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Research Article

Recognition of License Number Plate using a Template Matching Technique

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Abstract

Recognition of license number plate (RLNP) is an image processing technique used to identify the vehicle. It is a mass surveillance method that recognizes the vehicle registration plates. It uses Optical Character Recognition (OCR) to read the license plate. This paper presents a robust method of license plate recognition based on using Template Matching Techniques. This technique is used in many traffic management and security systems such as automatic speed control, tracking stolen cars, automatic toll management, and access control to limited areas. In this paper, we have considered four robust steps as follows: Pre-processing of captured image, Extracting license number plate region, Segmentation and Character Recognition of license number plate. The proposed RLNP technique consists of two major modules: 1) License Plate detection. 2) License number recognition using Template Matching technique. This paper proposes a template matching approach for vehicle license plate number recognition. The results shows an acceptably well recognition rate, with very few errors in alphanumeric character recognition. The accuracy may further be improved by use of complex techniques like ANN, pattern recognition approaches.

Keywords: *License Plate Detection, Optical Character Recognition (OCR), Character Segmentation, Character Recognition, Template Matching technique.*

1. Introduction

The Recognition of License Number Plate (RLNP) is used by various security and traffic applications such as entrance of highly restricted areas for security and access control. These systems are also used for the traffic prospective gathering, traffic flow statistics, finding stolen car, controlling access to car parks, like in parking area, vehicle number plates are used to calculate duration of the parking (Saqid Rasheed, *et al*, 2012). In RLNP system, firstly, image of car is captured such that license plate is present in the image. In next stage, eliminate the non-useful parts of the image so that the characters on the license plates are easily identified and segmented. In the last stage, the segmented characters will be transformed from usage into text and it is known as Optical Character Recognition (OCR) (Ali Al-Zawqari, *et al*, 2016). In India, basically two types of vehicle registration number plates are used:

1) White background with black letters on plate.
2) Yellow background with black letters on plate.

In companion to foreign vehicle registration number plate, the Indian License number plate recognition is laborious because Indian license plate does not follow any standard aspects ratio (Divya Gilly, *et al*, 2013).

The goal of this paper is to study and evaluate some most important License Plate Detection algorithms and compare them in terms of accuracy, performance, complexity, and their usefulness in different environmental conditions and adopts classification template matching of font characteristics, largely reduces the time of template matching and effectively eliminates the misidentification of similar characters (Jin Chong, *et al*, 2013). License Plate Recognition is an important function in intelligent traffic management systems such as parking management systems, access control, border control and monitoring, and tracking vehicles.

Recognition of license number plate (RLNP) system is made up of four modules:

Pre-processing of captured image, Extracting license number plate region, Segmentation and Character Recognition of license number plate and every step has its own importance in order to recognize the vehicle number plate (Mahesh Babu K, *et al*, 2016).

2. Literature Survey

Vehicle number plate detection and recognition is very important in security transport system field.

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Researchers had used different techniques and methods to detect and recognize the vehicle number plate. There are four fundamental processing steps: enhancement of a digital image, license number plate region detection in the image, character segmentation and characters recognition. In first step, enhancement of an image was done. Removal of noise, brightness and contrast adjustment were made and then the input image was converted into grayscale and then it is binarized. Sometimes, first image was converted to grayscale and later, removing of noise was done. Locating the exact plate region with the help of Hough lines is done using Hough transform (Hadi Sharifi Kolour, *et al*, 2011).

Many designed RLNP (Recognition of license number plate) systems in the past were implemented on resource rich computer system that were connected to cameras. These systems face various challenges, including high cost and power consumption, and large size. In addition, some of the used algorithms depend on extensive calculations which slow down the operation. Therefore, the need for new systems that are cost effective, smaller in size (i.e. system on chip), low power consumption and utilizes fast algorithms became critical (Nighat Naaz Ansari, *et al*, 2016).

OCR is a critical stage in RLNP (Recognition of license number plate) systems as it converts the segmented characters from the image of the plate to a sequence of digital characters. Therefore, many algorithms and techniques have been developed to handle noisy plates and various uncontrolled environmental effects, to improve the recognition rate and meet real-time requirements for some applications such as RLNP. Various algorithms and techniques are reported in literature to perform OCR such as feature extraction techniques, template matching or correlation (Mahesh Babu K, *et al*, 2016; Hadi Sharifi Kolour, *et al*, 2011), statistical classifiers (Ali Al-Zawqari, *et al*, 2016; Mahesh Babu K, *et al*, 2016) and artificial neural networks (ANN).

3. Proposed method of RLNP

In this paper, the method of RLNP technique has been proposed into two steps. First, license number identification module using template matching technique to recognize individual alphanumeric with the help of database stored for each and every character (A to Z) and number (0 to 9). Second, the alphanumeric on the plates are identified and segmented. The alphanumeric identification and recognition stage converts any identified character and numbers to text string, the segmented characters will be encoded into text and it is known as optical character recognition (OCR) (Velappa Ganapathy, *et al*, 2007).

Firstly, various vehicle images have been acquired through camera. Exact location of license plate region is masked and extracted from image. Then, those color images are converted into grayscale images with brightness adjustment, contrast up to optimum values and removal of noise using median filtering in order to get better quality images, as shown in Fig.1 (a). The histogram of grayscale image displays small amount of information which is in favor of quick image processing, as shown in Fig.1 (b).

Fig.1 (a) Original Image to Grayscale Image

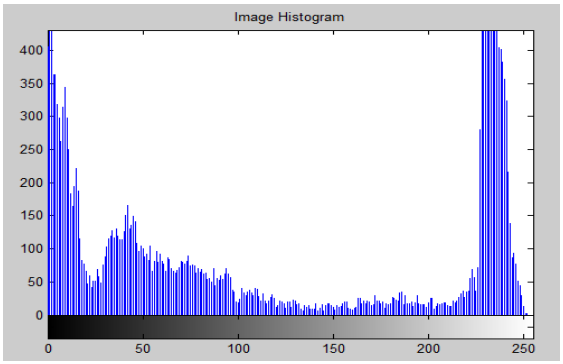


Fig.1 (b) Histogram of gray-scale image

Secondly, segmentation of each character is done for extracted region. Segmentation is a process of subdividing a digital image into the consequent parts. The main purpose of image subdividing into consequent parts or objects present in the image is to extract some meaningful information. Therefore, segmentation is the crucial step in recognizing the vehicle license plate. After segmentation, character recognition is done. Each segmented character is compared with template matching, if characters are matched then it will display the output in text.

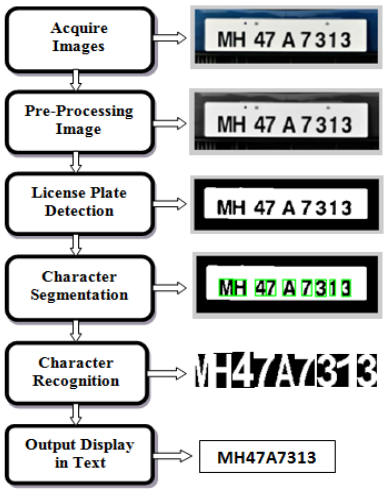


Fig.2 Flowchart of a RLNP System

4. Character Segmentation

This is an important phase in RLNP (Recognition of license number plate) system to perform the character

recognition. Segmentation of each character is done for extracted region. Segmentation is a process of subdividing a digital image into the consequent parts. The main purpose of image subdividing into consequent parts or objects present in the image is that we sought for the analysis that is to extract some meaningful information. The character segmentation acts as a bridge between the license plate extraction and optical character recognition modules. Bounding boxes are placed on each alphanumeric to extract the alphanumeric of the license plate which will only require the location of the bounding box of each (Cl'audio Rosito Jung, *et al*, 2004) object in the chosen candidate region. Then, for each extracted bounding box, the object with the maximum area is retained. All other objects are removed, after segmentation is done. Each segmented character is compared with template matching, if characters are matched then it will display the output in text. (Shyang-Lih Chang, *et al*, 2004; Akram A. Moustafal, *et al*, 2015). The output text will be exported via MATLAB as well as Notepad.

5. Character Recognition

The Optical Character Recognition (OCR) technique is used in order to recognize different alphanumeric. This approach is based on pattern recognition principles and the system of OCR engine is based on a template-matching algorithm (Madhuri Latha, *et al*, 2012).

Template Matching is a technique that compares portions of images against one another. Sample of images may be used to recognize similar objects in the source image. If a standard deviation of the template image in comparison to source image is small enough, then template matching may be used. The matching process moves the template image to all possible positions in a larger source image and (Aini Najwa Azmi, *et al*, 2014) computes a numerical index that indicates how well the template matches the image in that position. Matching is done on a pixel by pixel basis. When all the numbers are matched and recognized through OCR technology. This number can be used by any organization as per its requirement. The best matched characters are recovered and the output is stored in a text file (Sandeep Saha, *et al*, 2013; Halina Kwasnika, *et al*, 2002).The size of images in template is 42 x 24 pixels which is shown in fig.3.

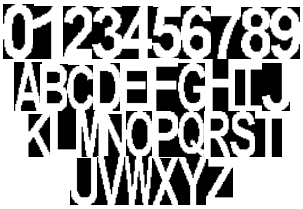


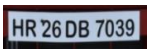
Fig.3 Templates Used for Template Matching

6. Results and Discussion

6.1 License Plate Recognition Output

We experimented on 118 license number plate images, out of which 10 results along with their detected and undetected alphanumeric counts are represented in table 1. These results showcase the exact result displayed in the output, via Notepad and MATLAB, which accurately defines how each license plate is interpreted by the system.

Table 1 Experiment Results Table

License Plate Images	Total Alpha-numeric	Detected Alpha-numeric	Undetected Alpha-numeric	Results
	10	10	0	DL4CAF4943
	9	7	2	AF98D3459
	10	9	1	HR26DB7Q39
	10	7	3	0L7CN55T7
	8	8	0	KL65A773
	10	8	2	MR46AU6474
	10	6	4	KRT4DT8834
	10	10	0	HR26DA0797
	10	8	2	KA05HK827I
	11	11	0	DL3TCSZ1704

License Number Plate Detection and Recognition accuracy (LPDRA) is the ratio of License plate detected and recognized with no errors N_{ZE} to the total number of license plates N_{TOT}, i.e.,

$$LPDRA = \frac{N_{ZE}}{N_{TOT}} \quad (1)$$

Table 2 License Number Plate Detection & Alphanumeric Recognition Accuracy

Total Number of License Plates N_{TOT}	License Plates detected and Alphanumeric recognition with errors					Detection and Recognition Accuracy Percentage *LPDRA*
	No error	1 error	2 errors	3 errors	4 errors	
118	48	30	22	10	8	**40.67%**

6.2 Algorithm

Step1→ Image Acquisition- Capture the image through digital camera and give as input to process.
Step2→ Convert Color image into grayscale image.
Step3→ Image Enhancement-Removal of noise using median filter.

Step4→ Plate extraction- Find rows and columns values of the image to identify the region. The image is dilated and removed connected objects, we extracted the desired region.

Step5→ Character Segmentation- Bounding box method is used to map each alphanumeric to a box and display it into a single image.

Step6→ Character Recognition- after segmenting all alphanumeric, each is compared with the template.

Step7→ The best mapped alphanumeric are converted into text string for storing in text size.

These steps are represented below in fig.4:

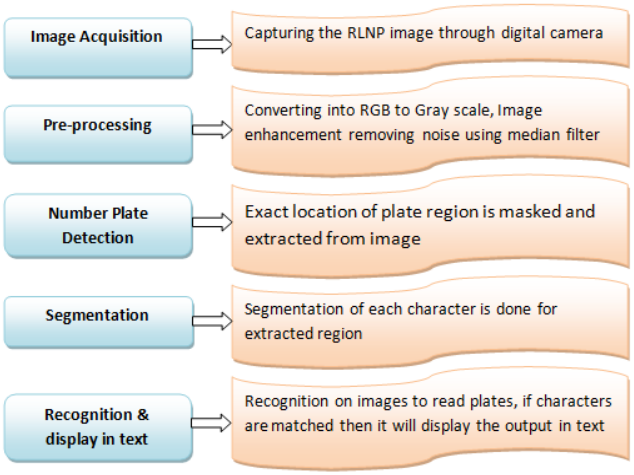


Fig.4 Algorithm of RLNP

6.3 Recognized and Misrecognized Alphanumeric

Accuracy of correctly recognized each alphanumeric character (CRA) is the ratio of total correct alphanumeric recognition (C_{CR}) to the total number of alphanumeric in all license plates that are used for experiment (C_{TOT}), i.e.,

$$CRA = \frac{C_{CR}}{C_{TOT}} \quad (2)$$

Table 3 (a) Recognized and Misrecognized Alphanumeric

Total License Plates	Total Number of Alpha-numeric *CTOT*	Total Correct Alpha-numeric Recognition C_{CR}	Total incorrect Alphanumeric Recognition	Percentage of correctly recognized Alpha-numeric *CRA*
118	1108	972	135	87.72%

Misrecognized alphanumeric are the alphanumeric that are quite similar in shape, therefore system gets confused and interpret them incorrectly. For example- similarities between O and D; 5 and S; 8 and B, E; O and 0, etc.as shown in table 3(b)

The error in alphanumeric character getting misrecognized C_{MRE} is the ratio of number of times all misrecognized alphanumeric occur C_{MR} to the total number of alphanumeric in all license plates C_{TOT} that are used for experiment, i.e.,

$$C_{MRE} = \frac{C_{MR}}{C_{TOT}} \quad (3)$$

Conclusion and future works

License Number Plate detection and Recognition is an important activity under various situations like security, access control, accidents, crime, vehicle tracking etc. The proposed approach is simple and has low turn-around time, which may be suitable for real time applications.

There are some practical difficulties, while character recognition operations were performed, leading to increase in error. Few of them are: 1. Non Standard number Plates like varying aspect ratio, color, patterned, background, font size and position etc., 2. Additional text, number, images, stickers, dirt on RLNP 3. Broken/ irregular shaped number plate, 4. Similarities between some characters such as O and D; 5 and S etc., 5. Poor/ Non-uniform illumination, shade on number plate etc.

The proposed approach offered good recognition rate, which may further be improved using advanced image and pattern recognition algorithms, Artificial Neura Network (ANN) etc.

Table 3 (b) Misrecognized Alphanumeric with error pool

S. No.	Misrecognized Alphanumeric Error Pool	Number of times misrecognized alphanumeric occur
1	A,4	6
2	B,8	8
3	C,G	10
4	D,0	21
5	M,H	11
6	H,R	14
7	W,V	12
8	1,T,I	18
9	2,Z,7	19
10	3,9	7
11	5,6	9
Percentage of misrecognized alphanumeric C_{MRE}		**12.18%**

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