fully charged, DC motor speed is varying according to the previous result. According to the result, we change the code and make a perfect result for our project. Afterward, the software programming part comes and programming is done in Arduino IDE with the C programming language. For storing data, we use an EEPROM memory in our application. The ATmega32 contains 1024 bytes of data EEPROM memory. It is organized as separate data space. Data bytes are addressed 0 to 1024. System implementation starts with hardware design after proper testing on a breadboard. PCB designing process will be done with the help of EAGLE Autodesk by selecting the proper component and libraries

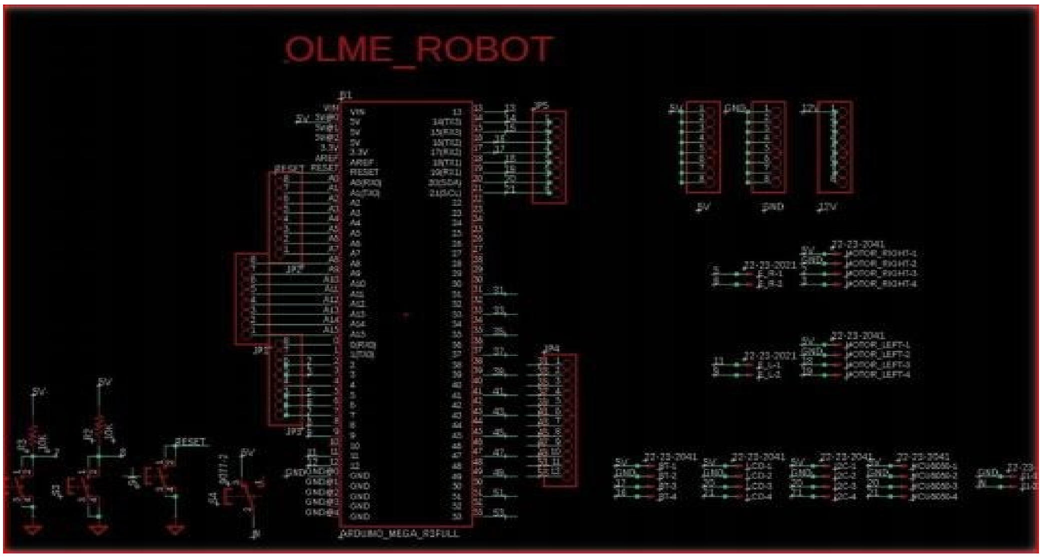


Figure 4. *Schematic Diagram*

The above mention schematic diagram (Figure 5.) is designed and then it's converted into ". brd" file. The layout file has been created with a proper place and route. This PCB has been soldered with pre-identified components. Although AutoRoute is very useful in quickly laying out traces but it's not perfect, so manual routing has been done for efficient design. For fabrication using chemical etching, we required a mask that will be used to expose the pre-etched core to ultraviolet radiation that transfers our layout design to the top layer. A typical method for accomplishing this is to use a printer and print our design onto transparency. We have to be sure to use the correct settings on our printer, with the correct type of transparency, otherwise, we could seriously damage the printer. The first step is to make sure; your board passes DRC and to double-check the schematic of designs to make sure that there are no missing or extra components. In a chemical etching we use an H2SO4, FECL and H2O.we have mixed a 50% H2SO4 and FECL and 50% H2O in one biker and then put our printed PCB into this biker. After 10 min tack, our PCB into this biker and clean with the cotton cloth. Generally, we use an iron to print a carbon copy of a layout.

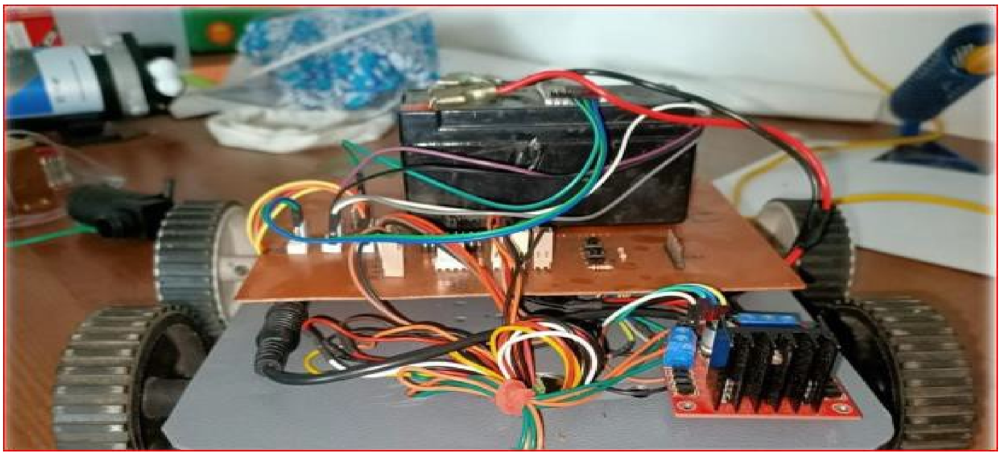
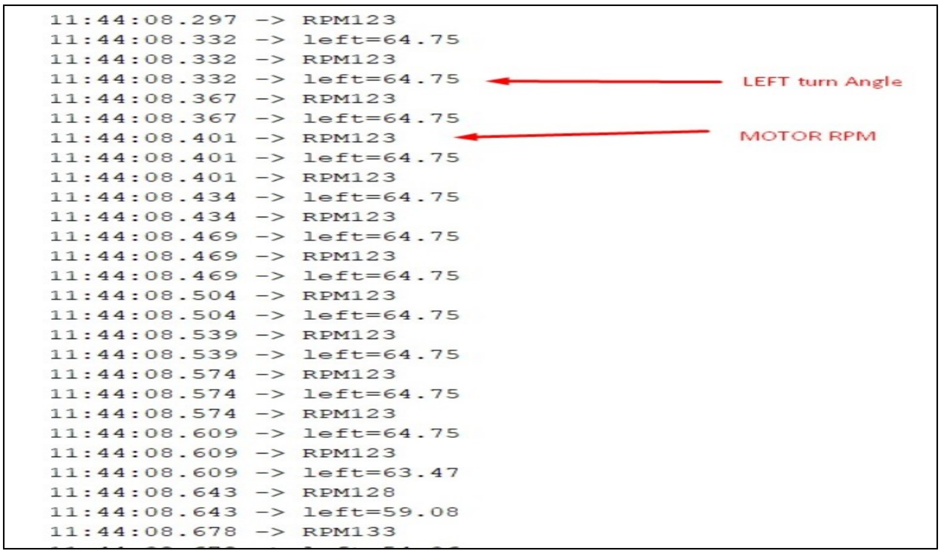
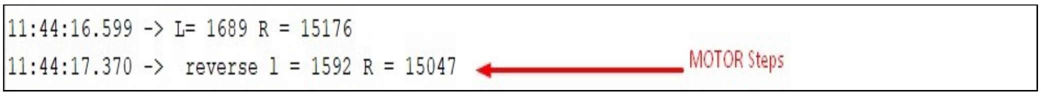


Figure 5. *Path planning ROBO*

As we know real-time application kind of project takes many tries to reach final output, so our project takes many trial and error. The robot with the moving object can face many problems like path obstacles, low battery power, etc. We use Bluetooth HC-05 to provide serial communication between the controller of the transmitter and the smartphone by using the app, which is developed by Bluetooth robot car controller app inventor. Using the Application, we can send the direction of a signal to provide the communication between the transmitter and receiver as a mobile phone. We are using Bluetooth on both sides of the network, which provides a range of up to 10 meters, and supported baud rate of 600 to 460800. At the receiver part, mobile receive the value of the direction signals which has established the serial communication between the mobile Bluetooth and microcontroller. The transmitter and receiver are the last tasks of the project. All the components and code are ready, then output is depending on the transmitted and received signal [3].

IV Results and Conclusion





The algorithm is designed to planning of paths in high-dimensional spaces and can be applied to robots with many degrees of freedom in static environments. In this experiment Encoder motor with compass sensor and Bluetooth connectivity are designed and developed to detect and determine the direction of the path and to move the robot to the desired place on the bases of path planning algorithms. HMC5883L compass sensor is very easy to use it in conjunction with microcontrollers due to I2C and SPI interfaces. Using the mobile application, we control the robot. The first time the robot starts moving and covers the path. In the end, press the stop button. This covered path is stored in the controller and also the controller is reset but the stored data is not erased. Then the robot can run multiple times on the same path and we achieved our final output. We can store one or more data paths in this algorithm. Then the robot can run multiple times on same path. This robot can be used in hospitals, manufacturing companies, and the medical field.

V. Future work

We can forecast with some degree of accuracy how the ongoing uptake of robots will affect industries, business models, jobs, and workers over the next 10 years. In this section, we look at the current state of robot implementation in three core industry sectors – manufacturing, logistics, and healthcare. robot adoption continues to increase globally. In this era of robotics, we can add some new path planning algorithms in a dynamic environment and create new purpose robots which will be helpful in all industries where robots are working. Mobile robot encountering any dynamic obstacles when traveling from the starting position to the desired goal according to the optimum collision-free path determined by the controller [4]. The controller should be capable of re- planning the new optimum collision-free path [6]. For designing, we can also use SoC, an advanced sensor like MaxBotix Ultrasonic Sensors. For path storage, we can use cloud storage.

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