Moving Video Camera Vigilance Using DBSCAN

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Abstract

The author is trying to develop a model for dynamic or moving video camera vigilance using Density Based Clustering and location sensors. The authors try to exploit the rich functionality exposed by the machine learning paradigm in which the stochastic environment to learn is depicted as a two dimensional graph where the position of an object can be given by its coordinates. The author uses DBSCAN algorithm along with sensor enabled test ground area that keeps the X and Y co-ordinates of the moving objects. The idea here is to capture continuous video of the densest cluster of objects moving together. One practical usage of such system is a wild landscape where groups of animals are moving together to some destination. There will be a somewhat unorganized haphazard movement but we intend to capture only those animals that are greater in number as a group and the camera should move picturing them. This can be achieved by the DBSCAN algorithm

1. Introduction

1.1 Clustering Techniques:

In Clustering we split the data into groups of similar objects. Each group is known as a cluster. The intra-cluster similarity is high while inter-cluster similarity index is low. It is a very important technique in data mining. Traditionally it is seen as part of unsupervised learning. Different types of clusters as reported in the literature [1], [2].

Well Separated Clusters: Every node in this type of cluster is much similar to every other node in the cluster, but different from any other node not in the cluster.

Centre-Based clusters: Every object in the cluster is more similar to the centre also called the centroid than to the centre of any other cluster. Contiguous clusters: A node in a cluster is nearest (or more alike) to one or more other nodes in the cluster as compared to any node that is not in the cluster.

Density based clusters: A cluster is a thick region of points, which is separated by according to the low-density regions, from other regions that is of high density Conceptual clusters: A conceptual cluster shares some common feature, or indicates a particular thought.

1.2. Use of Clustering and Methods

Clustering has wide applications in Image Processing, Document Classification, Pattern Recognition, Spatial Data Analysis, Economic Science and Cluster Web log data to discover similar web access patterns, etc. Various Methods of clustering have been reported in literature [3], [4], [5]:

Partitioning method: In literature different Partitioning methods reported are: K-mean method [3], [4], K-Medoids method (PAM) [5], [6], Farthest First Traversal k-center (FFT) [7], [8], CLARA [9], CLARANS [10], Fuzzy K-Means [11], Fuzzy K-Modes [12], K-Modes [13], Squeezer [14], K-prototypes [15] and COOLCAT [16], etc.

Hierarchical Methods: Agglomerative Nesting (AGNES) [17], Divisive Analysis (DIANA) [18], Clustering using Representatives (CURE), Balanced Iterative Reducing and Clustering using Hierarchies (BIRCH) are some of the hierarchical methods.

Grid Based: Some of the Grid based clustering methods are STING, Wave Cluster, CLIQUE [19] and MAFIA [20].

Density Based Methods: Density based clustering methods include DBSCAN, GDBSCANS, OPTICS, DBCLASD and DENCLUE.

Model Based method: Model based methods are divided into two approaches: Statistical approach includes AutoClass method while Neural Network Approach includes Competitive learning and Self-organizing feature maps.

2. DBSCAN

(**D**ensity-**B**ased **S**patial **C**lustering of **A**pplications with **N**oise) is a popular **unsupervised** learning method utilized in model building and machine learning algorithms. Before we go any further, we need to define what an "unsupervised" learning method is. **Unsupervised** learning methods are when there is no clear objective or outcome we are seeking to find. Instead, we are clustering the data together based on the similarity of observations.

DBSCAN is a clustering method that is used in machine learning to separate clusters of high density from clusters of low density. Given that **DBSCAN** is a **density based clustering algorithm**, it does a great job of seeking areas in the data that have a high density of observations, versus areas of the data that are not very dense with observations. DBSCAN can sort data into clusters of varying shapes as well, another strong advantage. DBSCAN works as such:

- Divides the dataset into *n* dimensions
- For each point in the dataset, DBSCAN forms an *n* dimensional shape around that data point, and then counts how many data points fall within that shape.
- DBSCAN counts this shape as a *cluster.* DBSCAN iteratively expands the cluster, by going through each individual point within the cluster, and counting the number of other data points nearby. Take the graphic shown in figure for an example:

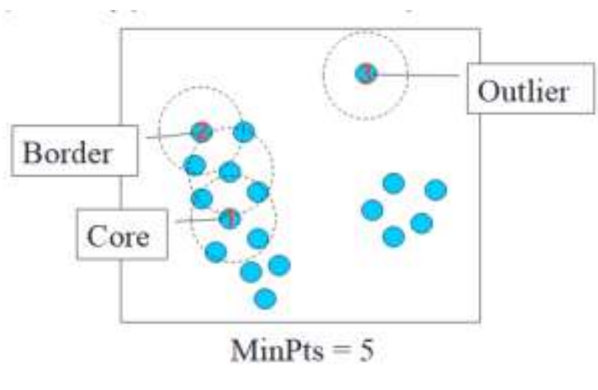

Fig. 1

3. Location Detection and Tracking of Moving Targets

Many applications require information about an object's location for rescue, emergency and security purposes. The approaches that access an object's location are typically divided into two groups: active and passive localization. In the former approach, the object is associated with a mobile station (MS), such as a tag or device in a communication network. The object's location is determined by sharing data between the MS and the base stations (BSs). The Global Positioning System (GPS), cellular networks, Bluetooth and wireless sensor networks (WSNs) are used in active localization. In the latter approach, the object does not communicate with other devices. However, the object's location can be determined by using the reflected signal from the object. Radio detection and ranging (radar), sound navigation and ranging (sonar) and laser detection and ranging (LADAR) are the most common types of passive localization. These methods have both advantages and disadvantages.

However, GPS and long-range radar generate many errors during indoor localization and tracking. Cellular networks and WSNs are limited by their complicated controls and protocols. Sonar and LADAR signals are degraded by environmental interference. Therefore, ultra-wide band (UWB) radar has become an emerging technology that is appropriate for indoor localization and tracking. UWB radar has many advantages, such as a high spatial resolution, the ability to mitigate interference, through-the-wall visibility, a simple transceiver and a low cost.

4. Methodology

The 2 dimensional area, A, assumed square in shape is plotted having X and Y coordinates. A random number of moving objects, here assumed to be small robotic cars with constant movement are left in the aforementioned area. Since the area, A, assumed here is small, location tracing sensors are fitted on the boundary of A. A video camera, C, is also planted which is used to position on the selected target. The ideal position of the camera should be on top, middle of A [21].

The DBSCAN algorithm then determines the cluster of robotic cars with maximum density. The algorithm also returns the center of the cluster which is one of the robotic cars. All the cars have built in emitters that generate a specific signal when they are selected as the center of the densest cluster shown in figure 1, called the core. Once the car is selected as the center of the densest cluster, it emits a signal that is received by the location tracing sensors [22]. As soon as the sensors receive the signal, they generate the X and Y coordinates of the car that emitted the signal. The coordinates are fed to the camera and the movement of the cluster gets recorded. This process is continuous and if the cluster changes then the process is repeated for the new cluster, center of focus being the new selected center of the densest cluster. The moving camera continuously positions its lens on the moving densest cluster and if the density of the cluster reduces then the new densest cluster is located by the DBSCAN algorithm and the camera starts focusing on the new most densely populated cluster.

The system demonstrated above can also find its application in larger areas. As pointed out earlier that the same process with slight modification can be applied to traffic monitoring and even wild life for framing videos on moving animals in groups, etc. With the aforementioned process a traffic accumulation can be reported or even a traffic jam for the traffic controllers.

In order to find the coordinates in bigger areas, we need the geo-locations in the form of the X and Y coordinates of the moving objects and the video camera will be fed with the coordinates as broadcasted by the satellites instead of location tracing sensors [23], [24].

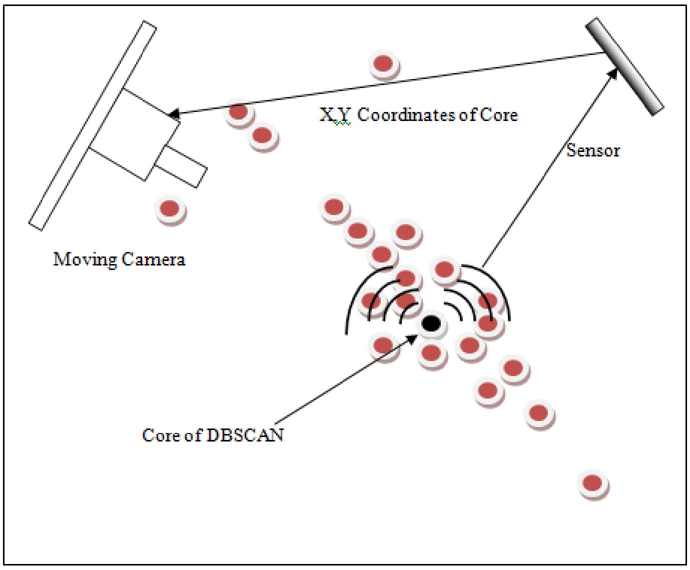

Fig. 2

5. Conclusion

In this paper the author has proposed a model to provide continuous moving camera recording for the most densely populated group of objects. Here, the author has used an unsupervised learning algorithm of the artificial intelligence, called DBSCAN to find out the most intensively crowded orientation of the objects under vigilance. The DBSCAN algorithm reports the densest point, called the core of a population. The crowd is depicted by robotic cars having a facility to emit radio signals. Once a robotic car is selected as the core, it emits radio signals. This signal is received by the sensor installed for this purpose. This sensor calculates the X and Y coordinates of the core robotic car and sends them to the positioning system of the camera. With coordinates at hand, the camera focuses its lens on the selected X and Y coordinates. In this manner, the automatic moving camera is able to keep track of the core. With time, the core is changed and so is the camera's focus. It focuses on the new car selected as the core. This installation facilitates a system where the camera always focuses on the densest part of the moving objects. As a future research, this concept can be applied in controlling the traffic, where the radio signals can be replaced by the geo-location finders.

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