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Vehicle Number Recognition From Vehicle Images using CNN

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Abstract: ***Automatic vehicle number recognition is used to recognize the vehicle number plate from images of vehicles and also the number from the number plate. It plays an important role in some applications such as automated parking, over speed tracking of vehicles, road traffic monitoring and issuing fine for traffic rule violators. Several challenges like number obstruction, faded numbers, blurring, time consumption, etc. are involved in number recognition from real-time images. We survey the techniques that have been applied for this problem. We also provide a classification of the techniques which will be useful for researchers to identify research gaps in this area. Finally, we provide future scope for research in this area.***

Keywords: License plate recognition, Extraction of character, Character Segmentation.

I. INTRODUCTION

Automatic number plate recognition was invented in the '80s. It was first used by the police in the UK. It helped them to detect vehicle numbers from video footages to file case against violators with proof. Nowadays, vehicles play an important role in transportation and their applications are increasing rapidly. To overcome issues in the modern world, new technology is being used every year. These technologies help us to detect the details from a picture or video footage to let us detect and recognize the number of a vehicle automatically. Number plate recognition is useful in controlling vehicle traffic like parking area, over-speed detection, violation of traffic signals, etc. For example, in speed violation application, it is used to detect the number from number plate of vehicles crossing speed limit and send fine to the violators. There are some studies in the literature investigating speeding as the cause of accidents. As an example, the study of [14] Cabral et al. aims to contribute to the reduction of accidents caused by speeding. Automated number recognition helps the driver to follow the traffic rules and control speed

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It is also very important for the development of the transportation infrastructure globally in applications such as auto-scanning of vehicle numbers entering and leaving the gate in campuses. It will also be useful in shopping malls, corporate companies, etc., The advantage with vehicle number recognition system is that it identifies vehicle number plate without human intervention. In previous methods, it was done with only the edge detection or color based methods in which it is computational complex to detect image in all conditions like

unequal level of plate or blur of the image or video and also it may not be supported for all the climatic conditions like dull light, night, Rainy, etc., In this paper, we survey the different techniques to automatically recognize and detect the number plate and also the characters in number plate. Because it can have high efficiency and accuracy. We can also use low-level features for both detection and recognition but it may not be as accurate. But our system can detect the number plate and Recognize the number from detected number plate be supported in any type of environmental conditions and also in all climatic conditions. Automated number recognition can also be called by other various names such as automatic license plate recognition, automatic license plate reader, number plate tracking, car plate recognition, vehicle number plate recognition, automatic vehicle identification, etc.

The rest of the paper is organized as follows: Section II provides a survey of literature on the topic number plate recognition. Section III gives the survey of the literature in character segmentation and recognition. Section IV gives the survey of the literature in the area of extraction of images. Section V concludes the paper.

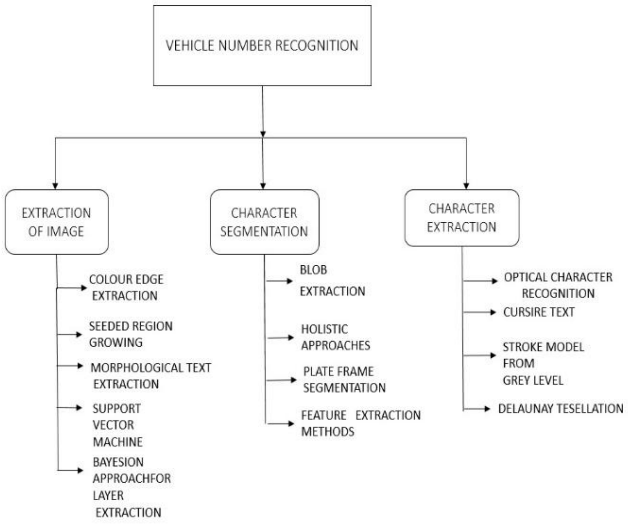

Fig. 1: Classification of Techniques used in Vehicle Number Recognition Systems

II. RELATED WORK ON NUMBER PLATE RECOGNITION

Automatic number plate recognition was invented in the '80s but the problem is being studied since the '90s. Several approaches have been studied so far. We describe some of them in this section.

Early methods are based on the boundary lines [1]. It means that it can detect based on the outer lines of the region. Initially, the input image is processed to enhance it and then some of the algorithms such as gradient filter are applied. This converts the image in the form of edges. The next step is converted into the binary counterpart and then processed by the Hough transform algorithm. The Hough transform algorithm is used to detect lines in the image. Which couple of lines together is described as the plate designate.

In another work, [2] license Plate Detection and Recognition is done using Mathematical Morphology and Support Vector Machines. In this, the proposed model consists of three steps. They are 1) Number plate detection 2) Segmentation 3) Recognition of number. Initially, the RGB image is converted into the greyscale image. To identify the license plate and extract it. It can be done with the help of contract enhancement. In this method, it consists of two operators such as Sobel operator, erodes operation. Sobel operator is used to tracking all the edges present in the image. Erode operation is used to eliminate the objects that are less than the license plate. The author used 8 connected component algorithms for the segmentation process. In which each character is clipped and then processed individually. Then the greyscale image is converted to the binary image for thresholding. Thresholding consists of two approaches know as a global approach and a local approach. The global approach is used to assign the threshold value for each pixel whereas the Local approach is defined as it can be applied to the individual local properties of images such as image is divided to sub-image in which the value is assigned to that. Generally, the histogram is used to calculate such threshold value. Then opening and erosion are used to remove the unwanted part from the number plate. And then finally the Support vector machine (SVM) is used as a classifier for input image from the number plate. After the segmentation step, the character is resized and features are formed.

MSER, also known as the Maximally Stable Extremal Region has been used in several other papers. The MSER method can also be applied for license plate detection and recognition [3]. In terms of preprocessing the image scaling and gray scaling are also applied. Grayscale transformation is used to reduce or convert the edge intensity and low edge intensity of the input image. The maximally stable extremal region is extracted from an image using some parameters. And some of the morphological processes are applied to process. In which this process helps them to eliminate the noise from the input image. horizontal projection is used to define top and bottom borders of the license plate and left and vertical projection are used to define top and bottom borders.

Number plate recognition can be done using the edge detection and morphological process [4]. In the process, they have used the operator known as Robert operator. Generally, the Robert operator is defined as the 2*2 operator in which it helps to find the edge operation and also the partial differential operator. But in this process to improve the performance of the operation, they have improved their algorithm. To improve Robert algorithm, they have followed some steps such as greyscale conversation, mean filter and image binarization. In which the image is converted into a greyscale image and then the binarization process is held for using the threshold value. In the binarization process, it helps to divide the image into the foreground and background. And then the threshold selector for the Robert operators. Finally, the character is recognized from the detected license plate using the morphological process.

In [5], Vehicle Identification on public roads (VIPUR) has been done. In this paper, they have used DT-CNN and classifier combining the process. In which they have considered 8-bit images as the input images. According to the paper, they have assumed that the number plate will be rectangular in most of the cases and also the character or number present in the number plate will be dark in color. They have used some of the processes such as conversion to greyscales and texture features. DT-CNN is used to specify the numeric value to each pixel of the image. It consists of two values that are 1 value is used to determine it as grey value and the second value is -1 value in which it helps to determine that it is the color pixel and is outside the grey value. Based on the greyscale they have prepared a table. According to their paper, they have fixed some values in the table for plate recognition. In this Sobel operator is used for texture feature. This operator uses the 3x3 matrix operator to each pixel of the image. According to their survey, they have some Sobel value for a license plate which more than the 0.73. Next is to detect the required part from the image by dimensions. In this process, it will help to eliminate the non-plate regions by minimizing and maximize the height and width of the region using DT-CNN. Union and subtraction are combined applied for license plate detection.

License plate detection is also done by global edge features and local Haar-like features [6]. In this system, the predefined classifier is used to scan the windows based on the number plate region and also number plate which are not present in the region. In which it consists of Training and testing. In training, it consists of six classifier layers. In the testing process, the two features are taken place and extracted. This one feature is generally used for gathering the information of the number of rectangles shapes that are covered in the input image. Another feature is to include the edge density and variable of density. In these, it consists of some fixed value in which it is predefined in the training process such as 38x19. For this process, the average time for recognition is 0.204. These proposed models is applicable for CCTV video footage.

In another paper [7], various methods have been applied to recognize the number plate in various conditions. Initially, the Greyscale convention is used for the pre processing step for the segmentation process.

In these, the image is split into a small region to make applying the thresholding method after which segmentation is done. According to the algorithm is applied to it. But the author designed an algorithm for the Japanese number plate. And also it will accurate for the brightness of the image.

In license plate recognition can also be detected by the other techniques. They are color, edge-based methods [8]. In which initially the pre processing step is taken place to improve the image intensity and eventually the edge-based technique is also applied to recognize the number plate. In the edge-based approach, it consists of a vertical approach and a horizontal approach. In this process, they have used both of them to improve the detection of the plate even in the bad brightness of the image. In these next steps is Gaussian mixture is used to give value to the intensity value of the region and then it consists of 80% thresholding value to it. And then finally the morphological process and color based are used to that region for detecting the number plate.

III. RELATED WORK ON CHARACTER SEGMENTATION AND CHARACTER RECOGNITION

In [8], the author designed a paper for the Indian vehicle number plate. For the character, segmentation is done by using the image scissoring algorithm. In which character recognition is done by statistical feature extraction. This algorithm works in scanning the greyscale image of the detected number plate. It scans vertically and horizontally with no white pixel and content is saved in the matrix. If more than one matrix is present then the unwanted matrix will be eliminated by using the algorithm based formula. In which the character is segmented and then moves to the next step for character recognition.

In [10], vehicle number recognition method contains three steps of the process by the author. In this paper, the author has proposed the algorithm known as the improved projection approach. In the Initial step, vertical and horizontal lines are scanned. The next step is for auxiliary lines are drawn between the character to explore the corners. In final step is for character segmentation after some of the thresholding processes. In some of them clipper is used to detect the rectangular boxes from the number plate and then it is separated into the boxes and then the feature extraction, classifier are used to recognize the character. This algorithm is known as character clipper.

In [11] character recognition is done using neural networks. This paper aims to detect or recognize the character from the given input image. The study of these changes the nature of ANN. This paper mainly describes the methods based on the neural network used in OCR. In this method, they have some desirable parameters like depth of layers and size of layers in the neural network. And also they have considered some processing techniques like segmentation of character, Normalizing character. Concerning this, they have a test set to find out the accuracy rate of the process.

In character segmentation is generally done by different approaches. In [12], it is done by using the vertical projections. In these license plate recognition process it consists of step by step process.

They are noise removing, plate location, character segmentation, character normalized, Result of identification. In the process of segmentation, it mainly consists of horizontal projection and vertical projection. This horizontal projection calculation is used to calculate and remove the horizontal Lines or frames from the input image. Eventually calculating the vertical projection for finding the boundary of character in the input image or license plate. But before applying we must remove all interference from the number plate. Generally the horizontal is used to detect the top and bottom edges of the image and also vertical projection is used to analyze the intensity change of image. In which both of these can be applied are the detection of the license plate from the image. And by applying some of the operation two-dimensional image content into the addition of one-dimensional rows pixels. Finally, the recognition part is done by the template matching or by the neural networks. But in these, the algorithm is trained by keeping the ideal Image for training. In which it should not contain any other distortion, blur and ideal angle of number plate. In real-time, no ideal image will be found in these real-life applications.

In [13], character segmentation is done by the median filtering and blob coloring method. According to their survey, Histogram is used to develop the efficiency of poor images. Median filtering is used to eliminate the noise regions. In this method, the L shape method is used to scan the image. Blob coloring algorithm is applied to the binary image for the segmentation process. In this process, the characters are divided into the box with some specific size. In which it makes them easier for character recognition.

IV. RELATED WORK ON EXTRACTION OF IMAGES

In [15] the author proposed the three normalized approaches such as Contrast Limited Adaptive Histogram Equalization, Discrete Cosine Transform, and Adaptive Histogram Equalization. These approaches help them to recognize the features from the face by using principal component analysis. Then the extracted features will transfer to the Euclidean distance for classification of images. In these, the author used two data sets known as ORL and FERET data set. Finally, a comparative analysis is applied to the data set for facial recognition. The classifier is used to describe whether it is matched or mismatched.

In their paper [16] author has tested more numbers of images with vehicles, not only passenger cars but also vans and trucks. Images from a large indoor parking place with different angles and different lighting conditions. The image acquisition system consists of a CCD camera, a photo sensor to detect the presence of a car. and a personal computer with an image grabber in it. The size of the image is 640x492. 1,000 of them were used for the evaluation purpose.

The experimental result shows that the proposed algorithm locates correctly the plate area for 90% of the images used. Sources of the failure can be classified into three major categories: existence of other text blocks, bounding box containing the plate is merged into another box,

and weak gradient information from the plate area by combining the features using the neural network the system becomes more robust against the noise and tilt comparing to the other method.

V. RESULTS AND DISCUSSION

Vehicle number plate detection is performed by the various algorithm. But some the algorithms have achieved good accuracy. For instance, Convolutional Neural network used for classification of number plate has shown good results. The purpose of classification is used to identify whether the image consists of number plate or not. If the image consists of number plate then it the will be detected from image and Number will be extracted from the detected plate using morphological process.

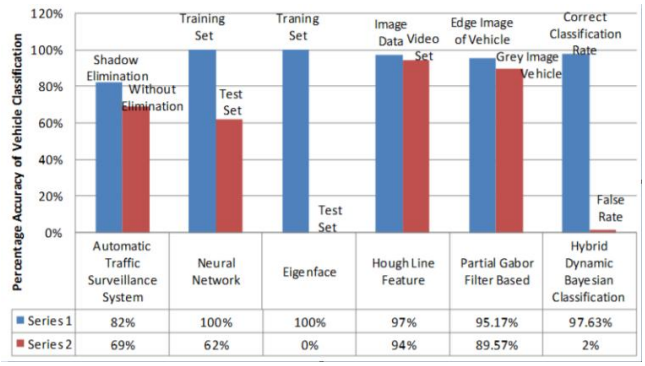

Fig. 2: Accuracy of vehicle classification of various algorithms

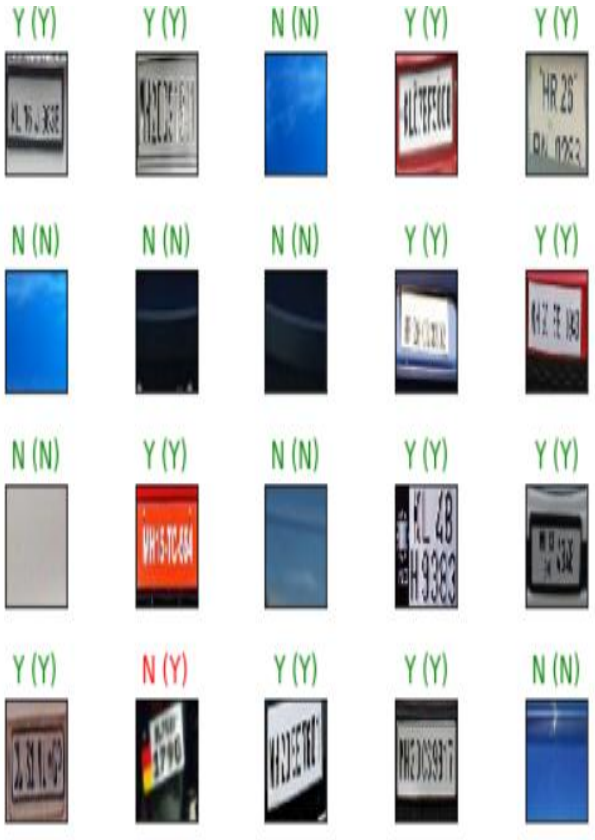

Fig. 3: Vehicle Number Plate classification using neural network

Fig. 4: Vehicle Number Plate Detection

VI. CONCLUSION

In this paper, we have surveyed all the techniques for vehicle number recognition using vehicle images. We have also given the classification of techniques for Extraction of images, Character Segmentation, Character recognition. From this survey, we concluded that edge detection and morphological process are more commonly used. There is more scope for research in extracting the vehicle numbers in rainy conditions, half-obstructed characters, blurred images, etc. Improving the resolution using GAN and applying deep neural networks in many other ways will make automatic vehicle number recognition a reality and will have many useful applications.

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Usha Kiruthika is currently working as an Assistant Professor in the Department of Computer Science and Engineering in SRM Institute of Science and Technology, Kattankulathur Campus. She has completed her Ph.D at Anna University and she has many publications to her credit. Her areas of interest include artificial intelligence and deep learning.

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