Recognition of Car License Plate using Kohonen Algorithm*

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Abstract: The recognition system of a car plate is largely classified as the extraction and recognition of number plate. In this paper, we extract the number plate domain by using a thresholding method as a preprocess step. The computation of the density in a given mask provides a clue of a candidate domain whose density ratio corresponds to the properties of the number plate obtained in the best condition. The contour of the number plate for the recognition of the texts of number plate is extracted by operating Kohonen Algorithm in a localized region. The algorithm reduces noises around the contour. The recognition system with the density computation and Kohonen Algorithm shows a high performance in the real system in connection with a car number plate.

1. Introduction

The investigation into the congestion and situation of the traffic has been difficult due to the rapid increase of the number of cars. Car-related crime rates have increased. Nevertheless, the resolution of the crime for many cases remains an unsolved problem since a suspect moves quickly using a car. Recently, some authors have reported several methods to extract the license plate by using the Hough Transformation, which is used after extracting the edge from a car image [1,2]. However, the method shows some difficulties in applying to the real car system because of the long processing time and the extracting problem. Kim et al. [3] proposed a method of merging after the partition of the area, while Cho et al. [4] suggested a method depending on the changing characteristics of gray level in the plate number area. The former divides the total image into infinitesimal rectangular domains, finds plausible candidate domains including a car plate with the measurement of the density in each rectangular domain and extracts the candidate domains one by one with the Hough Transformation. This method has the disadvantage of extracting the domains of the car plate, when the edge of the car plate is not sharply shown by synchronizing the deviation of focal point or there are some noises resulting from the reflection and distortion of light[5]. The latter extracts the domains of number plate by using facts that the domain of a car plate is more intense and has a larger width of change than other domains. This method requires a huge cost of hardware and equipment to operate in real time even though the rate of recognition is high.

In order to overcome these problems, we propose a new method to extract the domain of the car plate by using information that the domain of a car plate is relatively more dense than the whole car image. The car number plate is recognized with the Kohonen Algorithm by way of a process that all the letters and numbers are detected by tracking edge lines. In addition, threshold techniques are presented with the Kohonen of neural networks and the embodiment of a car plate system.

2. Extraction of number plate and letters from a car image

The properties to extract the number plate from a car image are as follows:
(1) The rate of a car plate (approximately x : y = 2 : 1)
(2) The car plate has higher density than other areas because of letters and numbers.
(3) Letters and numbers in a car plate have fixed location information[6,7].

Extract a car plate areas utilizing character using threshold technique. A car plate extraction disposal procedure do threshold technique a car image, figure density of result a car image and extract area satisfied (1) and (2) character of a car plate.

2.1. A car plate extraction from a car image

The extraction method of a car plate area uses a threshold method. Thresholding value is a very important element at threshold course. Luminosity of a car image is very important as pre-process workings of a car plate extraction. It may not clearly separate each letter and background of a car plate in spite of creating an average through the threshold technique of a car image. It's hard to find a clear threshold technique because of it being affected by luminosity and also by a color of the image. Earlier this paper, created an average through threshold technique of a car image but this dynamically changed threshold technique value in case of failing a car plate extraction of a car image. Threshold value creates an approximate to average when changing dynamically. Because there are many times that ideal threshold value shows an approximate to average. A car plate area extraction after executing threshold working has some problems. Because 'high density' happens from a noisy

* The work was supported by the Research Grant of Silla University in 1999.

area due to character (2) of a car plate. Road or land is one element to make shadows to a car plate by the effect of light. Plenty of noise creates after threshold course and then it heightens density. Therefore shadows to be included in mask of fixing size erases after defined as noise. Compute density after ending threshold course and remove noise course. Area with high density rate is indicated candidate area. If there were more than one candidate areas, it extracts a car plate using character of a car plate area. If the character of a car plate was shown, it executes again threshold course as a problem of threshold course. To execute again the threshold course when there isn't a selected candidate area. Figure 1. shows an executed car plate extraction course.

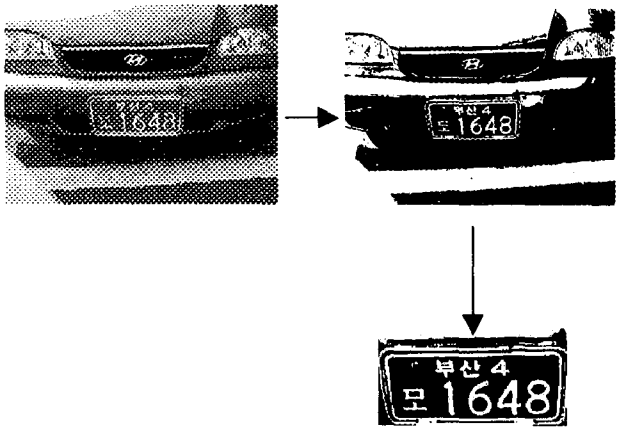

Figure 1. Car plate extraction course.

2.2. Extraction of a letter contour of a car plate using Kohonen Algorithm

This paper uses an contour extraction method for separating number and letter. Using 3×3 mask a method extract contour 8-direction and using 2×2 mask a method extract 4-direction[8]. This paper divides y-coordinates of extracting a car plate and shows a histogram calculating density to part upper-lower. And extract numbers and letters by contour extraction method using Kohonen Algorithm about the divided areas. Figure 2. shows 2×2 mask for edge extraction.

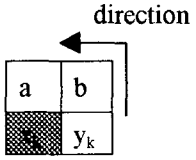

Figure 2. 2×2 mask for edge extraction.

2×2 mask algorithm selects one of the areas' border pixel as start point. Next put x_k of mask like Figure 2. to start point. Last decide next direction of mask to consider two pixels to correspond to 'a' and 'b'. If 'a' is a border pixel and 'b' is a background pixel, make progress to keep the present state. If 'a' and 'b' are border pixels or 'a' is a background pixel and 'b' is a border pixel, change next direction to turn right like Figure 3(a). If 'a' and 'b' are background pixels, change next direction to turn left like Figure 3(b). Table 1. means next direction of 2×2 mask and it extracts the outline along this next direction using Kohonen Algorithm.

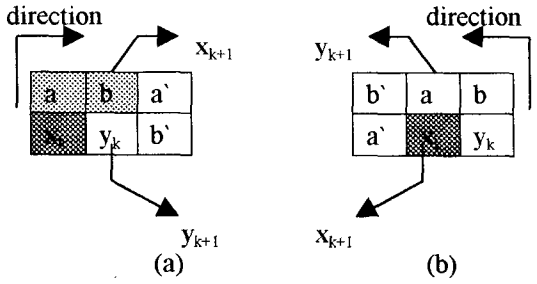

Figure 3. Next direction.

Table 1. Next direction by 2 × 2 mask

	a	b	x_{k+1}	y_{k+1}
Forward	1	0	a	b
Right turn	0	1	b	y_k
Left turn	1	1	a	x_k
Backward	0	1	x_k	a

The working to extract letters and numbers from a car plate area is as follows :
Input : A car plate image
Output : Text file of each letter and number

Step 1 : Input extracted car plate image.
Step 2 : Count histogram of y-coordinates.
Step 3 : Separate a part of upper car plate and a part of lower car plate.
Step 4 :
(1) Read pixels until reaching start point. Reaching start point to step 2, and repeat every pixels of image to step 5.
(2) Follow contour along with figure 1 basis start point.
(3) Reaching start point, save information of letter and to step 4(1) or to step 4(2).
Step 5 : Grasp the situation to analyze situation information like a car plate character (3) information of each letters.
Step 6 : Save as file changed a text-shape each letters.

3. Recognition using Kohonen Algorithm

We use Kohonen Algorithm for extracting a car plate[9]. Input text value of formal each letter extracted at extracting edge course in input layer. Competitive layer s consists of the second dimension or the first dimension and classify each letter and number. Kohonen Algorithm used letter matching and extracted edge at recognition of a car plate as following.

Input : Text file of all letters and numbers, text file

recognizing letters and numbers.
Output : Extracted result of each letters and numbers.
Procedure : Kohonen Algorithm.

Step 1 : Initialize network.
Define $w_{ij}(t)$ ($0 \leq i \leq n-1$) to be the weight from input i to node j at time t. Initialize weights from the n inputs to the nodes to small random values. Set the initial radius of the neighborhood around node j, $N_j(0)$, to be large.

$$d_j = \sum_{i=0}^{n-1} (x_i(t) - w_{ij}(t))^2$$

Step 2 : Present input
Present input $x_0(t)$, $x_1(t)$, ... , $x_{n-1}(t)$, where $x_i(t)$ is the input to node i at time t.
Step 3 : Calculate distances
Compute the distance d_j between the input and each output node j, given by
Step 4 : Select minimum distance
Designate the output node with minimum d_j to be j*.
Step 5 : Update weights
Update weights for node j* and its neighbors, defined by the neighborhood size $N_{j^*}(t)$. New weights are

$$w_{ij}(t+1) = w_{ij}(t) + \eta(t)(x_i(t) - w_{ij}(t))$$

For j in $N_{j^*}(t)$, $0 \leq i \leq n-1$

The term $\eta(t)$ is a gain term ($0 \leq \eta(t) \leq 1$) that decreases in time, so slowing the weight adaption. Notice that the neighbourhood $N_{j^*}(t)$ decreases in size as time goes on, thus localising the area of maximum activity.
Step 6 : Repeat by going to 2.

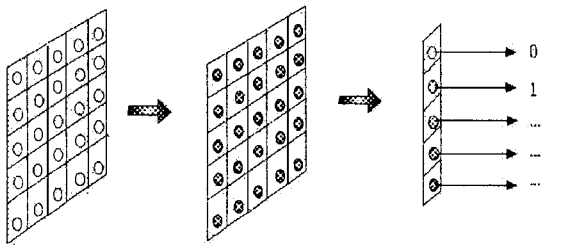

Figure 4. Kohonen network

4. Experimental Results

The results implemented recognition system of a car plate suggested in this paper is like Figure 2. We experimented on 50 car images of 256 colors of 640 × 480 pixel. The recognition system of a car plate was implemented by using C++ Builder at Pentium of IBM-compatible equipment. Table 2 shows all extraction of 50 images. The Total Number of extracted car plates is number of letter and number of exactly extracted car plates. As shown in Table 2, the Kohonen Method was excellent in recognition of car plates, and threshold technique combined with computing density was perfect in extraction of car plates.

Table 2. Car plate extraction and recognition

	No. of Extracted plates	No. of Extracted characters	No. of Recognized plates
Small character	50 / 50	97 / 100	97 / 100
Big character		50 / 50	50 / 50
Small digits		83 / 85	83 / 85
Big digits		200 / 200	200 / 200

Figure of 5. and Figure 6. shows result of Kohonen Algorithm. Figure 5 shows the course to classify the attributes of a car plate by numbers and letters.
Figure 6. confirm the increased number of clusters as the training number increases. The number of winner nodes tends to increase as the training number increases. The Results of Kohonen Algorithm are given in Figure 5 and 6.

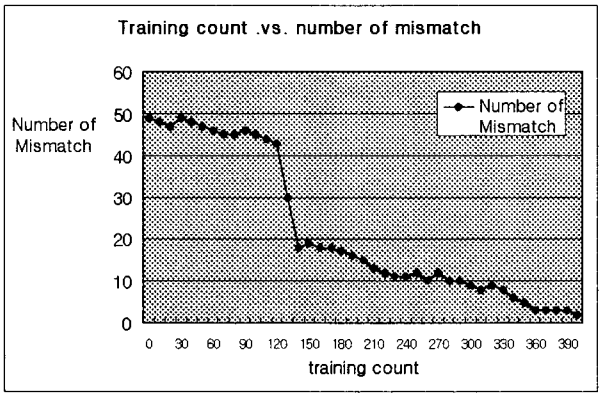

Figure 5. Kohonen recognition results : training count .vs. number of mismatch

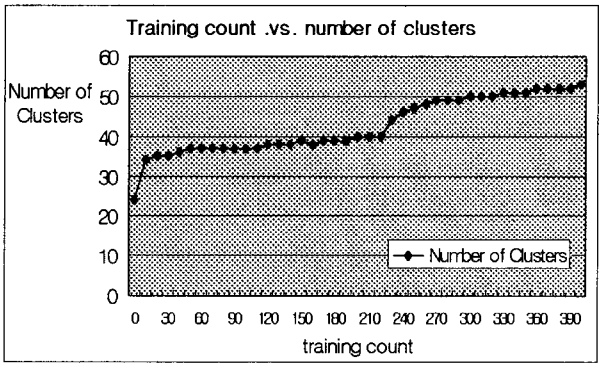

Figure 6. Kohonen recognition results : training count .vs. number of clusters

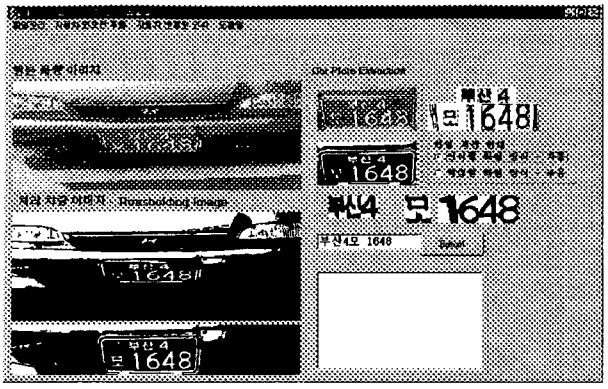

Figure 7.Recognition system

5. Conclusion

In this paper, a thresholding method was used to extract the image of a car plate area. Kohonen Algorithm was implemented to recognize the numbers and letters from the extracted image of plate. The total number of car plates used for this study was 50. It was found that Kohonen Algorithm is a markedly better model in real-time processing, compared to a supervised learning method. In addition, the thresholding method was much better in extracting the image of a car plate area than the conventional methods. But the major problem of the thresolding method is that the results could be different depending of the values of the threshold to be set up.

At present, we are working on the way to apply Wavelet Transform method to extract the attributes of the edge of a car plate.

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