Automatic Number Plate Recognition (ANPR) System for Indian conditions

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***Abstract*-Automatic Number Plate Recognition (ANPR) is a real time embedded system which automatically recognizes the license number of vehicles. In this paper, the task of recognizing number plate for Indian conditions is considered, where number plate standards are rarely followed.**

The system consists of integration of algorithms like: 'Feature-based number plate Localization' for locating the number plate, 'Image Scissoring' for character segmentation and statistical feature extraction for character recognition; which are specifically designed for Indian number plates.

The system can recognize single and double line number plates under widely varying illumination conditions with a success rate of about 82%.

***Keywords*- Number plate recognition, Indian number plates.**

1. 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 traffic surveillance and tracking system, automated high-way/parking toll collection systems, automation of petrol stations, journey time monitoring.

Such systems automate the process of recognizing the license number of vehicles, making it fast, time-efficient and cost-effective.

1.1 Existing systems

ANPR systems have been implemented in many countries like Australia, Korea and few others [1]. Strict implementation of license plate standards in these countries has helped the early development of ANPR systems. These systems use standard features of the license plates such as: dimensions of plate, border for the plate, color and font of characters, etc. help to localize the number plate easily and identify the license number of the vehicle.

In India, number plate standards are rarely followed [2]. Wide variations are found in terms of font types, script, size, placement and color of the number plates. In few cases, other unwanted decorations are present on the number plate. Also, unlike other countries, no special features are available on Indian number plates to ease their recognition process. Hence, currently only manual recording systems are used and ANPR has not been commercially implemented in India.

1.2 Proposed system

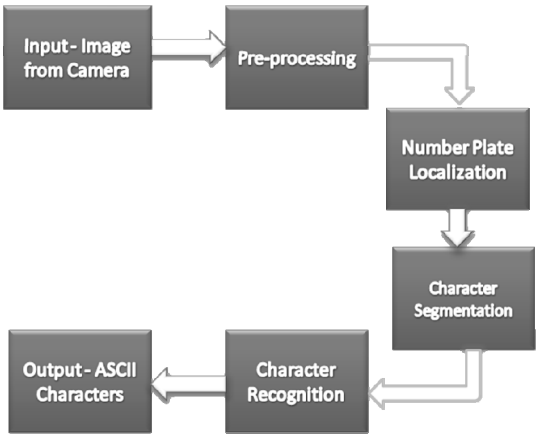

Figure 1: Software flow of the system

In designing this system (fig. 1), various Image Processing algorithms were designed in Matlab and implemented on the Digital Signal Processor TMS320DM6437 which is optimized for video and image processing applications.

A rear image of a vehicle is captured and processed using various algorithms. Initially, the number plate area is localized using a novel 'feature-based number plate localization' method which consists of many algorithms. This algorithm satisfactorily eliminates all the background noise and preserves only the number plate area in the image. This area is then segmented into individual characters using 'Image Scissoring' algorithm. After this step, the characters are extracted from the gray-sale image and each character is enhanced using some character enhancement techniques. These characters are given to the character recognition module, which uses statistical feature extraction to recognize the characters.

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2. System Overview

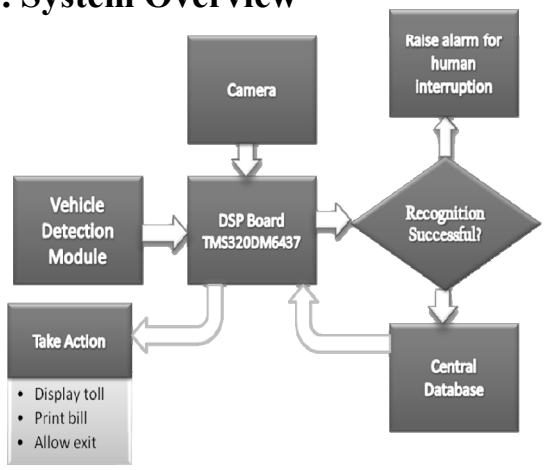

Figure 2: System Overview

Vehicle detection module detects the presence of vehicle by using inductive sensors in which metal wire loop is placed beneath the road. When a vehicle crosses the loop, there is change in induced current which detects presence of vehicle. As a result the DSP is interrupted and it triggers the IR camera to capture the image (fig. 2).
The captured image is processed by DSP to recognize license number of vehicle by employing various image processing algorithms, as mentioned earlier. The DSP gives the license number in ASCII format, using which all relevant details about the vehicle are obtained from a centralized database.

3. Pre-processing and Number Plate Localization

Figure 3: Input gray-scale image.

A number of algorithms are suggested for number plate localization such as: multiple interlacing algorithm [3], 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.

Hence, we designed and implemented '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.

For pre-processing, the input gray-scale image (fig.3) is adaptively converted into binary image (fig. 4) using Ostu's method. This method is better suited for our application compared to other adaptive binarizartion methods like the Niblack's method [4].

Figure 4: Adaptively binarized image: Ostu's method.

Step 1: 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 (fig 5).
Step 2: Size of each shortlisted character calculated. If it is less than half of maximum possible character size that location discarded (fig.

Figure 5: Output of step 1

Figure 6: Output of step 2

6).

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

Figure 7: Output of step 3.

preserved (fig. 7).

All the preceding steps are carried out in a 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 (fig. 8).

Step 5: For a set of columns having width equal to maximum possible number plate width, white pixel

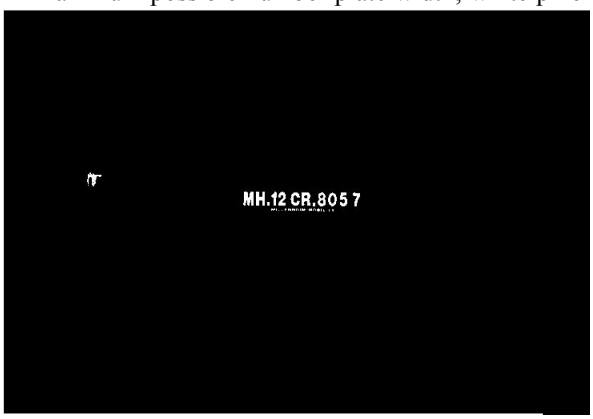

Figure 8: Output of step 4.

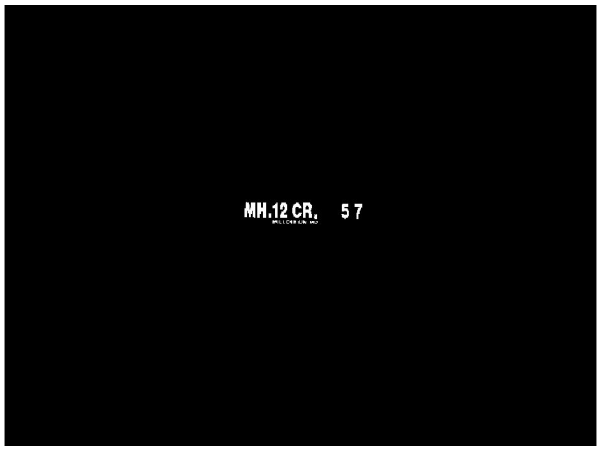

Figure 9: Output of step 5.

density is calculated. If it is not above certain threshold, that area is again discarded (fig. 9).

Step 6: Number of characters in the finalized number plate areas is calculated. If number of

Figure 10: Output of step 6.

characters is less than four, then that area is discarded. If two number plate areas with nearly same number of characters are found in close vicinity of each other, then those areas are merged together.

After applying these steps, the number plate within the image is exactly located and all other background noise is eliminated. Number plate is now extracted (fig. 10) from the input binary image and is then eroded using square of size 2X2 which eliminates overlapping of characters before segmentation.

4. Character Segmentation

Various methods like blob coloring [4], peak-to-valley method [5] 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.

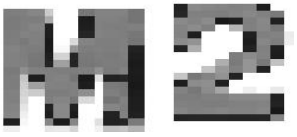

Figure 11: Sample output of Image Scissoring.

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 $1/4^{th}$ 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. 11).

5. Pre-recognition character enhancement

In this step, 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. 12).

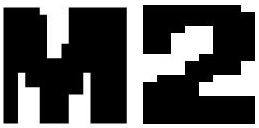

Figure 12: Sample output after character enhancement.

6. Character Recognition and Syntax Checking

This is the most critical stage of the ANPR system. Direct template matching can be used to identify characters [6]. However, this method yields a very low success rate for font variations which are commonly found in Indian number plates.

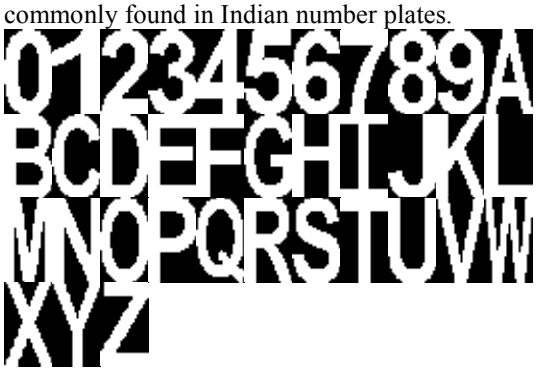

Figure 13: Samples of templates used.

Artificial Neural Networks like BPNNs [1] can be used to classify the characters. However, they do not provide hardware and time optimization. Therefore statistical feature extraction has been used.

In this method, initially the character is divided into twelve equal parts and fourteen features are extracted from every part. The features used are binary edges (2X2) of fourteen types. The feature vector is thus formed is compared with feature vectors of all the stored templates (fig. 13) and the maximum value of correlation is calculated to give the right character. Lastly syntax checking is done to ensure that any false characters are not recognized as a valid license number.

7. Experiments and Testing

The system was tested with a set of images not used during testing, having wide variations in illumination conditions. The complete recognition process takes an average of 2 seconds. This can be further improved by optimizing the code.

If cases where the number plate script is non-English or the number plate is badly distorted are excluded then, 82% of the plates were recognized correctly. The performance of individual sections is: 87% for number plate localization, 95% for character segmentation and 85% for character recognition.

8. Conclusions and Future Research

The system works satisfactorily for wide variations in illumination conditions and different types of number plates commonly found in India. It is definitely a better alternative to the existing manual systems in India.

Currently there are certain restrictions on parameters like speed of the vehicle, script on the number plate, skew in the image which can be aptly removed by enhancing the algorithms further.

References

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