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Detecting the Car Number Plate Using Segmentation

V. Lakshmi Priya [1], K. Perumal[2]

[1]Dept. of Computer Applications
Madurai Kamaraj University
Madurai
lakpriyaaapk@gmail.com

[2]Associate Professor
Dept. of Computer Applications
Madurai Kamaraj University
Madurai
perumalmala@gmail.com

Abstract: ***The number plate recognition system is one kind of an Intelligent Transport System. The proposed work is used to extract numbers from the number plate. This technology is used in various security purposes for finding stolen cars, traffic management system, in electronic toll collection, smuggling of cars, usage of cars in terrorist attacks and illegal activities. This work is based on edge detection and efficient morphological operations. Character segmentation is the process of extracting the characters and numbers from the license plate. Noises in the image are removed using filtering techniques. Optical Character Recognition (OCR) technique is used for the character recognition. In OCR the filtering character is matched with template using template matching algorithm and finally the character is extracted.***

Keywords: Number Plate Recognition(CNPR), Character Segmentation, Optical Character Recognition., Template Matching.

1. Introduction

Car number plate recognition systems have received a lot of attention from the research community. This system is a part of digital image processing which broadly used in vehicle transportation system to identify the vehicle. A number plate is the unique identification of vehicle. Real time number plate recognition plays an important role in maintaining law enforcement and maintaining traffic rules. It has wide applications areas such as toll plaza, parking area, highly security areas, boarder's areas etc. The identification task is challenging because of the nature of the light. The location error will increase if the color of the number plate is very similar to the background. Noise on the number plates some time causes error and results in low accuracy [1].

Car number plate Recognition is a part of digital image processing which plays vital role in vehicle transportation system to identify the vehicle. A number plate is the unique identification of vehicle. Real time number plate recognition plays an important role in maintaining law enforcement and maintaining traffic rules. Many number plates have different styles and varying state by state. The number plates have one row or two rows of numbers and have six to more than ten letters for example given below in figure 1.

Figure 1: Different number plates.

Car number plate recognition process contains three steps. One is Vehicle number plate extraction, the next is character segmentation and finally Optical Character Recognition (OCR). Number plate extraction is that stage where vehicle number plate is detected. The purpose of edge detection is significantly reducing the amount of data in an image and preserves the structural properties for further image processing [2].

The detected number plate is pre-processed to remove the noise and then the result is passed to the segmentation part to segment the individually characters from the extracted number plate. In OCR, the characters are recognized using Template matching. Those systems allow measurement of vehicle's speed, counting the number of vehicles, classification of vehicles, and the identification of traffic incidents (such as accidents or heavy congestion). The vehicle identification

number is actually a plate number, which states a legal license to participate in the public traffic [3].

The main objective of this work is to locate the license plate regions from vehicle's image. Quality of image forms an important part of this technique so preprocessing the image helps in improving the quality. The complexity of smart license number plate recognition work varies throughout the world. For the standard number plate, the system is easier to read and recognize. This task becomes much difficult due to variation in plate model and their size. Different vehicles have plates located on different position. The proposed system control of vehicles is becoming a big problem and much more difficult to solve. License Plate Recognition systems are used for the purpose of effective control. The scope of the dissertation is to identify the number plate using Template Matching algorithm of Object Character Recognition methods. First the input color image is converted to gray scale image for easy to handle and simple way to find the location in the number plate. This system uses blurred regions and different font style and sizes using the character reorganization. This work has reduced the error, and time. An everyday increase in the number of cars on roads and highways facing numerous problems for example identification of stolen cars, smuggling of cars, invalid license plate, usage of cars in terrorist attacks and illegal activities.

2. Related Works

Morphology [5] [6] is used to extract the license plate from the original image. It helps to remove unwanted small parts from license plate. A survey of image thresholding methods is conducted categorized and formulated under a uniform notation and then evaluate the performance comparison presented in paper [4]. They categorized the thresholding methods such as histogram shape, measurement space clustering, entropy, object attributes, spatial correction and local-gray level surface. In [7] Optical Character Recognition is technique in image processing. It is used to classify/ scan alphanumeric text into computer – readable text to recognize the license plate. It requires preprocessing stage to remove the boundaries which helps in recognizing the characters. It process information more quickly, accurately and efficiently and also minimizes the errors.

Template Matching [8] is used to test the characters with templates which are designed. It is useful for recognizing fixed size characters and non-broken. It finds small blocks of an image and match with template image. Template design is vital part of template matching. Template design must match templates to it corresponding image also have some amount of mismatch to other templates. Ch. Jaya Lakshmi, Dr. A. Jhansi Rani, Dr K.Sri Ramakrishna, M. kanti Kiran and V.R Siddhartha proposed a novel approach for Indian license plate recognition system. [9].

A Wavelet transform based method is used in [10] for the extraction of important contrast features used as guides to search for desired license plates. The major advantage of wavelet transform, when applied for license plate location, is the fact that it can locate multiple plates with different orientations in one image.

3. Proposed Work

The number plate has been detected using the optical character recognition using template matching algorithm. A set of characters are pre-defined, the detected image has been separated by the characters and matched with these pre-defined set of characters. Image has been detected from the car, and converted to the gray scale image. The purpose of the gray scale image is to detect the number plate easily. The edge detection is performed on the number plate area. Canny edge detection algorithm produces better output than the other edge detection algorithms. The Canny edge detection algorithm is considered a standard method because it provides very sharp and thin edges [7].

Morphological operators can also be applied. Dilation is an operation that "grows" or "thickens" objects in a binary image. Character segmentation from the number plate region is the important step in CNPR system, which influences the accuracy of character recognition significantly. The goal of this phase, given the number plate image, is to segment all the characters, without losing features of the characters.

4. Methodology

The proposed work has following stages such as,

1. Pre-processing
2. Edge Detection
3. Morphological operations
4. Character Segmentation
5. Image Enhancement
6. Optical Character Recognition.

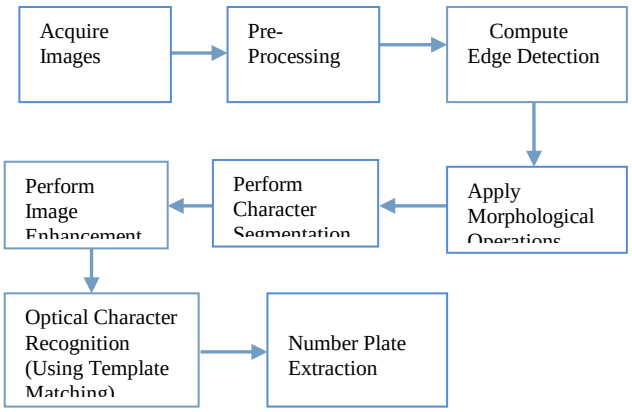


Figure 2: Block Number plate Extraction.

A. Pre-Processing

RGB to Grayscale Conversion

In RGB format, each Pixel has three colour components: Red, Green, and Blue. In pre-processing step, the colour image is given as an input and it is converted into grayscale image. The first step to digitize a "black and white" image composed of an array of gray shades is to divide the image into a number of pixels, depending on the required spatial resolution. This range is represented in abstract way as a range from 0 (black) and 1 (white), with any fractional values.

(a) (b)

Figure 3: (a) input image (b) Grayscale image

B. Edge Detection

The purpose of edge detection is significantly reducing the amount of data in an image and preserves the structural properties for further image processing. Edge detection performs the locating sharp discontinuities in an image. This is the most common approach for detecting meaningful discontinuities in intensity values. The edge is a boundary between two regions with relatively distinct gray level properties. In edge detection, many operators are defined such as sobel, log, canny, prewitt. The Canny operator was designed to be an optimal edge detector. It takes as input a gray scale image, and produces as output an image showing the positions of tracked intensity discontinuities. Edge detection example figure is given below.

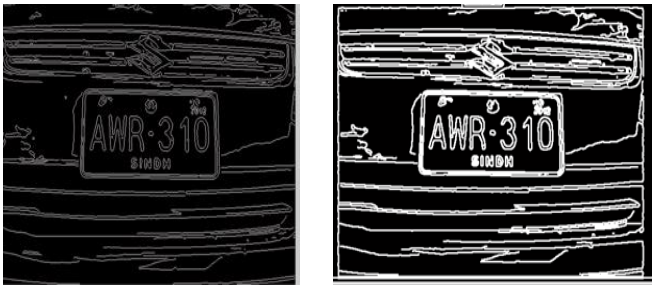
(a) (b)

Figure 4: (a) Grayscale image (b) Canny edge detection

Here, canny edge detection was used for clear view in the image.

C. Morphological operations

Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size. The most basic morphological operations are dilation and erosion. **Dilation** performed by adding pixels to the boundaries of objects for all the pixels in the input pixel's neighborhood. In a binary image, if any of the pixels is set to the value 1, the output pixel is set to 1. Dilation is used for the purpose of increasing thickness of the number plate edges. So we can find the numbers easily.



(a) (b)

Figure 5: (a) Canny Edge Detection (b) Dilated Image

D. Character Segmentation

The goal of this phase, given the dilation image, is to segment all the characters, without losing features of the characters. Segmentation is one of the most important processes in the automatic number plate recognition. If the segmentation fails, a character can be improperly divided into two pieces, or two characters can be improperly merged together. In order to recognize the vehicle number plate characters afterwards, each character must be divided respectively. The individual characters have to be distinguished (segmented) from each other. In Character Segmentation, the characters & digits of the plate are segmented and each is saved as different image. Matlab toolbox function provides a function called regionprops (). It measures a set of properties for each labeled region in the label matrix. The bounding box is used to measure the properties of the image region. This technique used for check the numbers with template used by template matching algorithm in Optical Character Recognition (OCR).

(a) (b)

Figure 6: (a) Dilated image (b) Segmented image

E. Image Enhancement

The objective of image enhancement is to process a given image so that the result is more suitable than the original image for a specific application. The enhancement doesn't increase the inherent information content of the data, but it increases the dynamic range of the chosen features so that they can be detected easily.

Median Filter

The median filter is a non-linear filtering technique used to remove noise from image under consideration. While it helps in removing the impulse noise it preserves the edges. After segmentation filtering was used for remove all lines expect characters. It is take consider noise. It is widely used and it is

very effective at removing noise while preserving edges. It is particularly effective at removing 'salt and pepper' type noise.

Figure 7: Filtered Image

F. Optical Character Recognition

The goal of Optical Character Recognition (OCR) is to classify optical patterns (often contained in a digital image) corresponding to alphanumeric or other characters. The character has been extracted after the filtering. This character has been matched with the pre-defined characters. The pre-defined characters have the data like Alphabets A-Z, numeric character 0-9. This pre-defined data are in the form of the images. Using these images the template has been matched with the segmented characters of the number plate.

Template Matching:

Template Matching is one of the most common classification methods. In Template Matching, the features that the classification is based on are the individual pixels. An image is compared with predefined images, which are referred to as templates. The template are given below in figure 8

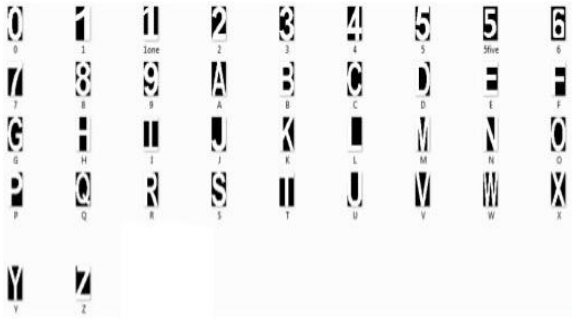


Figure 8: Template

G. Number Plate Extraction

The character segmentation algorithm is used to segment the character. Due to this character segmentation process noise is added and that noise is removed using the filter. The noise removed character is matched with template using template matching algorithm and finally the character is extracted in notepad.

5. Results And Analysis

Experiments have been performed to test the proposed Car Number Plate Recognition system. Here, various images are tested using by optical character recognition. Experiments show that the algorithm has good performance on number plate extraction, and character segmentation work. The results produced from the implementation of the algorithm are presented in this section. In figure 9, all the figures (a-f) are denoted extract the numbers from the car number plate image.

Fig (a) Input Image

Fig (b) Grayscale image

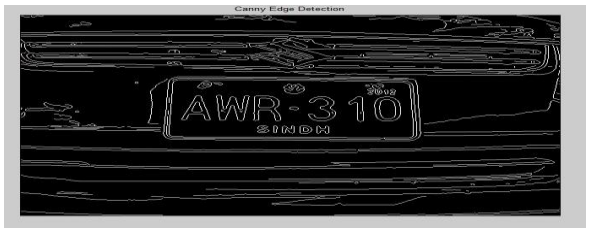


Fig (c) Canny Edge Detection

Fig (d) Character Segmentation

Fig (e) Dilation & Filtered Image

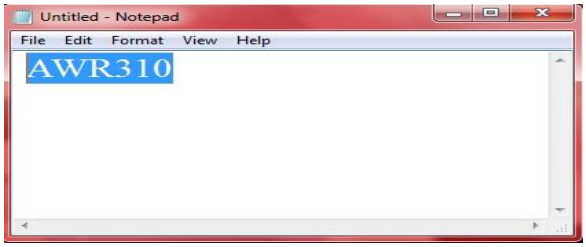


Fig (f) Extracted Number Plate Using OCR

Figure 9: Process of Number Plate Extraction (a-f)

Analysis

In this proposed system, edge detection operators are used to detect the edges. They are sobel, log, prewitt and canny. On comparing these operators canny edge detector is considered as the best one. To conclude that canny is given good result of this analysis is done as follows:

Table 1 (a) Compared with Four edge operators

Input Image				
Sobel Edge				
Log Edge				
Prewitt Edge				
Canny Edge				

Table 1 (b) Compared with Four edge operators

Input Image				
Sobel Edge				
Log Edge				
Prewitt Edge				
Canny Edge				

In Table1 (a) & (b) considered by four different edge detection operators. Finally the best result is given by canny edge operator.

Quality Measurement

Mean Square Error (MSE), MSE is computed by averaging the squared intensity of the original (input) image and the resultant (output) image pixels. Peak Signal-to-Noise Ratio (PSNR) is a mathematical measure of image quality based on the pixel difference between two images. Here, these two values are find it. For the purpose of find the quality of edges.

Table 2: Quality Measurement with MSE and PSNR.

Input Image	Sobel Edge		Log Edge		Prewitt Edge		Canny Edge	
	MSE	PSNR	MSE	PSNR	MSE	PSNR	MSE	PSNR
Plate 1	0.04	13.47	0.07	11.74	0.05	12.67	0.06	12.26
Plate 2	0.07	11.38	0.09	10.33	0.07	11.71	0.07	11.57
Plate 3	0.04	13.87	0.05	12.77	0.05	13.38	0.04	13.91
Plate 4	0.04	11.81	0.06	12.43	0.05	13.02	0.05	13.15
Plate 5	0.03	15.29	0.04	13.56	0.04	14.14	0.02	16.15
Plate 6	0.05	13.08	0.09	10.56	0.09	10.30	0.05	13.30
Plate 7	0.06	12.12	0.07	11.39	0.10	10.14	0.05	13.12
Plate 8	0.04	14.06	0.11	9.75	0.11	9.64	0.04	14.14

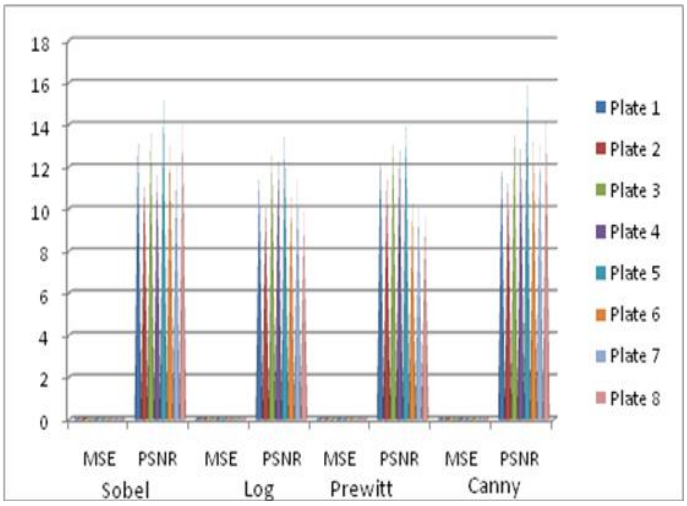
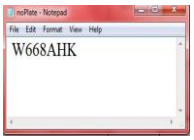
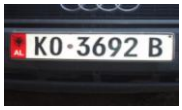
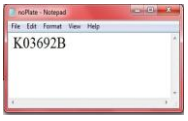
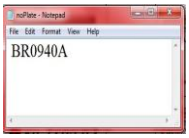
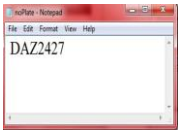
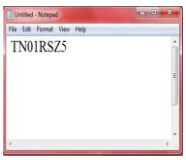
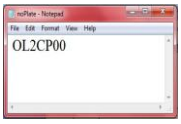
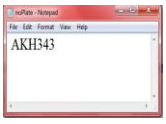


Figure 10: Bar chart for MSE and PSNR.

Comparison of various images:

Testing is done on the various images to this system. Check the correct number plate from the result. If the result is failed the column is given as Result is failure. In Table 2 number of car images was tested for successful result at the same time the failure case also detected. In this work the image no 5 and 6 was failure case and the reason is the image has been not cleared.

Table 3: Tested images

Input Image	Correct Number	Number Read by our system	Result
	AWR-310		Successful
	W668 AHK		Successful
	K03692B		Successful
	BR0940A		Successful
	DAZ2427		Successful
	TN01 R5252		Failure
	DL2C P0056		Failure
	AKH 343		Successful

Conclusion:

The proposed work is the automatic vehicle identification system using vehicle license plate is presented. The system is implemented in Matlab and it performance is tested on real images. A number plate recognition system is one kind of an Intelligent Transport System. In this document, template matching algorithm has been used to extract the vehicle number plate. The automatic vehicle identification system plays an important role in detecting security threat. Here, character segmentation for separating individual characters. Finally, match with template using template match algorithm and extract the number plate in notepad.

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