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Number Plate Recognition for Indian Cars Using Morphological Dilation and Erosion with the Aid Of Ocrs

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Abstract. Vehicle number plate recognition(VNPR) has been intensively studied in many countries. Due to the different types of number plates being used, the requirements of an automatic number plate recognition system is different for each country. In this paper, a number plate localization and recognition system for vehicles in Tamilnadu(India) is proposed. This system is developed based on digital images and can be easily applied to commercial car park systems for the use of documenting access of parking services, secure usage of parking houses and also to prevent car theft issues. The proposed algorithm is based on a combination of morphological operation with area criteria tests for number plate localization. Segmentation of the plate characters was achieved by the application of edge detectors, labeling and fill hole approach. The character recognition was accomplished with the aid of optical characters by the process of Template matching. The system was experimented with four different edge detectors namely Sobel, Canny, Prewitt, LOG. A comparative analysis on the success rate of the proposed system showed overall better success rate of 96.8% by using canny edge detector.

Keywords: Vehicle number plate recognition, mathematical morphology, edge detectors, optical character recognition.

1. Introduction

In the current information technology era, the use of automations and intelligent systems is becoming more and more widespread. The Intelligent Transport System (ITS) technology has gotten so much attention that many systems are being developed and applied all over the world. Vehicle number plate recognition has turned out to be an important research issue. VNPR has many applications in traffic monitoring system, including controlling the traffic volume, ticketing vehicle without the human control, vehicle tracking, policing, security, and so on.

The most vital and the most difficult part of any VNPR system is the detection and extraction of the vehicle Number plate, which directly affects the systems overall accuracy. The presence of noise, blurring in the image, uneven illumination, dim light and foggy conditions make the task even more difficult. In this paper we propose a detailed and novel method for accurately detecting the location of vehicle number plates and recognizing the numerals and characters in it. The proposed system can work very accurately for cars in almost any environment, time of day, and conditions.

2. Related Work

The problem of automatic VNP recognition is being studied since the 90's [5], [8]. The early approaches were based on characteristics of boundary lines. The input image being first processed to enrich and enhance

boundary line-information by using algorithms such as the gradient filter, and resulting in an image formed of edges. The image thus processed was converted to its binary counterpart and then processed by certain algorithms, such as Hough transform, to detect lines. Eventually, couples of 2-parallel lines were considered as a plate-designate [6].

Another approach was based on the morphology of objects in an image [1], [7]. This approach focuses on some salient properties of vehicle plate images such as their brightness, contrast, symmetry, angles, etc. Due to these features, this method could be used to detect the similar properties in a certain image and locate the position of number plate regions.

The third approach was based on statistical properties of text [3], [4]. In this approach, text regions were discovered using statistical properties of text like the variance of gray level, number of edges, edge densities in the region, etc. This approach was commonly used in finding text in images, and could well be used for discovering and designating candidate number plate areas as they include alphabets and numerals.

In addition, there have been a number of other methods relating to this problem focusing on detecting VNP using artificial intelligence and genetic algorithms [2]. These systems used edge detection and edge statistics and then AI techniques to detect the location of the number plate-designate area. All of the systems discussed above have some kind of limitations for example they are plate size dependent, color dependent, work only in certain conditions or environment like indoor images etc. The method that we are proposing is independent of color, size, location and angle of the number plate of the vehicle.

3. Proposed System

Fig: 1 shows the Diagram of the proposed VNPR Process.

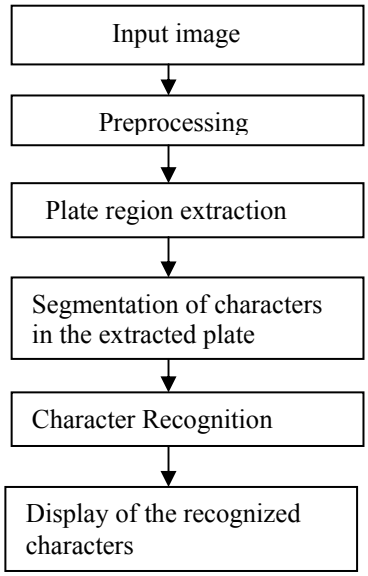

Fig. 1: Proposed VNPR Process

Input of this system is the image captured by a camera placed at a distance of 4-5metres away from the vehicle as shown in Fig 2.

Fig. 2: Original image for recognition

3.1. Preprocessing

The RGB image is then converted into a grayscale image for easy analysis as it consists of only two color channels. Median filtering is then implemented for the effective removal of speckle noise, salt and pepper noise (impulsive noise).

3.2. Plate Region Extraction

Morphological-dilation operation with rectangular structuring element(SE) of sixe 3X3 is then performed on the binary image.

Dilation is a morphological transformation that combines two sets by using vector addition of set SEs, and Erosion can be obtained by dilating the complement of the black pixels and the taking the complement of the resulting point set.

Let B denote an SE which is a 3x3 square. The dilation of the image A using the SE B result in another binary image z which is defined as (1) and (2),

$$A \oplus B = \{z \in E | (B^s)_z \cap A \neq \varnothing\} \quad (1)$$

Similarly, the erosion of the image A by SE B is the binary image z defined by

$$A \ominus B = \{z \in E | B_z \subseteq A\} \quad (2)$$

Suppression of structures that are lighter than their surroundings and that are connected to the image border was performed. The area of each of the rectangle is then calculated. From the experiments conducted with large number of real scene images it was observed that the region representing the number plate are of larger area in majority of the images. Therefore the rectangle which is of maximum size is selected. Morphological-erosion operation with rectangular structuring element of sixe 10X5 was then performed.

In erosion, every object pixel that is touching a background pixel is changed into a background pixel. It makes the objects smaller. By subtracting the original image from the eroded image, the number plate would be extracted as there is a large difference between the two images.

Fig. 3: Result of Morphological Dilation

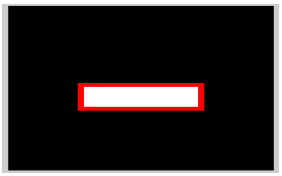

Fig. 4 : Result of Morphological Erosion with a Bounding box

Fig. 5:Result of subtraction

3.3. Segmentation of Individual Characters in the Number Plate

The character segmentation acts as a bridge between the number plate extraction and optical character recognition modules. Its main function is to segment the characters on the chosen candidate region(number plate) such that each character can be sent to the optical character recognition module individually for recognition. This was achieved by the application of the edge operators and by the relaxation labeling approach.

Four edge detection methods were used for comparison. They are

1. Canny Edge Detection
2. Sobel Edge Detection
3. Prewitt edge detection.
4. Log edge detection

(a) Canny (b) Sobel (C) Prewitt (d) LOG

Fig. 6: Result of application of the four different edge detectors

Labels are then assigned to the edges which are obtained as the result of the application of the edge detection operators. The characters are then extracted through the assigned labels. Fill hole approach is then performed in order to facilitate the labels for character recognition

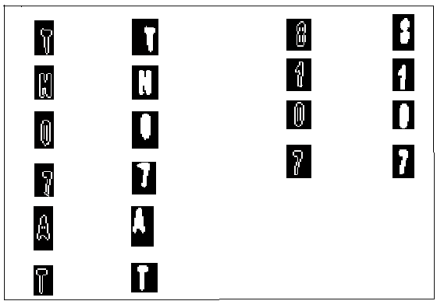

Fig.7: Result of Fill hole approach of Fig.6(a)

3.4. Character Recognition

It is employed for the purpose of conversion of images of text into characters. OCR Software and ICR Software technology are analytical artificial intelligence systems that consider sequences of characters rather than whole words or phrases. Based on the analysis of sequential lines and curves, OCR and ICR make 'best guesses' at characters using database look-up tables to closely associate or match the strings of characters that form words.

The number plates may be bent and/or tilted with respect to the camera, characters extracted from such number plates may be deformed. Furthermore, input characters may be noisy, broken or incomplete. Character recognition techniques should be able to tolerate these defects. We developed our own character templates to suit our particular application which are shown in Fig 8. The topological features of the input character are computed and are compared with those of prestored character templates. The character template that best matches the input characters are then displayed.

Fig.8 : OCR templates used for character recognition.

4. Experiments

Experiments were performed to test the proposed system and to measure the accuracy of the system. The system was designed in MatlabR2009b. 288 color images were used for testing the technique. All the images were normalized to just about 640 x 480 because some images were double this size and also it is normal to use the size. For improving the complexity and generality of the test databases, the images were acquired from the highways, car parks, at different lighting condition (cloudy, sunny, daytime, night time). The images taken were of different color and variable sized number plates, also the images were irrespective of the angle and orientation of the camera. Also many images were acquired using the worldwide web. These results report a high accuracy rate of above 96%.

5. Results

Results have shown that canny edge detector offers greater accuracy of 96.8% . The system's accuracy in locating the number plate is more than 98%. The problem encountered in the earlier systems in locating the number plate when vehicle bodies and their number plates have similar colors were overcome with this method as morphological operation was employed, thereby achieving higher accuracy in number plate extraction step. As the fonts vary from one number plate to the other, ambiguous situation may arise in recognizing the characters 'G' and 'C', 'I' and '1', '7' and 'T' and alike since OCR template was developed for one particular font. But some of them were overcome by "character categorization" approach.

Units of VNPR system	Number of Accuracy	Percentage of accuracy(%)
Extraction of plate region	283/288	98.2
Segmentation by implementing Canny edge detector	279/283	98.5
Segmentation by implementing sobel detector	265/283	93.6
Segmentation by implementing prewitt edge detector	254/283	89.7
Segmentation by implementing Log edge detector	243/283	85.8
Recognition of characters with the best (canny) edge detector	279/288	96.8

Table 1: Experimental results

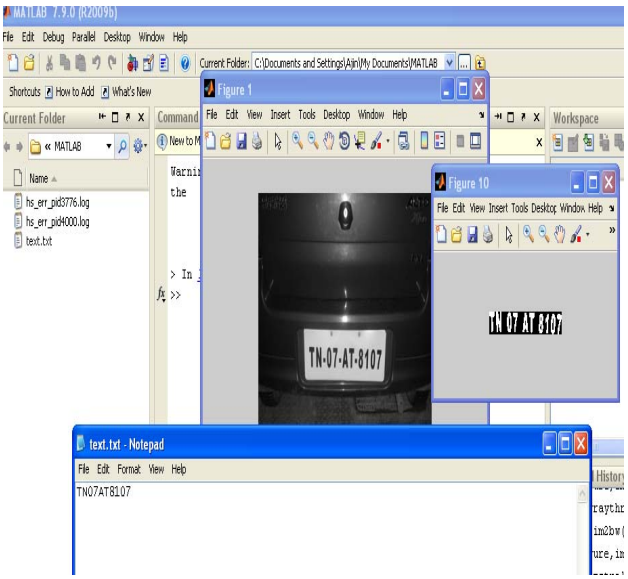

Fig. 9: Snapshot of the notepad displaying the recognized characters

6. Conclusion

In this paper, we presented application software designed for the recognition of car number plate. Firstly we extracted the plate location by performing the morphological operation and area criteria tests, the edge detectors are then applied and finally template matching based on optical character recognition templates was applied to recognize the number plate characters. A comparison of edge detectors sobel, prewitt, canny, log operators was performed. The results showed that the performance of the canny edge detector is far better than the other three operators. Although the proposed algorithm is concerned with the number plate of Indian cars, many parts in the algorithm are readily extended to use with the number plates of other countries.

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