AUTOMATIC NUMBER PLATE RECOGNITION (ANPR) SYSTEM FOR INDIAN CONDITIONS USING SUPPORT VECTOR MACHINE (SVM)

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***Abstract*—Automatic Number Plate Recognition (ANPR) System automatically recognize the number plate of the vehicle. In this paper proposed approach is present. It has considered the Indian number plates, where rear follows the number plate standards. This system consist of few algorithm like "Feature based number plate Localization" for locating the number plate, "Image Scissoring" algorithm for character segmentation and proposed algorithm for character recognition using Support Vector Machine (SVM).System can recognize single or double line number plate.**

Keywords-Feature based number plate Localization, Image Scissoring, character reorganization using SVM.

I. INTRODUCTION

ANPR is a mass surveillance system that captures the image of vehicles and recognizes their license number. Some applications of an ANPR system are, automated high-way toll collection systems, automation of petrol stations, journey time monitoring [1].

In parking, number plates are used to calculate duration of the parking. When a vehicle enters an input gate, number plate is automatically recognized and stored in database. When a vehicle later exits the parking area through an output gate, number plate is recognized again and paired with the first-one stored in the database. The difference in time is used to calculate the parking fee [4].

In some countries, ANPR systems installed on country borders automatically detect and monitor border crossings. Each vehicle can be registered in a central database and compared to a black list of stolen vehicles. In traffic control, vehicles can be directed to different lanes for a better congestion control in busy urban communications during the rush hours [4].

In tradition, a general recognition method of supervisory vehicle apparatus usually uses human to recognize the license number monitored by a camera. Basically, using human to recognize vehicle license number in this way may solve the problems. But using people to do the recognition takes time and needs many workers to do this work. Hence, we want to develop a system for the vehicle identification to help a human operator and improve the service or work quality [9]. In this paper, we proposed system that incorporates a novel combination of image processing and artificial neural network technologies to successfully locate and read Indian vehicle number plates in digital images.

A. Existing Approaches

Indian number plates can have single row or double row. Few types of variations found in Indian number plates have been shown in the figures 1 [2]. There are a number of algorithms proposed for number plate localization such as multiple interlacing and transform domain filtering. In case of multiple interlacing algorithm [5], horizontal edge detection and vertical edge detection is performed separately on input vehicle image. Then horizontal and vertical edge detected images are added to get an image which avails co-ordinates of number plate. This approach cannot be employed for Indian number plates because they do not necessarily have a border which mandatory for this algorithm. Transform domain filtering is another approach in which high frequency area of input image is taken out as number plate. This algorithm is also not suitable for Indian conditions because of the presence of other characters or character like structures in input image [7].

Fig.1 Example of Indian number plate–with unwanted drawing and text

B. Proposed Approach

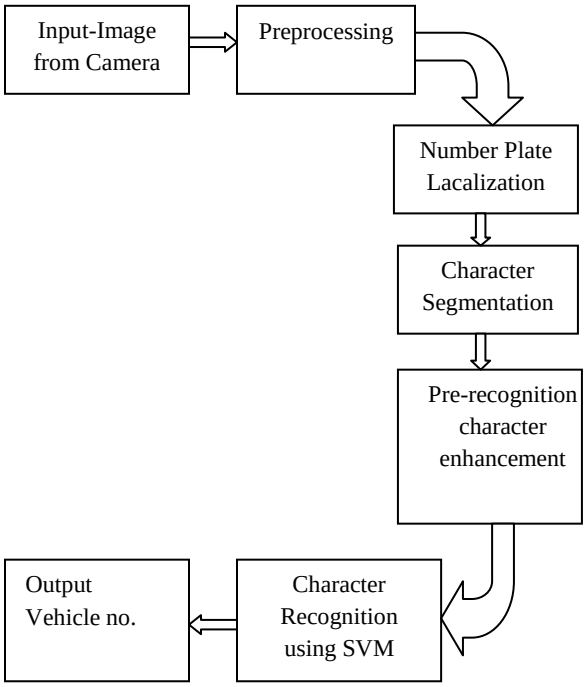

Fig.2 Proposed ANPR System

In this proposed approach consist from various fields (Fig.2), such as input image from camera, pre-processing, number plate localization, character segmentation, character recognition using SVM. These fields describe in father section in detail.

II. Pre-processing and Number Plate Localization

The input image for pre-processing is a gray-scale image taken from an Infra Red (IR) camera. Preprocessing has to be performed by taking into account the background illumination conditions and the number plate localization algorithms which are employed in the further steps. It is important to eliminate as much background noise as possible in the pre-processing step itself to optimize the localization algorithm and also save the processing time [7]. A number of algorithms are suggested for number plate localization such as: multiple interlacing algorithm, Fourier domain filtering, and color image processing. These algorithms however do not satisfactorily work for Indian number plates since they assume features like: border for the plate, color of plate and color of characters to be present on the number plate [1].

Hence, we observe 'Feature-based number plate localization' method well suited for Indian conditions. This approach consists of number of algorithms developed on the basis of general features of both, characters and number plate [1].

To eliminate the effect of shadows and to eliminate the low contrast area of an image, binarization has to be performed adaptively. Some approaches like Otsu's algorithm and Niblack's algorithm were tested [7]. The corresponding results are shown in figures 3 and 4 respectively. After testing on many images, it is observed that, Niblack's algorithm provided robust thresholding in the presence of shadows and other image defects [3]. It also provide better result as compare to Otsu's algorithm, But it takes more processing time as compare to Otsu's algorithm. Also, Otsu's method, being globally adaptive, provides satisfactory results for a wide variation in selected for binarization [7].

Fig.3 Output of Otsu's algorithm

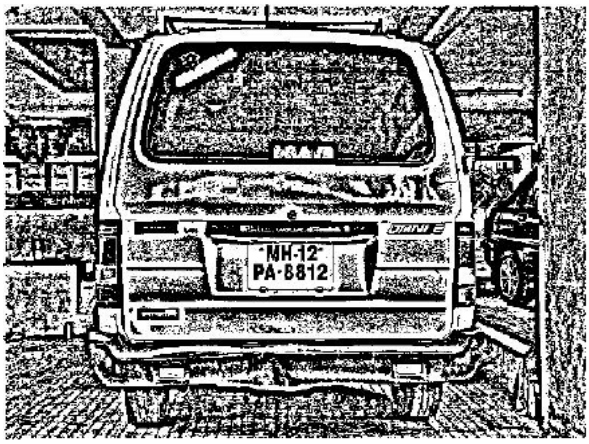

Fig.4 Output of Niblack's algorithm

Following steps are describing the preprocessing and number plate localization using Otsu's algorithm.

Step1. A mask having shape of inverted 'L' and size equal to maximum possible character dimensions is rolled throughout the binary image. At every increment, a position is shortlisted as possible character location if: There is at least a single white pixel on the mask and there is at least a single white pixel on the immediate next row and column of the mask [1].

Step2. Calculate size of each shortlisted character. If it is less than half of maximum possible character size that location discarded.

Step.3 White pixel density of each probable character is calculated. If it is above 40% of total number of pixels, only then the location is preserved. Above steps is multiple iteration step that take some time to perform. But preceding steps carried out in single iteration to achieve time optimization.

Step.4 For a set of rows having height equal to maximum possible number plate height, white pixel density is calculated. If it is not above certain threshold, that area is discarded.

Step.5 For a set of columns having width equal to maximum possible number plate width, white pixel density is calculated. If it is not above certain threshold, that area is again discarded [1].

Step.6 if false number plate location is present, it is discarded by using character count. The number of characters in finalized number plate areas is calculated. If number of characters is less than four, then it is discarded. If two number plate areas with nearly same number of characters are found to be closer to each other, those areas are merged together.

Hence, double row Indian number plates can also be located and extracted. After applying these steps on an input image, all other unwanted data except number plate is removed. Number plate co-ordinates are applied on an input gray-scale image and number plate is extracted. Extracted number plate is adaptively binarized using Otsu's method to enhance its quality. Shows extracted binarized number plate (fig 5)[7].

Fig.5 Localised and enhanced number plate

After applying these steps, the number plate within the image is exactly located and eliminating the background noise .Here we get the exact vehicle number plate.

III. Character Segmentation

The next step after the identification of the rectangular plate is to isolate its characters or digit contents. Various methods like blob coloring [3], peak-to-valley method [8] are suggested for character segmentation. However, these methods are not suitable for Indian number plates since they do not provide good results in cases where the characters are overlapping and are also time consuming.To have reliability and time-optimization, a new 'Image Scissoring' algorithm is developed. In this algorithm, the number plate is vertically scanned and scissored at the row on which there is no white pixel (i.e., a blank row) and the scissored area is copied into new matrix. This scanning procedure proceeds further in search of a blank row and thus different scissored areas are obtained in different matrices. Indian number plates can have either single or double rows. Hence, maximum two matrices must co-exist. To discard false matrices, heights of the matrices are compared. If the height of any of matrix is less than 1/4th of the height of tallest matrix, then the prior matrix is discarded. The same procedure is repeated horizontally on each matrix and using width as a threshold, individual characters are segmented (Fig.6) [1].

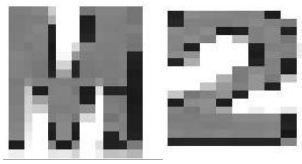

Fig.6 Sample output of Image Scissoring.

IV. Pre-recognition character enhancement

Before going to character recognition step. You have to enhance the characters which are getting from character segmentation. Segmented characters are extracted from input grayscale image. Then each character is adaptively binarized using Ostu's method. After that, the binary character is scissored centered. These steps help to optimize the further recognition process (Fig.7) [1].

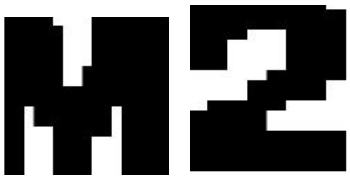

Fig.7 Sample output after character enhancement.

V. Character Recognition Using SVM

The fundamental issue in number recognition is shape analysis. Many methods on shape analysis have been seen in the past ten years such as methods using Morphological Functions, methods based on gradient propagation and methods by comparing weighted shape graphs. Many other techniques such as Fourier description, template matching, invariant moments and neural network are also used for shape analysis [6].

In this paper, we propose another algorithm to number recognition. This technique uses a Support Vector Machine (SVM) to train character samples and obtain the rules that are used to recognize the numbers on number plates. SVM is forcefully competing with many methods for pattern classification. An SVM is a supervised learning technique first discussed by Vapnik. SVM takes Statistical Learning Theory (SLT) as its theoretical foundation,
and the structural risk minimization as its optimal object to realize the best generalization. They are based on some simple ideas and provide a clear intuition of what learning from examples is all about. More importantly, they possess the feature of high performance in practical applications. From 1960s to present, SVMs become more and more important in the field of pattern recognition [6].

A. *Principles* of *SVMs*

An Support Vector Machine (SVM) is a pattern recognizer that classifies data without making any assumptions about the underlying process by which the observations were granted. The SVMs use hyperplanes to separate the different classes. Many hyperplanes are fitted to separate the classes, but there is only one optimal separating hyperplane. The optimal one is expected to generalize well in comparison to the others. The optimal hyperplane is determined only by support vectors which are ideally distributed near class boundaries. The hyperplane is constructed so as to maximize a measure of the "margin" between classes. A new data sample is classified by the SVM according to the decision boundary defined by the hyperplane. An SVM corresponds to a linear method in a very high dimensional feature space. The feature space is nonlinearly related to the input space. Classification is achieved by realizing a linear or non-linear separation surface in this space [6].

B. *Multi*-class *Model of SVMs*

Among many classification methods, SVM has demonstrated superior performance. It has been successfully utilized in handwritten numeral recognition. However, SVM was originally designed for binary classification, and its extension to solve multi-class problems is not straightforward. The popular methods for applying SVM to multi-class problems decompose a multi-class problem into many binary-class problems and incorporate many binary-class SVMs [6].

Two main approaches have been suggested for applying SVMs for multi-class classification. In each approach, the underlying basis has been to reduce the multi-class problem to a set of binary problems, and to enable the use of basic SVM. The first approach, called "one against all", uses a set of binary classifiers, each trained to separate one class from the rest. The second approach is called "one against one". In this approach, a series of classifiers are applied to each pair of classes, and only the label of the most commonly computed class is kept for each case [6].

C .*Proposed Algorithm ANPR system* using *SVM*

We summarize the SVM based algorithm for number recognition in this paper as follows. In order to recognize a number plate, we go through the following steps.

Step.1 Pre-process the image of number plate.

Step.2 Segment the image into several parts of which each contains only a single character.
Step.3 Normalize each letter or digit on the number plate.
Step.4 Extract the feature vector of each normalized candidate
Step.5 Recognizes the single character (a digit or a letter) by the 36 SVMs trained in advance.
Step.6 If there are no more unclassified samples, then STOP. Otherwise, go to Step 5.
Step.7 Add these test samples into their corresponding data base for further training.
Step.8 Recognize number plate by bringing all characters used together.

When a number plate region is extracted, the vertical and horizontal histogram projection methods are applied for character segmentation. The number plate is segmented and the images containing individual characters (digits and letters) forming the number plate are obtained. Each image of a character is normalized into size of 20x36. Then the support vectors are calculated directly from the normalized sub-images. The high dimensional feature vectors are stored into two kinds of database, one is for digital numbers, and the other is for letters (Fig.8). The above feature vectors are used to train SVMs with RBF kernel. 720 dimensional feature vectors are input into SVMs which have been trained successfully. Then, which character a given candidate should be can be obtained in according to the outputs of SVMs. When all digits and letters on a number plate are recognized (or classified), the recognition of the number plate is complete [6].

Fig.8 Samples of templates used.

VI. Conclusion and Future Research

In this proposed model pre-processing and number plate localization is performed by using "Ostu's methods" and "feature based localization methods" respectively. It provides satisfactory results for a wide variation in selected for binarization. Character segmentation a new "Image Scissoring" algorithm is used. I t gives reliability and time optimization. Finally the character reorganization performs using the Support Vector Machine. This application is very useful in government as well as big private organizations. But ANPR system still has some restriction such parameter like speed of vehicle, script on the number plate and skew in image
This can be removed by enhancing the further algorithms

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