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Recognition of Car License Plates using Morphological Information and SOM Algorithm

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Abstract - In this paper, we propose the recognition system of a license plate using SOM algorithm. The recognition of license plate was investigated by means of the SOM algorithm. The morphological information of horizontal and vertical edges was used to extract a plate region from a car image. In addition, the 4-direction contour tracking algorithm was applied to extract the specific area, which includes characters from an extracted plate area. Therefore, we proposed how to extract license plate region using morphological information and how to recognize the character string using SOM algorithm.

In this paper, 50 car images were tested. The extraction rate obtained by the proposed extraction method showed better results than that from the color information of RGB and HSI, respectively. And the license plate recognition using SOM algorithm was very efficient.

Ⅰ. Introduction

Though there have been numerous studies on extracting license plate region and recognizing the extracted character string from the region for a long time, it is very difficult to extract license plate region on images having low brightness or on images having complexities around the license plate[1, 2]. The conventional methods used several models such as gray illumination variation, RGB(Red, Green, Blue) color model, and HSI(Hue, Saturation, Intensity) color model to extract license plate regions from vehicle images. Extraction method using gray illumination variation has the problem of extracting incorrectly non-license plate region as the corresponding region, in case that there exists non-license plate region of satisfying the previous threshold value and it has similar features like license plate region. So, it also has the problem of not trying to extract the correct region any more. When readjusting the threshold of illumination variation, total extracting time is delayed because of additional time of (total image processing time × the number of readjusting threshold value)[3, 4]. The conventional extraction method using RGB color model is affected by the change of brightness as though they have the same colors[5].

In case of a passenger car, the extraction method using RGB color model extracts values similar to that of Green and recognizes the region, in which density of green color is high, as license plate region. However, it is difficult to extract license plate region when an entire car image is green or when green region does not exist at all by effect of a light. The extraction method using HSI color model can solve the above problem arising from RGB color model. However, it has the disadvantage that it takes much time to compute HSI color values[6].

As methods of recognizing license plate region, there exist the algorithms using the pattern recognition and the artificial neural network. The neural Networks are trainable dynamical systems whose learning, noise-tolerance, and generalization abilities grow out of their connectionist structures, their dynamics, and their distributed data representation [7, 8].

Therefore, in this paper, we propose an efficient recognition method of license plate region from the car images by using Morphological information and SOM algorithm.

Ⅱ. Extracting of license plate region and character string

The recognition of a license plate from a vehicle (front) image is basically divided into three parts; Isolation of a license plate region from a vehicle image, Extraction of character strings from an extracted license plate region, and recognition of extracted character strings[5, 6].

We use the following features to extract license plate region from a vehicle image.

(1) The ratio of vertical line to horizontal line for the

plate region is 2:1.

(2) The density of the license plate region is higher than that of other regions because characters are in the plate region.

(3) Characters in the plate region have their position information.

A. Extracting of a license plate region

First, for extracting a license plate region, we convert the input car image into gray image. From the gray image, to extract horizontal edges and vertical edges using the first order differential, we convert the image into vertical edge image and horizontal edge image using the mask. And then, we search a rectangle by means of edges using the morphological information that the license plate region has rectangular form. This method detects rectangular form by connecting the points, which come across horizontal edge and vertical edge.

In case that the size of detected rectangles is too small, if the density of detected rectangle is similar to that of neighboring rectangles, the detected rectangles are combined into the neighboring rectangles. In case that the size of detected rectangles is too large, the density of detected rectangles should be examined, and if their density is irregular, the rectangles should be divided. This method considers the detected rectangles as candidate regions. And then, among the candidate regions, the most suitable region for features of license plate region is selected as the corresponding region. Of candidate regions, the rectangle, which meets the conditions that the ratio of horizontal line to vertical line is 2:1 and the density is higher than the other regions, is considered as license plate region. The related works for each component are as follows. The steps extracting license plate region from vehicle image are shown as Figure 1.

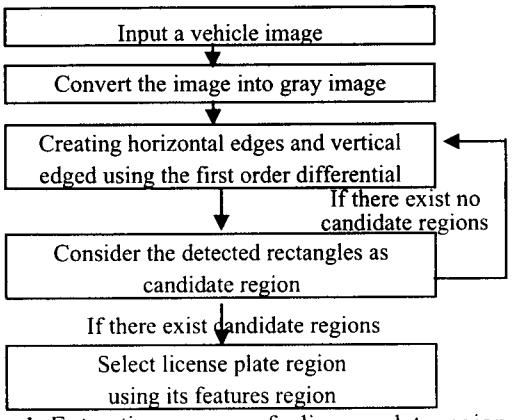
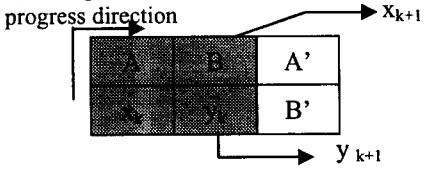


Figure 1. Extraction process of a license plate region

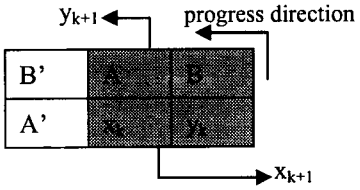
B. Extracting of character string

In this paper, we use the contour tracking algorithm, a method that uses the boundary information of characters. As methods of extracting contour line, there are methods of extracting contour line into eight directions by using 3×3 mask and into four directions by using 2×2 mask[7-12]. In extraction method applied in this paper, for license plate region, compute the density indicating histogram for y-axis direction, divide license plate region into higher part and lower part, and extract each character and digit by the four directions contour tracking method for each of the divided regions.

2×2 mask algorithm locates mask x_k into starting point as Figure 2 by selecting one of boundary pixels in the corresponding region as starting point, and determines the next progressing direction of mask by considering two pixels which correspond to A and B. Contour tracking circulates basically counterclockwise. If A and B are boundary pixel and background pixel respectively, the contour tracking circulates as current status. If A and B are boundary pixels, or A and B are background pixel and boundary respectively, it circulates as Figure 2(a). If A and B are background pixels, it circulates to left and progress direction is converted, as Figure 2(b).



(a) Progress direction when a and b are boundary pixels



(b) Progress direction when a and b are background pixels

Figure 2. The progressing direction of a mask according to (a) and (b)

Ⅲ. Recognition of a license plate

The license plate recognition system using SOM algorithm inputs and learns input patterns. Learning process of SOM algorithm is as follows.

1. Calculate distance between input pattern and connection weight vector of each neuron.
2. Provide the neurons of which the calculated distance are shortest and their neighboring neurons with the privilege

3. Modify connection weight vector so that the neurons with short distance may be closer to input patterns.
4. Recognition starts at the time when learning finishes.
5. Search the neuron from which input pattern is closest to among neurons in the learned competition layer.
6. Recognize the searched neuron by comparing the input pattern with its output value.

SOM algorithm is based on statistical model, and it works well on a large network to increase accuracy[8, 13]. Learning process of characters and recognition process of a license plate use SOM algorithm and are shown as Figure 3.

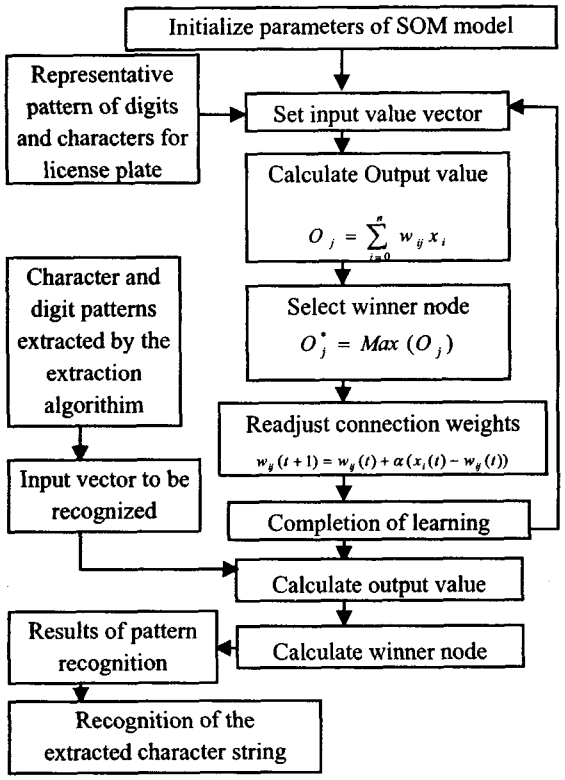


Figure 3. Learning process and recognition process of license plate using SOM

IV. Performance evaluation and results

We implemented a license plate recognition system proposed in this paper and its results are in shown Table 1 and Table 2. For the performance test, we take 40 vehicle front images of 640×480 pixels with 256 colors and 10 vehicle front images with gray colors. The license plate recognition system is implemented by using C++ Builder on Pentium PC compatible to IBM PC.

In the experiments using 50 vehicle images, all of 50 license plates were extracted by the license plate extraction method using horizontal and vertical edges. Table 1 indicates the number of character strings extracted from 50 isolated license plates by contour tracking method and the number of the recognized character strings by SOM algorithm. The second column in Table 1 indicates the number of the character strings extracted correctly and the number of the character strings should be extracted from image. The third column shown Table 1 indicates the number of the character strings recognized correctly and the number of the character strings should be recognized from image.

Table1. Results of character string extraction and recognition

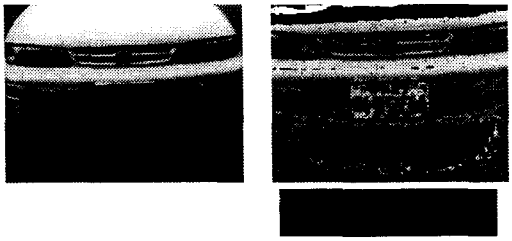
	The number of character string by contour tracking	The number of recognition by SOM algorithm
Area code	100/100	100/100
Purpose code	50/50	50/50
Vehicle type code	83/85	82/83
Plate code	200/200	200/200

We added 10 vehicle images with 256 colors for comparing in Table 2. Table 2 shows results, which compare the extraction method, which is proposed in this paper, with the extraction methods, which are using RGB or HSI. And also, it shows that license plate extraction method proposed in this paper was more enhanced than other extraction methods.

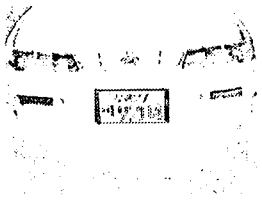
Table2. Comparison of license plate extraction results among the proposed method and methods usingRGB/HSI color

	Extraction method Using RGB	Extraction method using HSI	Proposed Method
The number of extraction	49/50	48/50	50/50

Figure 4 shows an example that license plate can not be extracted by the extraction method using HSI color information but can be extracted by the proposed method. Figure 5 shows the number of winner nodes to the cluster, which is created by SOM algorithm. Winner node to the cluster indicates classification of patterns. In pattern classification, the number of winner nodes to the cluster has important meaning, and if the number of them is large, it wastes time and space to classify a pattern because features are not focusing. If the number of them is small, it occurs to miss-classify because features of the pattern are overlapped. Therefore, as shown in figure 5, as the number of repetitions increases, the number of winner nodes to the cluster is also increasing.



(a) original image (b) a image failed in extracting license plate region with HSI color information



(c) An extraction image of license plate region using morphological features

Figure 4. Comparison of the extraction results between the proposed method and the method using HIS

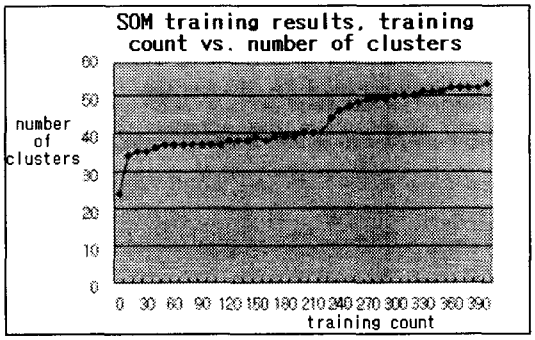


Figure 5. Training results of SOM

V. Conclusion

In this paper, we extracted license plate region using morphological features by horizontal and vertical edges, and recognized character strings of a license plate using SOM algorithm. In experiments using 50 vehicle images, all of 50 license plates were extracted by the license plate extraction method using horizontal and vertical edges. Experimental results show that the extraction method of a license plate region using morphological features by horizontal and vertical edges is more enhanced than the extraction methods using RGB or HSI color information.

433 characters of 435 characters were extracted from 50 the isolated license plate region by contour tracking algorithm, while 432 characters of them were extracted by SOM algorithm.

The proposed extraction of license plate region can be extracted on both of color image and gray image, and it has an advantage that the plate region can be extracted regardless of vehicle type.

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