Recognition of Car License Plates Using Fuzzy Clustering Algorithm

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Abstract—In this paper, we proposed the recognition system of car license plates to mitigate traffic problems. The processing sequence of the proposed algorithm is as follows. At first, a license plate segment is extracted from an acquired car image using morphological features and color information, and noises are eliminated from the extracted license plate segment using line scan algorithm and Grassfire algorithm, and then individual codes are extracted from the license plate segment using edge tracking algorithm. Finally the extracted individual codes are recognized by an FCM algorithm. In order to evaluate performance of segment extraction and code recognition of the proposed method, we used 100 car images for experiment. In the results, we could verify the proposed method is more effective and recognition performance is improved in comparison with conventional car license plate recognition methods.

Index Terms— Car License Plates, Morphological Features, Color Information, FCM Algorithm.

I. INTRODUCTION

There are many troubles in traffic environment recently. Speed of cars is decreasing and safety of cars is also seriously threatened because of heavy traffic. Inefficient movement of cars causes energy waste and increase in amount of car fumes. In order to resolve these matters efficiently and quickly, many countries trying hard to develop ITS(Intelligent Transport System). In one of the ITS research fields, car license plate recognition systems are developed as core technique[1].

There are many researches under developing car plate recognition systems in the inside and outside of the country until now. Methods using contrast transformation characteristics and methods using RGB and HIS color space are related with researches for car license plate segment extraction[2-5].

In conventional researches, it used to fail to extract a car license plate segment in case of an image of low contrast because structural features are not used but only contrast and color information are used. In this paper, we proposed a method to extract a car license plate segment using morphological features of car license plate in order to improve the problem of conventional researches.

Noises by fixing pins of car license plate and degradation of an acquired image must be removed in order to find out codes from an extracted car license plate segment. So we used line scan algorithm and Grass Fire algorithm to remove the noises and FCM algorithm to recognize the codes extracted from a car license plate segment.

II. THE PROPOSED METHOD TO EXTRACT A CAR LICENSE PLATE SEGMENT

A. Extraction of a Car License Plate Segment Using Vertical Edge Information

In this paper, we proposed a method to extract car a license plate segment using morphological features in order to improve the performance of extraction in low contrast car images. The process flow to extract a car license plate segment using vertical edge information is as shown in Fig. 1.

Morphological features for extracting candidate segments of car license plate are as follows.

1. Variation of vertical distance in two objects must be within 20 percent.
2. Centers of candidate objects must be found in area of 1.8 to 2.25 times from center coordinates of length of a standard object.
3. Top and bottom coordinates of candidate objects must be found in area of about 25 percent of top and bottom coordinates of a standard object.

Final candidate segment is extracted from candidate segments of a car image using color information of license plate. Green component in license plate is much more than red or blue component because the background color of Korean car license plate is green. So we could extract final license plate segment from a car image using color features.

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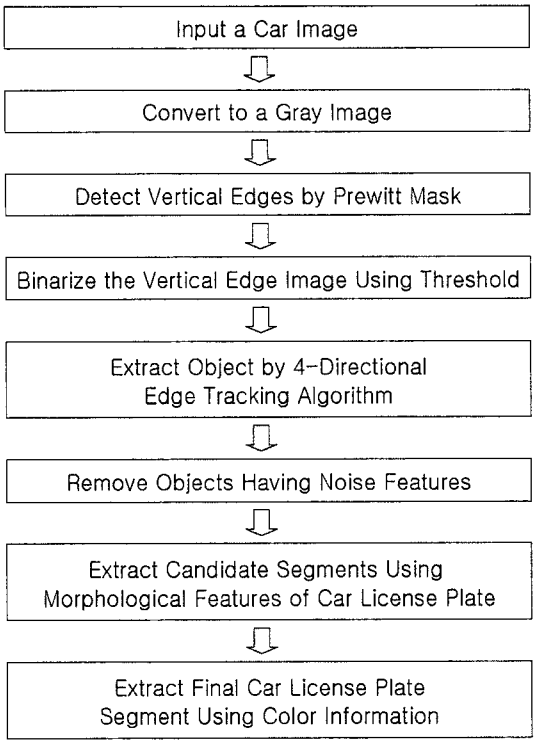


Fig. 1 Flow of extracting a car license plate segment

B. Extraction of Individual Codes by Edge Tracking

It is difficult to extract individual codes from a license plate segment because noises by fixing pins of car license plate and degradation of an acquired image. So in this paper, we used line scan algorithm and Grass Fire algorithm after binarizing an extracted license plate segment to remove noises in the extracted segment. The extracted license plate segment is binarized using an interval threshold value computed by average contrast value of the extracted segment. Some horizontal parts longer than certain length detected by line scan algorithm are considered as noises and removed. The process to remove noises using line scan algorithm is shown Fig. 2.

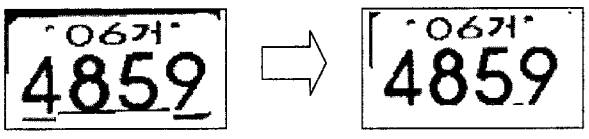
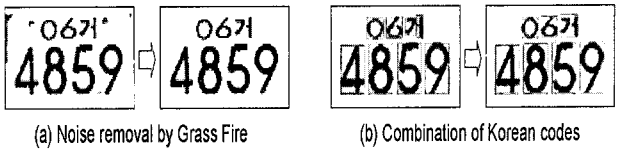


Fig. 2 Noise removal using line scan algorithm

Objects are extracted from the noise removed segment by horizontal line scan using Grass Fire algorithm, and then other objects except code objects are deleted using structural features of individual codes. Individual codes are extracted from the noise removed segment using 4-directional edge tracking algorithm. A consonant part and a vowel part in a Korean character are combined into a single code using morphological features of license plate, and then individual codes are extracted finally. The process to extract individual codes is shown in Fig. 3. The extracted codes are normalized to be applied to FCM algorithm as input patterns.



(a) Noise removal by Grass Fire (b) Combination of Korean codes

Fig. 3 Process of extracting individual codes

III. RECOGNITION OF CAR LICENSE PLATE USING AN ENHANCED FCM ALGORITHM

In this paper, individual codes are recognized using an FCM algorithm[6] utilizing variation by cluster intervals and centers of clusters by cluster locations utilizing symmetric characteristics and fuzzy theory.

Learning process of the FCM algorithm is shown in Fig. 4.

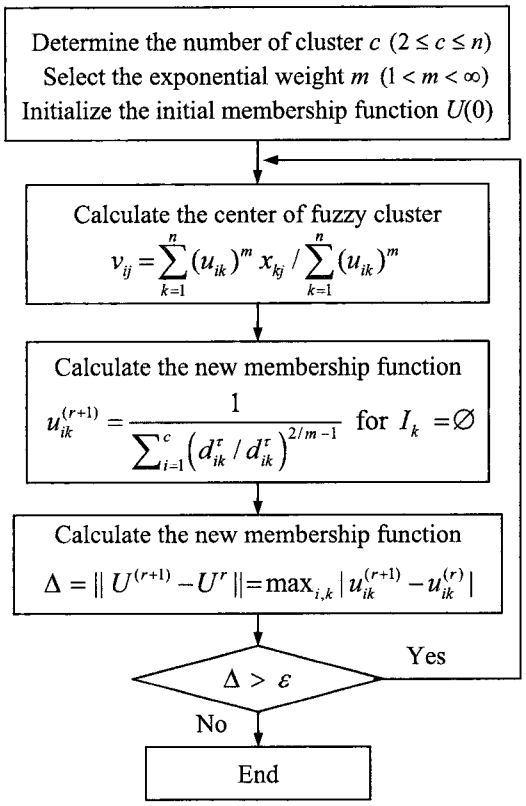


Fig. 4 Learning process of the enhanced FCM algorithm

IV. EXPERIMENTAL RESULTS

We used an IBM compatible personal computer of Intel Pentium-IV 2GHz CPU and 256MB of main memory, and 100 front side images(resolution : 640

by 480) of cars for experiments. A sample image used in experiments is shown in Fig. 5.

Fig. 5 A sample car image

In the proposed method, we could verify extraction rate was improved in comparison with conventional methods by experiments. Table 1 shows Number of extracted license plate and number of extracted codes in the proposed method and conventional methods.

Table 1 Comparison of extraction results by three methods

	Extraction of plate	Number	Character
Proposed method	97 / 100	582 / 600	97 / 100

The proposed method was better than conventional methods even in low contrast images because candidate segments are selected by morphological features of license plate and then color information of license plate was used in candidate segments. If there are similar areas like license plate shape in front of a car, the areas are removed as noise by color information of license plate. But there were failures in extracting a license plate segment because of area having lots of vertical edges like license plate. A sample image failed to extract a license plate segment is shown in Fig. 6.

Fig. 6 A sample image of extraction failure

In order to evaluate learning and recognition performance of FCM algorithm in the proposed method, we used 70 numbers and 97 characters extracted from 100 car images as learning patterns. Parameters in the FCM algorithm for learning are shown in table 2. In table 2, m is a weight value of exponent and ε is a parameter for terminating learning process in the FCM algorithm.

Table 2 Parameters in the enhanced FCM algorithm

FCM	
Character	Number
m =30	m =30
ε = 0.01	ε = 0.01

Table 3 shows results of learning and recognition in the FCM algorithm.

Table 3 Comparison of individual code recognition results

		# of clusters	# of Recognized codes	Recognition rate
FCM	Number	10	572 / 582	98.2 %
	Character	25	90 / 97	92.8%

There were some failures in recognizing individual codes in the FCM algorithm because codes were deformed in the process of binarization by damage in license plates. Sample images of individual code recognition failure are shown in Fig. 7.

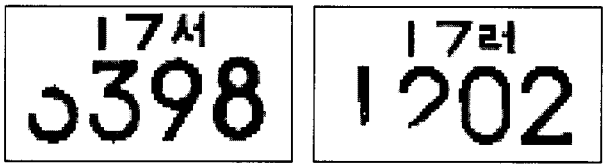


Fig. 7 Sample images of recognition failure

V. CONCLUSIONS

We proposed a method for recognition of car license plate considered as key technique in intelligent transport systems. We processed in accordance with the following steps. At first an input car image was converted to a gray image and vertical edges were detected by Prewitt mask. The detected edge image was binarized by a threshold value and objects were extracted by 4-directional edge tracking algorithm. Objects with noise in extracted objects were removed and candidate license plate segments were extracted using morphological features by shape of car license plate. Final license plate segment

was extracted using color information. In order to recognize individual codes in license plate, we processed in accordance with the following steps. At first line scan algorithm and Grass Fire algorithm were used to remove noises in an extracted license plate segment and individual codes were extracted using 4-directional edge tracking algorithm. Finally an FCM algorithm was used to recognize the extracted individual codes from license plate segment.

In experiments by the proposed method using 100 car images, license plate segments of about 97% of car images were extracted correctly and we acquired about 95.4% recognition rate of individual codes extracted from license plate segments using the FCM algorithm. But there are some failures in extracting license plate segment because of confusion license plate with other areas having vertical edges.

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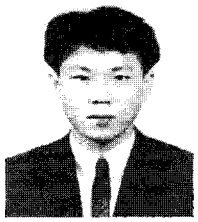

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