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ANALYSIS & PREDICTION OF MISCHIEVOUS BEHAVIOR OF VEHICLE USING ANPR AND DBSCAN

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ABSTRACT

There are several frameworks to deal with vehicle number plate detection and recognition. Utilizing one of the best framework for the same and applying statistical algorithms will result some advantageous outcome to the society. In this paper ANPR (Automatic Number Plate Recognition) is used to detect and recognize the vehicle number plate from the captured image. The features like time, city and state along with recognized details are used to construct database. DBSCAN is applied on the data which is specific to a particular vehicle number and is also used to draw the conclusion regarding the behaviour of the vehicle.

KEYWORDS: ANPR, DBSCAN, Vehicle Number Plate Detection and Recognition, Traffic Department

INTRODUCTION

Experts predict that by the year 2020, there will be 450 million vehicles playing on Indian roads. At the moment the total number of vehicles in India stands at about 100 million. Most of the vehicles are owned in the urban areas with a maximum density in the metropolitan cities[11]. Our country is capable of maintaining all these vehicles. But the problem lies with the management of these vehicles. In this situation there are some people whose intention is to harm the society in any manner, so sometimes they steal others vehicle and use that vehicle for their illegal activities. Usually these people will not stay at one particular city. They move from one place to another within the state/country. Whenever there is a random or abnormal pattern found in the vehicle trajectory, it shows the vehicle is mischievous. This paper only predicts the mischievous vehicle but not conclude the same.

METHODOLOGY

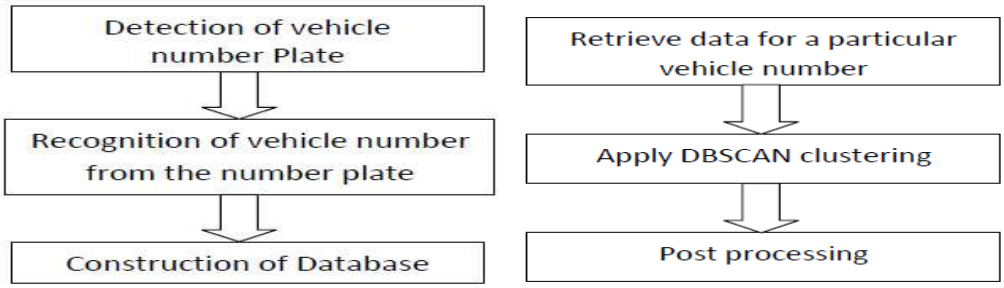

Figure 1: a) First Phase (Database Construction) b) Second Phase (Analysis and Prediction)

In the first phase, the image is captured and send to centralized server. The accepted image will be processed to recognize vehicle number and store it into database. Where as in the second phase the data is retrieved from the database for a particular vehicle number and DBSCAN is applied to cluster the samples. Then proceed with post processing steps,where it highlights the decision making concepts.

REVIEW OF LITERATURE

In [3], for faster detection of region of interest (ROI) a technique called sliding concentric window (SCW) is developed. It is a two step method contains two concentric windows moving from upper left corner of the image. Then statistical measurements in both windows were calculated based on the segmentation rule which says that if the ratio of the mean or median in the two windows exceeds a threshold, which is set by the, then the central pixel of the windows is considered to belong to an ROI. The two windows stop sliding after the whole image is scanned. The threshold value can be decided based on trial and error basis.

An Improved bernsen algorithm is used in [5] for license plate location. This algorithm is used for the conditions like uneven illumination and particularly for shadow removal. The authors used local Otsu, global Otsu, and differential local threshold binary methods for good accuracy. By using this algorithm, shadow was removed and license plate was successfully detected, which was not possible with the traditional bernsen algorithm.

To locate Chinese number plate Hui Wu and Bing Li [6] proposed a method to find horizontal and vertical difference to find exact rectangle with vehicle number. The Authors converted vehicle image into gray scale and then applied automatic binarization using MATLAB. Any further detail regarding number plate detection algorithm is not mentioned in this paper.

To extract license plate characters in Indian condition Ch.Jaya Lakshmi et al. [4] proposed a novel approach which is based on texture characteristics and wavelets [7]. The authors also used morphological operation [8] for better performance in complicated background. Sobel mask is used to detect vertical edges. The system was implemented using MATLAB. A Sobel edge detector operator is also used in [9].

In [10], license plate character extraction for video is discussed. As per Cui, Yuntao, localization of license plate means finding text in the images. The authors assumed license plate with light background and characters with dark back ground. To do localization, spatial variance method is used for finding text regions and non text regions as high variance means text region and low variance means non text region.

ANPR (Automatic Number Plate Recognition)

ANPR uses a series of image manipulation techniques to detect, normalize and enhance the image of the number plate, and then optical character recognition (OCR) to extract the alphanumeric of the license plate. The algorithm takes a raster image of the rear or front view of a vehicle as input and yields the recognized numbers and characters in the number plate as the output. Following are the steps in ANPR.

Image Acquisition

It is the process of obtaining an image from the camera. In the current research the images using a digital camera placed by the road side facing towards the incoming vehicles are acquired . Here the main objective is to get the frontal image of vehicles which contains license plate. The remaining stages of the system works in offline mode.

Grayscale Image: After acquiring the image, the very next step is to derive the gray scale image. Pseudo code to convert an image to a grayscale:

Step 1: Load the image

Step 2: Retrieve the properties of image like width, height and nchannels

Step 3: Get the pointer to access image data

Step 4: For each height and for each width of the image, convert image to grayscale by calculating average of r,g,b channels of the imageconvert to grayscale manually

Step5: Display the image after converting to grayscale

Sobel Edge Detection: It is used to find the edges of the given image. The process is explained in the figure 2 and figure 3 below

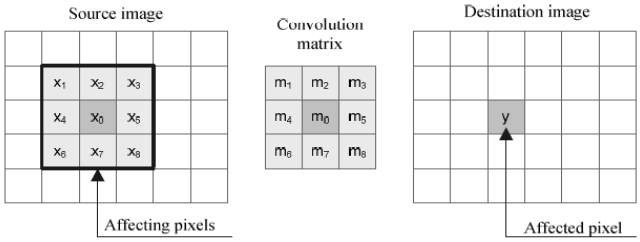

Figure 2: Convolution Process for Edge Detection Using Sobel

$$\mathbf{G}_x = \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix} ; \mathbf{G}_y = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}$$

Figure 3: Convolution Matrices of Sobel Edge Detector

Image Processing

Pre-Processing: It is the first step in number plate recognition which consists of the following two stages

Binarization: The input image is initially processed to improve its quality and prepare it to next stages of the system. First, the system will convert RGB images to gray-level images.

Noise Removal: In this stage the noise of the image is removed i.e., while preserving the sharpness of the image. Once the Localization of the Number Plate is successfull, next is to go on with Optical Character Recognition which involves the Segmentation, Feature extraction and Number plate Recognition.

Character Segmentation: The most important processes in the automatic number plate recognition is segmentation, as all further steps rely on it. If the segmentation fails, a character can be improperly divided into two pieces, or two characters can be improperly merged together.

The Steps involved in character Segmentation are:

Preprocessing: It consists of conversion to grayscale and binarization using a object enhancement technique. The steps involved are: Conversion to Grayscale, Binarization. Compared with the usual methods of image binarization, this algorithm uses the information of intensity and avoids the abruption and conglutination of characters that are the drawbacks of usual image binarization techniques.

Object Enhancement Algorithm: The quality of plate images varies much in different capture conditions. Illumination variance and noise make it difficult for character segmentation. Then some image enhancement should be

adopted to improve the quality of images. For character segmentation, only the character pixels need to be enhanced and the background pixels should be weakened at the same time. The following figure 4 (a) and (b) shows the result of object enhancement.

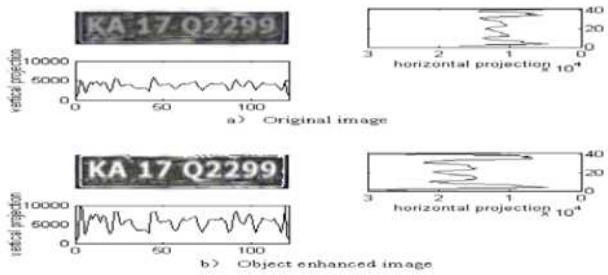

Figure 4: a) Original Image b) Object Enhanced Image

A horizontal projection of a number plate for the segmentation, or one of the more sophisticated methods, such as segmentation using the neural networks can be used. In this two types of segmentation is used:

- Horizontal segmentation
- Vertical segmentation.

Firstly vertical segmentation is done on the number plate then the characters are vertically segmented. After performing vertical segmentation, horizontal segmentation is performed inorder to get character from the plate.

Optical Character Recognition

OCR is consists of two important steps, training and recognition. Training: The program is first trained with a set of sample images for each of the characters to extract the important features based on which the recognition operation would be performed.

Preprocessing: Before preparing the template for each of the characters for further use, processing on the images is done. The following are the operations that are performed: Binarization, Inversion of intensity of the characters.

Extract License Plate: From the above steps, we can get the row and column position of the license plate. Implemented algorithm at times gives more than 1 license plate on detection.

Figure 5: A) Vehicle Jpg B) After Binarization and Noise Removal

Figure 6: Candidate Regions

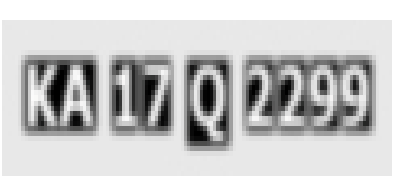

Figure 7: Extracted License Plate Figure 8: Segmented Number Plate

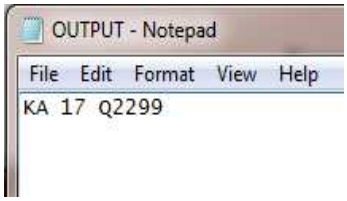

Figure 9: Recognized Number Plate of the Vehicle

DBSCAN

The key idea of density based clustering is that for each object of a cluster the neighbourhood of a given radius ε has to contain at least a minimum number of μ objects, i.e, the cardinality of the neighborhood has to exceed a given threshold. The following are the basic definitions of density based clustering.

Definition 1: Core Object

Object o is called a core object w.r.t ε and μ in a set of objects D, if |N ε(o)|>= μ, where N ε(o) denotes the subset of D contained in the ε neighborhood of o.

NEps(p) = {q ϵ D|dist(p,q)<Eps}

Definition 2: Directly Density-Reachable

Object p is directly density-reachable from object o w.r.t ε and μ in a set of objects D, if o is the core object and p ϵ N ε(o), where again N ε(o) denotes the subset of D contained in the ε-neighborhood of o. note that objects can be directly density reachable only from core objects.

Definition 3: Density-Reachable, Density-Connected

Object p is density-reachable from object o w.r.t ε and μ in a set of objects D, if there is a chain of objects $p_{1,\ldots,}p_{n,}$ $p_{1=}o$, $p_{n=}p$ such that $p_i \epsilon$ D and p_{i+1} is directly density-reachable from p_i w.r.t ε and μ. Object p is density-connected to object q w.r.t ε and μ in the set of objects D, if there is an object o ϵ D such that both p and q are density reachable from o w.r.t t ε and μ in D[2].

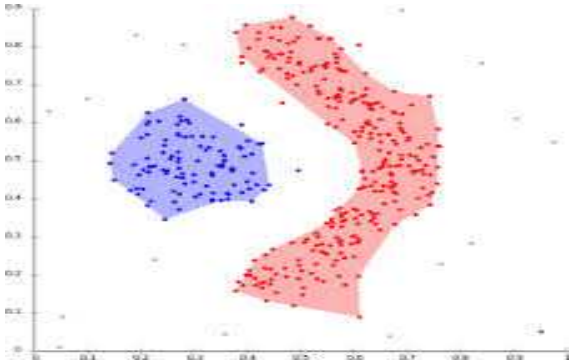

Figure 10: Db Clustering

PROPOSED SYSTEM

The proposed system works in 2 phases, Construction of Database and Analysis & prediction using DBSCAN

Construction of Database

The data which has been collected from different cameras across the country is stored in the database with the following fields like STATE, CITY, CAMERA ID, VEHICLE NUMBER, TIME AND TIMESTAMP. The sample set of data is shown for a particular vehicle number is as shown in the figure 11. The records for the table are found by using ANPR system at each entry and exit of the district. When a vehicle enters the city, the entry camera captures an image and sends the data to the centralized server. At the server, processing of the captured image for the number plate detection and recognition takes place. Once it finds the details, the data goes to database.

State	Dist	Cid	Vehicle Num	Time	Time Stamp
KA	DVG	2	KA17Q2299	8.35	176766
KA	DVG	3	KA17Q2299	15.30	176798
KA	DVG	2	KA17Q2299	8.40	176853
KA	DVG	3	KA17Q2299	16.03	176881
KA	DVG	1	KA17Q2299	8.45	176930
KA	DVG	3	KA17Q2299	16.40	176768
KA	HAR	4	KA17Q2299	13.50	176987
KA	HAR	5	KA17Q2299	15.40	176787
KA	DVG	1	KA17Q2299	16.25	176776

Figure 11: Sample Table Showing Data of Particular Vehicle

ANALYSIS AND PREDICTION USING DBSCAN

Applying DBSCAN algorithm on the retrieved data set for a particular vehicle number. DBSCAN clusters the data as shown in the figure 12

There are total of 3 and city wise 2 clusters in the graph. For a state Karnataka, there are around 30 districts. So the probability of mischievous vehicle is given by

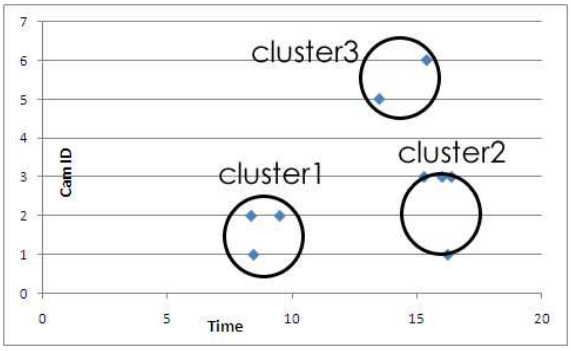

Figure 12: Showing Clusters Done Using DBSCAN on Figure 13

P (MD) = Total Number of Districtwise Cluster / Total Number of Districts (1)

Also

P (MS) = Total Number of Statewise Clusters / Total Number of States (2)

Here P(MD) is the probability of Michievous vehicle when district wise clusters known and P(MS) is the probability of Mischievous vehicle when state wise clusters known. When P(MD) crosses 0.6 or P(MS) crosses 0.3 immediately system will report to traffic department for further investigations.

POST PROCESSING

Case 1: ***Mischievous Vehicle***

From the figure 12 there are 2 district wise clusters, if there are only 3 districts in the state then the P(MD)>0.6 it says that the vehicle is suspicious and it is to be tracked based on timestamp. Similar to P(MD) P(MS) is estaimated. Here instead of number of districts, it takes number of states and number of state wise clusters

Case 2: ***Not a Mischievous Vehicle***

From the figure 12 there are only 2 district wise clusters, If there are total of 30 districts then P(MD)<0.6. it says that the vehicle is not suspicious. Similar to P(MD) P(MS) is estaimated. Here instead of number of districts, it takes number of states and number of state wise clusters

EXPERIMENTAL RESULTS

For the experiment, it is assumed that there are only 4 districts in a state. The figure 13 shows that there are about 9 clusters are formed using DBSCAN. When it is done according to districts it becomes around 3 clusters. The total number of districts 4 and total number of district wise clusters are 3.

P (MD) = #district wise clusters / #districts = ¾ =0.75

This0.75 > 0.6, so this vehicle details will be notified to the traffic department Where as from the figure 14

P (MD) = #district wise clusters / #districts = ¼ = 0.25

Here 0.25 < 0.6, It shows that vehicle details need not necessary to send to traffic department for further investigations.

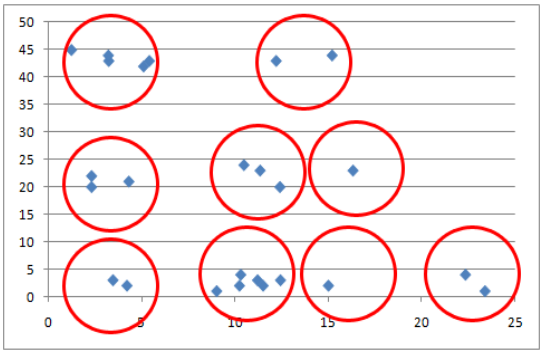

Figure 13: DB Clustering for Success Case

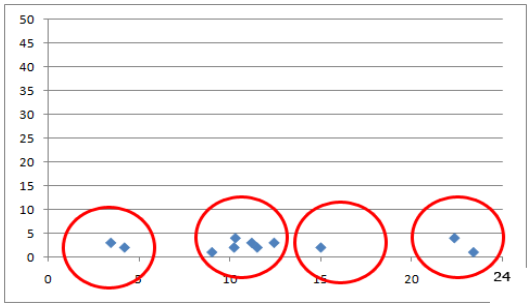

Figure 14: DB Clustering for Failure Case

CONCLUSIONS

In the present hasty increase of traffic in the cities, the need of automatic system is obligatory to find and console the mysterious trajectories.

In this concern, the proposed paper tries to give the solution to blueprint the automated system for civilian purpose in the country and for the military department as well which inturn helps to avoide the misusing of vehicles for that matter any illegal activities.

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