



Automatic Number Plate Recognition System

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Abstract— Automatic Number Plate Recognition (ANPR) is a mass surveillance system that captures the image of vehicles and recognizes their license number. The objective is to design an efficient automatic authorized vehicle identification system by using the Indian vehicle number plate. In this paper we discuss different methodology for number plate localization, character segmentation & recognition of the number plate. The system is mainly applicable for non standard Indian number plates by recognizing single & double line number plates under different varying illumination condition and works on multilingual, multicolour number plates according to Indian condition.

Keywords— ANPR, Localization, Segmentation, Artificial Neural Network, Optical Character Recognition

I. INTRODUCTION

A. Automatic Number Plate Recognition (ANPR)

The Automatic number plate recognition (ANPR) [1] is a real time embedded system that uses optical character recognition on images to read the license plates on vehicles. They can use existing closed-circuit television or road-rule enforcement cameras, or ones specifically designed for the task. They are used by various police forces and as a method of electronic toll collection on pay-per-use roads and monitoring traffic activity. License plate standards vary from country to country. Therefore, current ANPR systems being employed are country specific, in that they use specific features found on their number plates such as, background and foreground colour, boundary of number plate, number plate size, etc. for localizing the number plates.

B. Scope of this paper

As it is not possible to judge which approach is better, different papers, which are based on steps mentioned in Fig.1, are surveyed and categorized based on the methodologies in each approach. Remainder of this paper is divided as follows: Section 5 contains survey of different techniques to detect number plate. Character segmentation methods are reviewed in section 6 and section 7 contains discussion about character recognition

methods. The paper concludes with the discussion of what is existing problems and how can resolve those problems in our proposed methodology.

II. EXISTING SYSTEM

In India, number plate standards, though they exist, are rarely practiced. As a result, wide variations are found in the number plates in terms of font type, character size and location of the number plate. Also, in certain cases, many unwanted characters are present on the number plate. In India [2],[3] we have various kinds of number plates. Old number plates following 1939 series as well as the vehicles following new number system. The new format license plates can be of lengths 8,9,10. For example

The figure shows the Indian licence plate that have: 1. Country Code, 2. State Code, 3. District Code, 4. Type of Vehicle, 5. Registration number.



Figure1. Indian Number Plate Format

III. STEPS FOR ANPR SYSTEM

The Algorithm of ANPR system consists of following **steps**:

Step 1: Capturing the image of car, extracting the image of number plate, extracting character from the plate image, recognize the number plate character & retrieve the vehicle number. A image of vehicle is captured and processed using various algorithms.

Step 2: This plate localization algorithm is based on combining textural characteristics of license plate and morphological operation sensitive to specific shapes in the input image with a good threshold value by which the license plate is located. A fine percentage of localization of License plates is achieved by this algorithm.

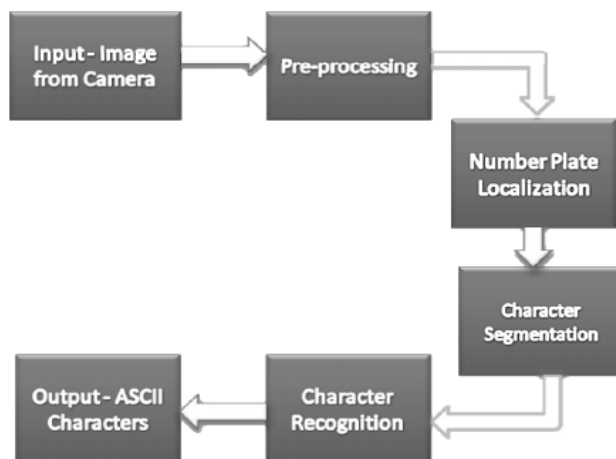


Figure 2: Software flow of the system

Step 3: The segmentation of license plate characters is done after license plate location and binarization. The character segmentation process act a as a bridge between the license plate localization and optical character recognition modules. Its main function is to segment the characters in the selected candidate region such that each character can be sent to the optical character recognition modules individually for recognition.

Step 4: : Character recognition helps in identifying and converting image text into editable text. As most of the number plate recognition algorithms use single method for character recognition. In this section, each method is explained.

IV. PROBLEM IDENTIFICATION

In India, number plates standards are rarely followed. 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. Main aim of this project is to implement a method efficient in recognizing license plates in Indian conditions. Our work is not restricted to car (in which size of license plate is small), transport vehicles which carry extra stylized characters and soiled license plate.

V. IMAGE ACQUISITION

Image acquisition is the process of obtaining an image from the camera. This is the first step of any vision based systems. 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.

Step 3 : Display the image after converting to grayscale

VI. PRE-PROCESSING

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



Fig.3: Output of Otsu's algorithm



Fig.4: Output of Niblack's

Following steps are pre-processing and number plate localization. :

Step 1: The first step for preprocessing is to convert the gray scale image into binary image using Otsu's algorithm by calculating thresholding.

Step 2: After binarization remove all the objects containing fewer than 30 pixel. Median filter to remove the noise.

Step 3: Calculating connected components of an image by scanning the image, pixel by pixel (from top to bottom and left to right) in order to identify connected pixel regions.

Step 4: Search for connected components in the image, each connected component will be assigned a special label in order to distinguish between different connected components in the image as shown in Fig.5.

Step 5: Resize each character from the previous step to the standard height and width in order to be used in the recognition process.



Fig 5: Identified Character Components

Step 6: Measure properties of image regions by plotting bounding box to get the separate character and numbers for recognition process.

VII. NUMBER PLATE LOCALIZATION

A number of algorithms are suggested for number plate localization such as: multiple interlacing algorithm, Fourier domain filtering, and colour image processing. These algorithms however do not satisfactorily work for Indian number plates. Hence, we designed and implemented 'Feature-based number plate localization' method well suited for Indian conditions.

To localize vehicle number plate following factors should be considered:

- (1). Plate size: a plate can be of different size in a vehicle image.
- (2). Plate location: a plate can be located anywhere in the vehicle.
- (3). Plate background: A plate can have different background colours based on vehicle type. For example a government vehicle number plate might have different background than other public vehicles.
- (4). Screw: A plate may have screw and that could be considered as a character.

A. Median Filtering

A statistical Median filter is used to remove salt and pepper noise from the image in gray scale before binarizing. We have used a 3 *3 masking sub window for this purpose.



Fig 6



Fig 7

B. Connected Components

Connected components labeling scans an image and groups its pixels into components based on pixel connectivity, i.e. all pixels in a connected component share similar pixel intensity values and are in some way connected with each other. Once all groups have been determined, each pixel is labeled with a gray level or a color (color labeling) according to the component it was assigned to. After the Localization of the number

plate of the vehicle involved, we need to recognize the number plate into a standard form. The vehicular number plates may be of Non-standard forms and may vary in their fonts.



Fig 8: License Plate after Localization

4 connected pixels are the neighbors of every pixel that touches on one of their edges. These pixels are connected both horizontally and vertically. Whereas 8 connected pixels can be connected horizontally vertically and diagonally.

VIII. CHARACTER SEGMENTATION

The character segmentation process acts as a bridge between the license plate localization and optical character recognition modules. Its main function is to segment the characters in the selected candidate region (extracted license plate) such that each character can be sent to the optical character recognition module individually for recognition.

Once the license plate is localized we proceed to obtain the individual characters. A license plate as described above has high intensity variation regions. This forms the basis for character segmentation. Sometimes it is observed that along with the license numbers, various texts may be present which have to be removed. By various observations we observed that for the license plate regions the amount of white on black or vice versa, is specific for the number regions and fall within a certain range. We ignore those regions which are out of range to isolate the number regions.

A. Bounding Box

The minimum or the smallest bounding box for any point set in N dimension is the box with smallest measure within which all points lie. In other words it has the minimum height and width that cover all the pixels present in a particular connected component or region.



Fig 9: After applying bounding box

B. Selecting the best Bounding Box

1. Contrast present in the bounding box : As the license plate consists of dark colored numbers on a lighter background or vice versa. The center row of the box can be scanned and the total sudden contrast can be recorded, if the image is binarized.

2. Aspect Ratio : Is the ratio of the width of the image to its height. The inverse of the aspect ratio should be less than 1 for any license plate. Hence all the regions which do not satisfy this property can be rejected.

3. Width of the license plate : After analyzing various datasets we have used the threshold limit to five times the height of the license plate so :

$$\text{Width} < (5 * \text{Height})$$

C. Cropping the Bounding Box

After identifying the best possible bounding box candidate for the license plate the coordinates of the bounding box are noted and the box is cropped from the image and sent to the character segmentation module for further processing.

IX. CHARACTER RECOGNITION

Template matching is useful for recognition of Indian characters. It can be also used for detection of objects generally in face detection and medical image processing. It is further divided in two parts: feature based matching and template based matching. Feature based approach is useful when template image has strong features otherwise template based approach can be useful. In statistical feature extraction method is applied for achieving 85% of character recognition rate. A template based approach is proposed in . The authors used low-resolution template matching method to work with lower resolution image such as 4 X 8. The authors used similarity function to measure similarity between patterns.

The image obtained after segmentation is Grayscale. Follow the preprocessing steps used for the training of the characters. Calculate the score for each of the characters: We calculate the matching score of the segmented character from the templates of the character stored by the following algorithm. We compare the pixel values of the matrix of segmented character and the template matrix, and for every match we add 1 to the matching score and for every miss-match we decrement 1. This is done for all 225 pixels. The match score is generated for every template and the one which gives the highest score is taken to be the recognized character. Character sets used for training the OCR: This is contained in the directory named "OCR Training Data".

X. RESULT & DISCUSSION

In this proposed model pre-processing and number plate localization is performed by using "Otsu's methods" and "feature based localization methods" respectively. It provides satisfactory results for a wide variation in selected for binarization. In Character segmentation a new "Image Scissoring" algorithm is used. It gives reliability and time optimization. Finally the character reorganization performs using the "Template Matching". We have also address the issue of multilingual number plate, multiscriptual number plate according to Indian condition. The algorithm has been found to be 80% accurate overall.

XI. ACKNOWLEDGEMENT

We would like to thank Prof. Dharmendra Roy of the Department of Computer Science & Engineering, Rungta group of college, Bhilai, C.G, India for his valuable suggestions and discussions regarding various aspects of this research work, particularly in the building of the recognition module.

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