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Automatic License Plate Recognition

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***Abstract*— This paper presents an automatic license plate recognition algorithm by using webcam. The images of vehicle license plate, which were captured by using webcam are noised, illuminated and skewed under natural environment. We have to preprocess to get clean binary image and extract each character area to recognize numbers. But they are not simple jobs. In this paper, the high-speed and sophisticated rules for preprocessing and segmenting of plate image are experimented. A new recognition technique is also proposed which has produced the best recognition rate of 98.5% when tested on the images of 120 vehicles by using webcam.**

***Keywords*— license plate recognition, car plate recognition, segmentation technique .**

1. Introduction

An automatic license plate recognition technique has a wide range of real applications[1] by using a captured image of the front or rear plates.

Access control is one of the popular application domains. The gate bar automatically opens for only authorized vehicles in a secured area without a security guards according to recognition result by the license plate recognition system. Automatic parking control is another application area of the license plate recognition system. When a vehicle is entering a car park, the vehicle plate is recognized and stored. When the vehicle will late exit the vehicle plate will be read again to charge for duration of the parking without any human guide. This recognition system may be used to detect the stolen cars on the roads. The license plate recognition system can recognize all plates of vehicles on the roadside and match between the recognized number and the black list numbers to immediately alarm to the police department. Police enforcement can be automatically processed by using the license plate recognition system. The plate recognition results are used to produce a violation on speed or red-right systems. Sometimes this recognition system may be used to compile a list of frequent visitors for marketing purposes or to build a traffic profile.

To use the license plate recognition system for various purpose such as the above applications, the system should be generate exact recognition results under the real environment of vehicles.

The license plate recognition system may use a camera for capturing the plate images under the stopping or driving vehicles and use a image processing technique for extracting the segments of numbers from the background image, and character recognition technique for identifying plate numbers.

Generally the plate images are illuminated by sunshine on the street, defiled by spots, or noised by ornaments. So, the segmentation of number area is not trivial work and the recognition of each number is also not simple. Traditional image processing techniques may be modified to successfully apply to plate number segmentation and robust recognition technique may be required to get exact recognition results.

In this paper, the license plate recognition system is proposed which has a sophisticated character extraction technique by modifying general image processing technique and a strong recognition engine by using neural network technique.

The license plate recognition system has been applied to recognize the images of vehicles which are captured by using webcam and analyzed to apply real applications.

2. Plate number images

Since the vehicle plates are based on different Country standards, they usually different in form, shape and material. Therefore the license plate recognition system is Country specific where they are installed and used[1].

In this paper, the plate number images of the front side of the car have been captured by using webcam form Korean domestic vehicles which has mixed characters with Korean characters and numeral numbers as shown in Fig. 1.

Fig. 1. An example of a captured plate image from Korean vehicle by using webcam.

The plates of Korean vehicles may be divided to several types depending on using purpose of the vehicle. The image of Fig. 1 is most popular type of plate of the

vehicles which are driving by general people. The plate composed of two different character lines, the upper one has small numbers and a small single Korean character and the lower one has big four digits. The boundary of the plate has a box line with white color same as characters from green background, and two screws for fixing the plate on the car.

A typical plate image has shadow area from the body of vehicle and illuminate area from sunshine.

3. Segmentation of characters

To recognize each character of plate image, each character region may be extracted from background image. Generally the original images which has been captured by webcam has true colors. The license plate recognition system may start with the true color plate image and end with recognition results as shown in Fig. 2.

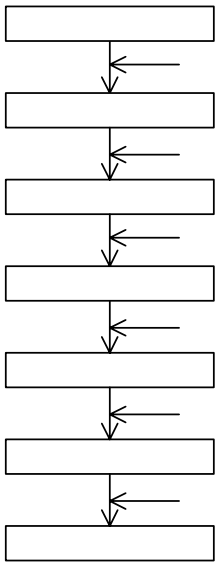


Fig. 2. The processing flow of license plate recognition system.

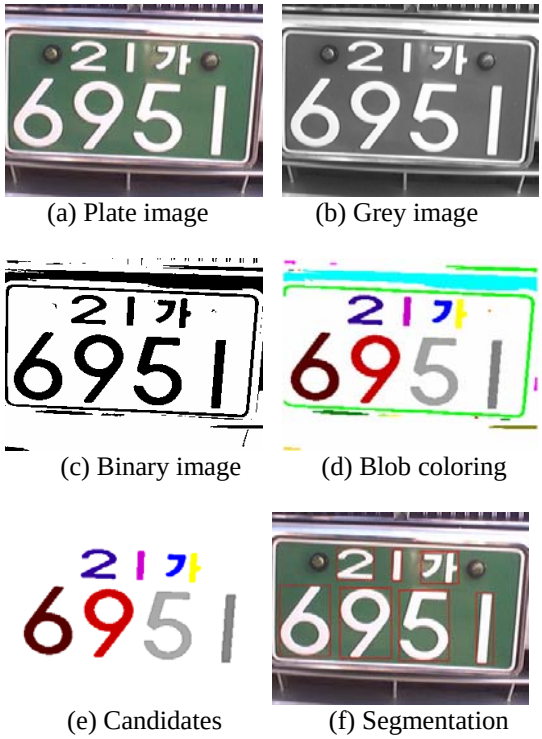
A true color plate image should be quantized 256 level grey image for converting into binary image. Quantization may be achieved with general algorithm without any decreased recognition performance. Image enhancement techniques may be applied to grey image such as histogram equalization and histogram normalization.

There have been various ways in converting 256 level grey image into binary image according to the application. General global binarization technique having a single threshold level for entire image area such as Otsu's algorithm is not useful in a plate image binarization which has not bi-modal histogram. Local binarization techniques are more useful in plate image binarization because of non-uniform background and shadows in character area. Local adaptive binarization techniques such as Niblack's algorithm and Bersen's algorithm have been used for binarization of complicated images. Niblack's algorithm has to calculated a mean and a standard deviation values to get a threshold value in the local image area. The calculations have a time consuming job in the real application. Bersen's algorithm uses the lowest and the highest grey level values to get a threshold value in the local image area. This technique has high speed processing time though rough binarization results for complicated background images can be obtained.

We developed a new binarization algorithm by mixing a global binarization technique for high processing speed and a local adaptive binarization technique for obtaining a clean result.

Blob coloring technique is very useful for analyzing of each component in a complicated image even though it has time consuming job. We also developed a new blob coloring algorithm for high speed processing by using memory stack control technique.

Segmenting character region of a plate image may be processed under some information of plates in form and character types. Blob coloring results of each component of a plate image may be used to get each single character region. Alphanumeric and English have a single stroke blob, otherwise Korean has multiple stroke blobs. We can obtain pre-defined number of candidate character regions according to blob analysis results as shown in Fig. 3.



(a) Plate image (b) Grey image

(c) Binary image (d) Blob coloring

(e) Candidates (f) Segmentation

Fig. 3. Examples of image processing results for segmentation.

As shown in Fig. 3, good segmentation results may be achieved simple processing steps under some illumination effects and background noise of plate image.

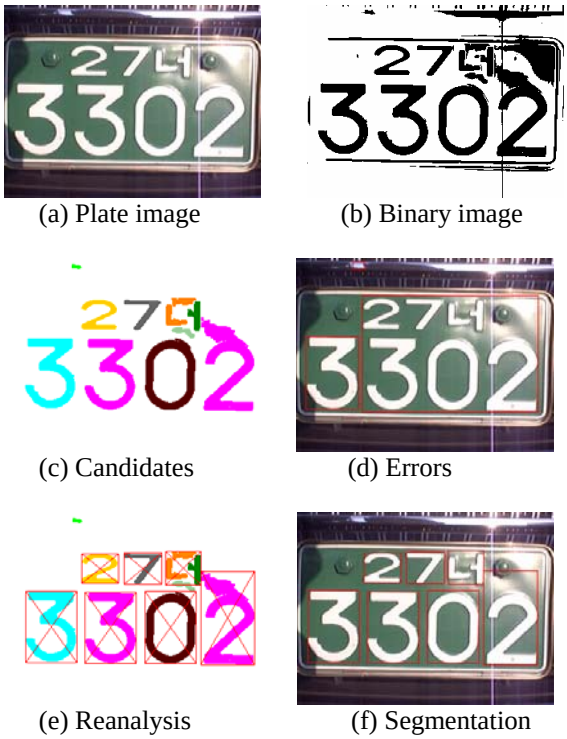


Fig. 4. Examples of image analysis results for segmentation

An illuminated plate has many noise blobs as shown in Fig. 4. In this case, simple blob analysis routines based on heuristic line information of character's simple position in plate depend on Country is not sufficient to get exact segmentation results. We developed a routine for analyzing each candidate blob. In Fig. 4 (e) shows analysis mechanism to use blob information of candidate characters.

Finally the same number of candidate character regions have been segmented with position information. We developed two different recognition engines for alphanumeric characters and Korean characters, which can be classified by position information in plate image.

4. Recognition of characters

Each candidate of character images may be recognized by using character recognition engine. A high speed and accurate neural network recognition system has been developed in this paper. We exploited two different recognition engines for Korean and alphanumeric characters.

Three layer backpropagation neural network has been developed for recognition engine as shown in Fig. 5.

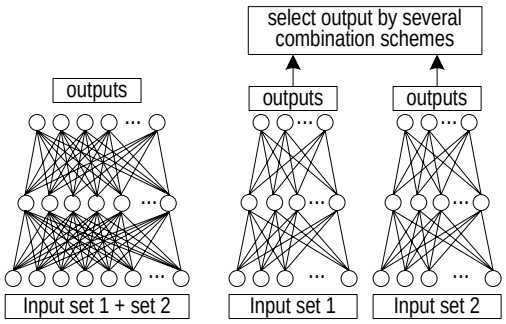


Fig. 5. Neural networks for character recognition

Two input feature sets have been extracted from each candidate character image among following five feature sets.

(1) Mesh feature: The number of black pixels in each of the sub-divided local regions of the binary.
(2) Chain feature: The number of same directional pixels in each of the sub-divide local regions of the contour. In general, four or eight directions can be considered.
(3) Crossing feature: The number of times the strokes are crossed by projection lines which are defined as equally spaced horizontal and vertical.
(4) Distance feature: The distance from minimum boundary rectangle of the word to the first black pixel of the binary image.
(5) Gradient feature: The number of pixels that have the same gradient angle in each of sub-divided local region of the binary. In general, 4, 8 or 12 partitions of 360^{o} can be considered.

Neural networks may be composed of several hybrid architectures to accomplish an exact recognition result under the high-speed processing environment.

5. Experiments

The automatic license plate recognition system has been developed by using a camera and a notebook computer with visual C/C++ environment. We have been captured 120 front plate images in a parking area of a single company with true color mode.

We extracted prototype characters from 20 plate images for training of recognition engine. The digit recognition engine has been trained with mixed size digits i.e. small and big digits in plate image. The Korean recognition engine has been trained with prototype characters which are extracted from plate images.

Fig. 6. The automatic license plate recognition system.

In the automatic license plate recognition system, webcam shows a video image of vehicle and captures a single frame of plate of target vehicle. Then recognition engine analysis the plate image to segment pre-defined candidate character regions and identify the plate numbers.

The 120 plate images include 20 training images have been tested on the recognition system and achieved 98.5% recognition rate. The most errors come from the miss-segmentation results. The recognition engine produced 100% recognition results for the exactly segmented candidate characters.

6. Conclusions

The license plate recognition system has been proposed which has a sophisticated character extraction technique by using some image blob analysis technique and a strong recognition engine by using neural network technique.

The license plate recognition system has been applied to recognize 120 plate images of vehicles, which are captured by using webcam, obtained 98.5% accuracy for whole plate recognition. We are going to develop more sophisticated segmentation method to reduce error rate.

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