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AUTOMATIC CAR LICENSE PLATE EXTRACTION

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ABSTRACT

License plate extraction is an important stage in the vehicle license plate recognition for an automated transport system. This paper presents a novel and practical license plate extraction algorithm based on the edge statistics and the morphology. The proposed approach can be divided into 4 sections, which are vertical edge detection, Linear Gray-scale Transformation, mathematical morphology-based license plate extraction. The proposed approach is designed to work in a wide range of acquisition conditions, including unrestricted scene environments, different camera-to-car distances, etc. Under the available database, the average accuracy of locating vehicle license plate is 84%.

KEYWORDS: License plate extraction; edge detection; morphology.

INTRODUCTION

Automatic vehicle identification is an essential stage in intelligent traffic systems. Nowadays vehicles play a very big role in transportation. Also the use of vehicles has been increasing because of population growth and human needs in recent years. Therefore, control of vehicles is becoming a big problem and much more difficult to solve. Automatic vehicle identification systems are used for the purpose of effective control. License plate recognition (LPR) is a form of automatic vehicle identification. It is an image processing technology used to identify vehicles by only their license plates. Real time LPR plays a major role in automatic monitoring of traffic rules and maintaining law enforcement on public roads. This research work will present an approach to get a scheme that can identify license plate in more accurate and efficient manner.

LPR

In this section, the styles of license plate that are considered in this study are discussed, followed by a brief description of the proposed LPR process. It shows assorted styles of license plates found on vehicles in India. Each style is associated with a particular class of vehicle. The classes include private auto-mobile, taxi, tour bus, truck, and government vehicles. Other categories of vehicles, such as diplomatic cars, and military vehicles, are not addressed since they are rarely seen. Styles of license plates can easily be distinguished based on two attributes: 1) the combination of colors used and 2) the compositional semantics of license numbers.

Each style has different foreground and/or background color. However, in all only four distinct colors (White, Black, Red, and Green) are utilized in these license plates. We shall pay attention to these four colors when searching for license plates in an input image. The compositional semantics of license numbers provides additional information for differentiating styles of license plates. Every license number is composed of two parts separated by a hyphen (e.g. CH-5533).The first part consist of two characters, one of which must be an alphabetical character (e.g. CH, HR). Second part may contain four (e.g. 5533) or three (e.g. 233) numerals, the former being used only on private automobiles, and the latter being used on the other vehicles classes.

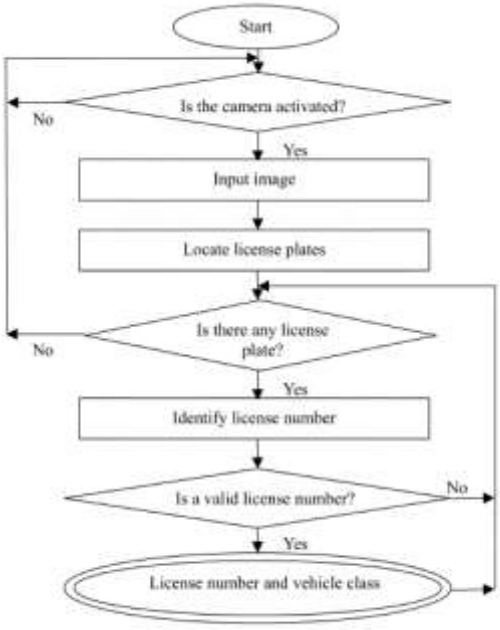


Fig. 1. Diagram of the proposed LPR process.

How does it work?

The following example shows how a typical access-control system works.

The vehicle approached the secured area, and starts the cycle by stepping over a magnetic loop detector (which is a most popular vehicle sensor). The loop detector senses the car and its presence is signaled to the LPR unit.

The LPR unit activates the illumination (invisible Infra-red in most cases) and takes pictures of the front or rear plates from the LPR camera (shown in the left side of gate). The image of the vehicle includes the plate and pixel information is read by the LPR unit's image processing hardware (the frame grabber).

The LPR unit analyses the image with different image processing software algorithms, enhances the image, detects the plate position, extract the plate string, and identifies the fonts using special artificial intelligence methods (such s neural networks).

Most LPR units are based on an application running on PC under Windows. Other systems exist that do not require a

PC (such as the standalone unit shown in this illustration).

The LPR unit checks if the vehicle appears on a predefined list of authorized cars, and if found- it signals to open the gate by activating its relay. The unit can also switch ON a green "go-ahead" light or red "stop" light. The unit can also display a Welcome! message with personalized data.

The authorized vehicle enters into the secured area. After passing the gate its detector closes the gate. Now the system waits for the next vehicle to approach the secured area.

MAIN ALGORITHM IN THIS PAPER

a. Edge Detection

The edge detection operators that we usually use are Robert operator, Sobel operator, Prewitt operator and Krisch operator. But through experiments we have discovered that SotropicSobel operator has a maximum response to edge. There are two masks for SotropicSobel, one is horizontal and the other is a vertical one. The mask is convolved with each pixel of the image. Figure shows these two masks:

$$\begin{pmatrix} -1 & 0 & 1 \\ -\sqrt{2} & 0 & \sqrt{2} \\ -1 & 0 & 1 \end{pmatrix} \qquad \begin{pmatrix} -1 & -\sqrt{2} & -1 \\ 0 & 0 & 0 \\ 1 & \sqrt{2} & 1 \end{pmatrix}$$

Figure: Vertical mask and horizontal mask.

b. Linear Gray-scale Transformation

The details of an image will be obscure when the image is under-exposed or over-exposed or when the nonlinear dynamical range of image device or recording device is too narrow. And in these circumstances, if we extend the gray-scale image

linearly, we can usually improve the image's visual effect.
Supposing the gray-scale range of the source image *f(x, y) is[a,b]* , and the expected dynamical range of transformed image *g(x,y) is [c,d]*, then we can use the equation(1) to achieve our purpose.

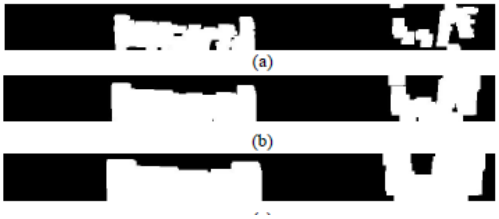
$$g(x,y)=\frac{(d-c)[f(x,y)-a]}{b-a}+c$$

c. Mathematical Morphology(MM)

Built on the basis of set theory, MM [8, 9] is a nonlinear theory for image processing and analysis. Recently, the MM theory has been widely used in the fields of image processing and computer vision. MM makes use of Structure Element (SE) for measuring the morphology of image to solve and understand problems accurately. An SE can be of different geometric shape and size. But the shape of SE widely used now in form of line (usually horizontal or vertical), and the size is usually computed according to the specific conditions. Erosion and dilation are two basic MM operations, which are carried out by convolving the SE with the image. Erosion is often used to remove irrelevant details from binary image, but on the contrary, dilation is used to fill in the gaps or holes. Now let B denote an SE, A stands for the input source image, X represents the result of erosion or dilation, then the operation of erosion and dilation can be defined as equation (2) and equation (3), and illustrated in figure.

d. Morphology-based license plate extraction

In this step we connect edges together by morphological operators and then we compare the candidate with the aspect ratio. We use dilation for three times. First a horizontal dilation, after that vertical dilation and at last, again a horizontal dilation. By these operations we connect edges of existent license plate together. Result of these operators is shown in Fig. Now we search for the biggest white strip in the region and set it as first candidate then, we compare it to the aspect ratio. If its dimensions are not closed to aspect ratio we delete this region from vertical edges image and repeat the above algorithm, if not, the first candidate is acceptable and the algorithm is finished. Final result is shown in fig.



CONCLUSIONS

In this paper a novel technique is introduced that is very cost effective solution of license plate recognition. We focused on performance factor as well to make this system efficient. This system is capable to recognize the license plate within few seconds (20-40). The specialty of the system is the use of very lost cost devices to achieve this critical and cumbersome task. Instead of using very costly cameras normally recommended by other such applications we used video recording devise, easily available at market at very low cost that is capable to perform same task with same quality level. For the extraction of image of interest own designed algorithm that is very simple and able to perform the task of image extraction through simple steps thatalso enrich the performance factor of this system.

This generic license plate recognition software has many applications in the market. It can be used for (1) automated entry in parking against prepaid membership, (2) Road-toll calculation between check in and check out points, (3) authentication while crossing countries boarders, (4) Stolen cars tracking by alarming the un-identified vehicles, (5) Detection of charged vehicles as mentioned in section one. The results of license plate edge identification, license plate extraction, license plate segmentation, and license plate text recognition as shown in table.

Speed	Accuracy	License Plate Edge Identification	License Plate Extraction	License Plate Segmentation	License Plate Text Recognition
Slow < 10km/h	Correct Recognition	89/110	89/110	85/110	86/110
	%age	80.90%	80.90%	77.27%	78.18%
Fast < 20km/h	Correct Recognition	54/110	54/110	50/110	51/110
	%age	49.09%	49.09%	45.45%	46.36%
Still	Correct Recognition	108/110	108/110	107/110	107/110
	%age	98.1%	98.1%	97.27%	97.27%

Table: Recognition rate for license plate edge identification, license plate extraction, license plate segmentation and license plate text recognition.

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