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A Method for Measurement of Distances using License Plate Detection

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Abstract. Among the methods of measuring distances between cameras and moving subjects, the method using stereo cameras is the most widely known. However, there is a limitation in measuring the distance to a car ahead using car black boxes that use a single camera. In this paper, a method of measuring distances between cars using license plate detection was proposed. Car number plates of which the sizes are determined by individual countries are one of the best subjects that enable measuring distances between cars using images taken by a single camera. For accurate distance measurement, car number plates were analyzed and extracted and calculated distances and actually measured distances were compared to identify error values in order to verify the method

Keywords: Measurement of Distances, Vehicle Black Box, License Plate

1 Introduction

As economic scales and the scopes of activities increase, traffic accidents are occurring unceasingly due to increases in demand for cars and severe traffic congestion. Although preventing accidents in advance is the best, accurately investigating and analyzing the causes of accidents that have already occurred is also very important. In addition, when accidents have occurred, cases where the opinions of assailants are different from those of victims frequently occur and car black boxes can be said to be devices that have been developed to solve some of these difficulties[1]. However, there are difficulties in measuring actual distances because there are differences between the distances between cars shown in images recorded by black boxes and actual distances. In this paper, a method of measuring distances to cars ahead by comparing the sizes of car number plates detected from images with the sizes of actual car numbers using stored car number plate information and camera view angle information was proposed. Through experiments, distances were measured from images stored by a single camera and the results were verified using only camera view angle information and car number plate size information so that error values between measured distances and actual distances can be reduced.

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2 Related studies

2.1 Black box lens view angle

Although the picture qualities of stored images of black boxes are diverse depending on product performance, most products released recently provide HD grade picture qualities exceeding two million pixels. Car black box cameras have different view angles by manufacturer. Table 1 below shows the view angles that are the most frequently used[2].

Table 1. Lens view angles by manufacturer

Manufacturer	A	B	C	D
View angle	120°	130°	144°	152°

2.2 Car number plates

Car number plates used in Korea have three characteristics as follows, which can be used as information for extraction of car number plate areas. First, although the colors of number plate areas and letters are diverse according to the use of cars, in black/white images, car number plates have contrasting light and shade such as bright backgrounds and dark letters or dark backgrounds and bright letters. That is, the colors of letter areas and those of background areas in car number plates are clearly distinguished from each other. Second, the sizes of widths and heights of car number plates have ratios such as 2:1, 2.16:1, and 4.73:1. Third, number plates are mostly located at the center bottom of cars[3]. Figure 1 shown below are schematized car number plates by size.

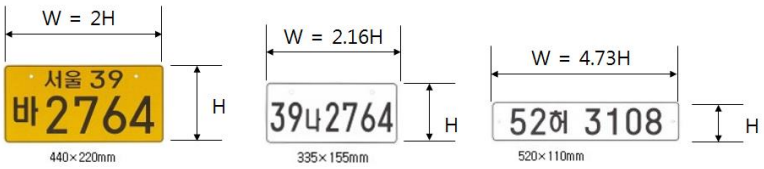

Fig. 1. Sizes of car number plates used in Korea

3 Measurement of distances between cars

The algorithm of number plate detection processes used in this study used the horizontal/vertical edge method that is generally implemented fast[4]. This method detects horizontal and vertical edge images from car images and sets rectangles

appearing as edges as candidate areas to detect the number plate area. In this study, only the number plate that was closest to the center was detected from among candidate areas and was utilized for distance detection[5]. In addition, the algorithm was made to recognize only one number plate seen at the front of images. If number plates not at the front are recognized, differences from actual distances can become larger because of differences in view angles. Figure 2 below shows screens in which diverse forms of number plates extracted from images recorded in black boxes during driving were recognized.

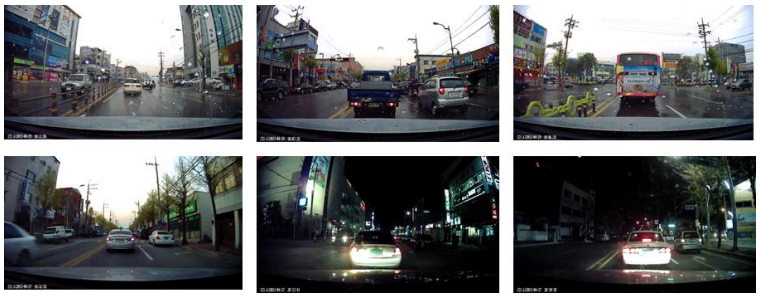

Fig. 2. Images used in the experiment

The width of each number plate detected from images becomes to have a value similar to one of the number plate size values (2H, 2.16H, 4.73H) mentioned in section 2. By comparing the sizes of number plates appearing on images and the sizes of actual number plates, critical values(C) according to view angles can be shown as per Table 2 below based on actually measured distances. The critical values were actually measured with minimum allowable error ranges(r) and were calculated considering the distance between the black box and the front bumper and the height of the number plate on the rear number of the car ahead.

Table 2. Critical values by view angle (reference size : 2H)

View angle	Critical value	Error range(unit:cm)
120°	5300	-34.62 ~ 52.17
130°	4975	-63.54 ~ 38.39
144°	4420	-24.33 ~ 34.00
152°	4080	-50.53 ~ 36.96

The experiment was conducted using the black box having a view angle of 120° from A Company and car number plate sizes 520x110mm and 440x220mm among the eight number plate sizes being used in Korea. The original images were 190.5mm high 338.7mm wide HD images. To obtain horizontal lengths at different distances, distances from randomly selected points on the left side to points on the right side were actually measured and the sizes of the number plates appearing on the images

were compared with the distances. As shown in Table 3 below, the errors in calculated resultant values could be identified using the actually measured distances between the left side and right side points and expression (1).

Table 3. Comparison between image widths and actually measured distances (Unit:cm)

Detected size	Actually measured distance	Measured distance	Error
11.4	440	464.91	+24.91
9.0	610	588.89	-21.11
6.5	840	815.38	-24.62
4.6	1,120	1,152.17	+32.17

According to the results of the distance measuring experiment, errors of 25.70cm on average were shown. Error ranges in the measured distances may differ depending on the view angles of black box cameras and car heights.

4 Conclusion

Car number plate sizes are the same for different car sizes. In this study, experiments were conducted using three sizes of number plates. Differences between distances detected from images and actual distances were shown to be between -63.54cm and 52.17cm. The average error range was shown to be 25.70cm when the size of number plates was 2H. Given that the black boxes are for cars, disputes can be reduced a little by grasping rough distances when accidents have occurred.

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