Proposal of Driver Symbol Mark Detection using One-Dimensional Histogram Figure Extraction Method

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Abstract. Nowadays, research and development in vehicle safety system has been intensively conducted. In the research field of intelligent transportation systems (ITS), various suggestions have been made concerning road signs which can be automatically recognized by driver-support systems. But, human factors are important risks of traffic accidents. However, research is focused on road signs, in the driver information analysis is not enough. So, In this study we describe a new method to extract driver symbol mark using one-dimensional histogram. The method utilizes the Polytope method which is one of minimization algorithms. For the extraction of figures, one-dimensional histogram is used. On the method of this study, the algorithm is simple, the memory space is very small, and the processing time is very short.

Introduction

In recent years, the problem of traffic congestion and traffic accident are more and more frequent. In order to solve these problems, Intelligent Transport System has been actively conducted. With the rapid development of automotive technology and the development of preventing accident technology, a large number of Traffic Safety Support Systems have been developed. For example, image processing based road signs detection system. All of these researches help drivers to recognize the forward information. However, the backward information is also important for a driver to know the following car condition. And recently, with the arrival of aging society, the traffic accidents of elderly drivers are increasing. Therefore, we need a method to extract driver symbol mark to avoid rear-end collision. The generalized Hough transform method (GHT) is the representative method to extract figures [1-7]. However, it takes much processing time and needs much memory space. So, we propose a new method to extract driver symbol mark using one-dimensional histogram and Polytope method. The time and memory space are greatly improved, and the algorithm is simple.

Figure Extraction Using One-dimensional Histogram

The proposed method utilizes the Polytope method and one-dimensional histogram. An application of the Polytope method to extract figures and a procedure of extraction of figures using one-dimensional histogram are mentioned as follows.

Characteristics of one-dimensional histogram and Polytope method. In this study, one-dimensional histogram is generated from figure. The histogram has two characteristics. (1) The distribution of histogram changes if the parameters representing figure changes. (2) The best parameters are gotten, if the value of most frequency of histogram becomes maximum. By using the Polytope method, the best parameters are searched so that the maximum value of most frequency can be obtained.

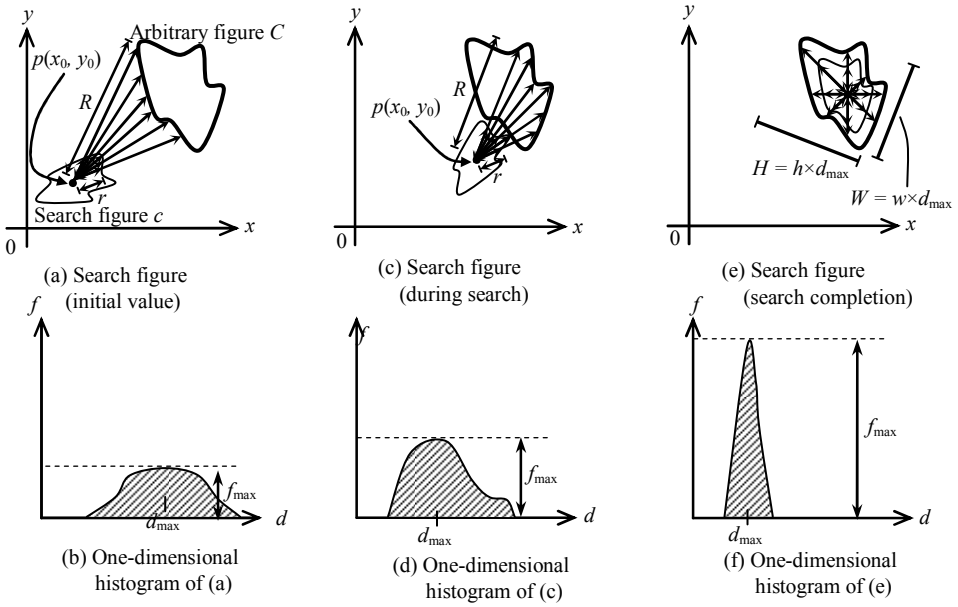


Fig.1. Figure *C*.

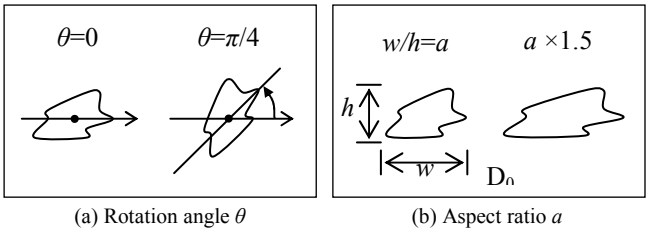


Fig.2.Rotation angle and aspect ratio.

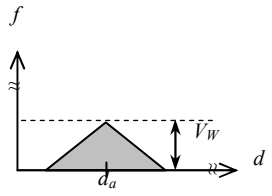


Fig.3.Weight of voting V_w.

The Polytope method is one of minimization algorithms. The Polytope method has three characteristics. (1) Since it can get a minimum value no using derived function different from the Newton's method, the concept can be used for search of histogram. (2) The program size is small. (3) The "initial values" must be set at first , because this method is only available for a single-peak function. If these are not suitable, the optimum value may not be obtained. For more details, see Ref. [8] and [9].

Procedure of figure extraction using one-dimensional histogram. A procedure to extract figure using one-dimensional histogram is mentioned here. A template figure (search figure *c*) is prepared for extraction of figure *C* as shown in Fig. 1(a). To represent figure *C* as parameters, gravity point $p(x_0, y_0)$ aspect ratio a(height h / width w), and rotation angle θ of template figure are defined as shown in Fig. 1(a) and Fig. 2. The template figure defined by the above is called "search figure" *c*. Let the distance between gravity point $p(x_0, y_0)$ of search figure and a point on figure *C* be *R*, let the distance of search figure to the direction of a point on *c* be *r*, and let *R*/*r* be the distance ratio *d*. The value of *d* is calculated for all pixels on figure *C*. Thus, one-dimensional histogram about *d* is obtained as shown in Fig. 1(b). It corresponds to the relationship between *d* and frequency *f*. Here, let the value of most frequency be f_{max}.

If the parameters of search figure *c* which are represented by $p(x_0, y_0)$, *a* and θ are much different from those of figure *C*, the deviation of distance ratio *d* is large. As a result, the distribution of the histogram is gentle. In consequence, the value of most frequency f_{max} is low as shown in Fig. 1(b). Here, let the value of *d* at the position of most frequency f_{max} be d_{max}. According as the parameters of search figure *c* approach those of figure *C*, the deviation of *d* becomes small. Then, the value of most frequency f_{max} becomes high as shown in Fig. 1(d). If the parameters of search figure *c* agree with those of figure *C*, the value of most frequency f_{max} is the highest as shown in Fig. 1(f). At the last case,

the height H of figure C is obtained as $h \times d_{\max}$, and the width W corresponds to $w \times d_{\max}$ as shown in Fig. 1(e). In this study, the height h of search figure is normalized as 1.

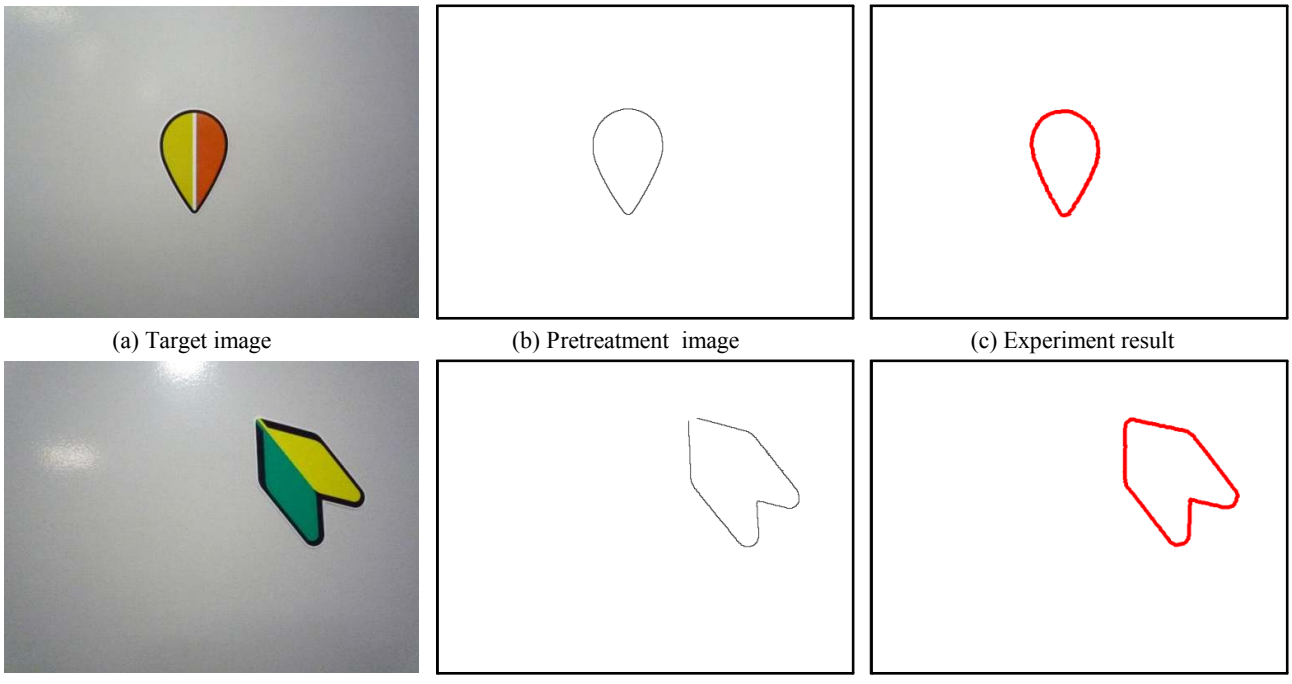
In this way, the figure C is gotten, if the value of most frequency $f_{\max}$ of histogram becomes maximum. We define the following evaluation function E to evaluate the histogram.

$$E = 1 - \frac{f_{\max}}{C_p \times V_w} \qquad (1)$$

where, C_p is the perimeter, which is obtained as perimeter of search figure $c_p \times d_{\max}$ when the value of $f_{\max}$ is the highest. Symbol V_w means a weight which is used when d is voted to one-dimensional histogram. The weight has a distribution. The example is shown in Fig. 3. We explain how to vote using the weight. Let a distance ratio d of a point on figure C be d_a. First, the value of V_W is voted at the position of d_a in histogram. According as the distance ratio d is away from d_a, the value is reduced one by one. If the parameters of search figure c which are represented by $p(x_0, y_0)$, a and θ are much different from those of figure C, the most frequency $f_{\max}$ is very low. Accordingly, the value of function E is nearly 1 as understood from equation (1). According as the parameters of search figure c approach those of figure C, $f_{\max}$ becomes high, so the value of function E is low. If the parameters of search figure c agree with those of figure C, the $f_{\max}$ is the highest. The value of function E can be the lowest. By the use of the Polytope method, $p(x_0, y_0)$, a, and θ of figure C are searched when the value of E becomes the lowest.

Experiment of Extraction of Driver Symbol Mark

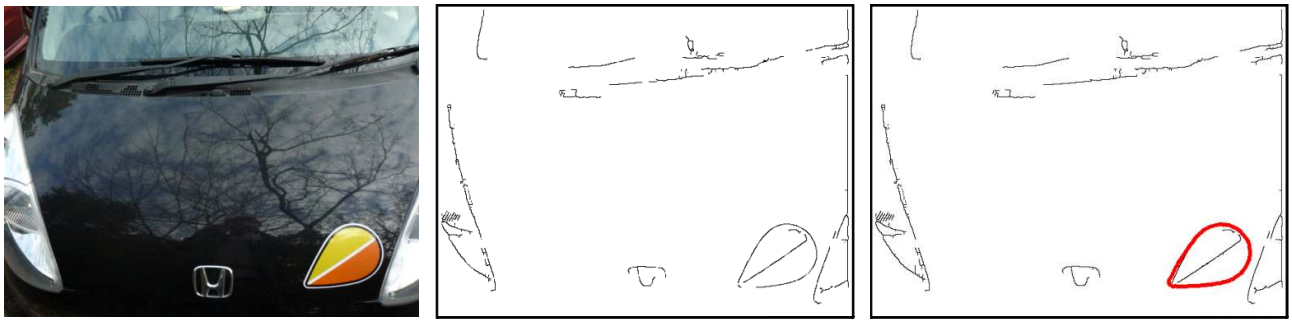
The Experimental conditions. The image consists of 640 × 480 pixels. For the experiments which are used by digital camera. (type Panasonic LUMIX DMC-FX35).



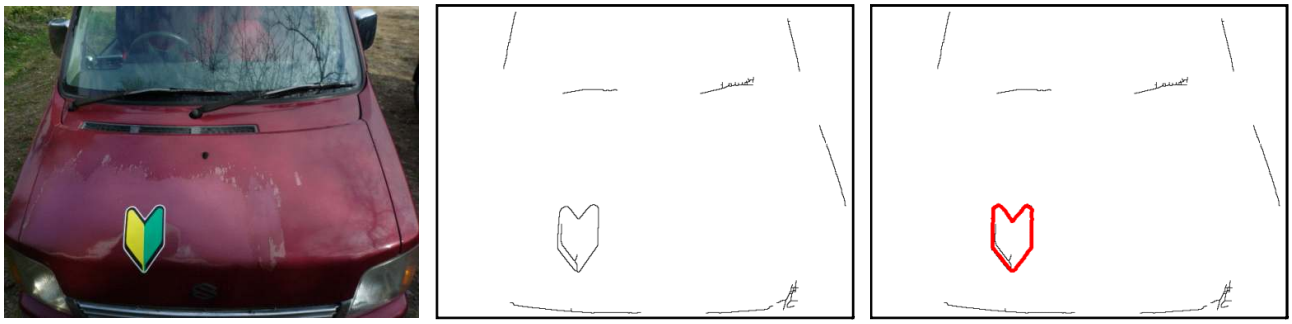
(a) Target image (b) Pretreatment image (c) Experiment result

(d) Target image (e) Pretreatment image (f) Experiment result

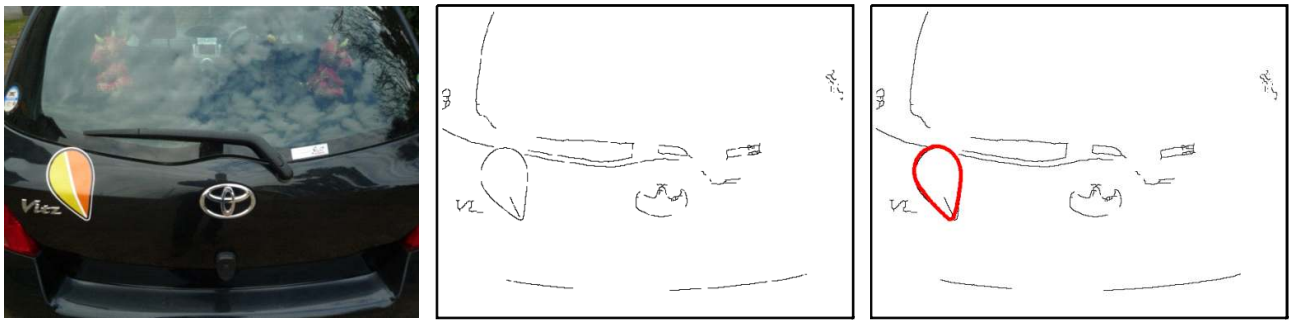
Fig. 4. Experiment of extraction of driver symbol mark in lab environment.



(a) Target image (b) Pretreatment image (c) Experiment result

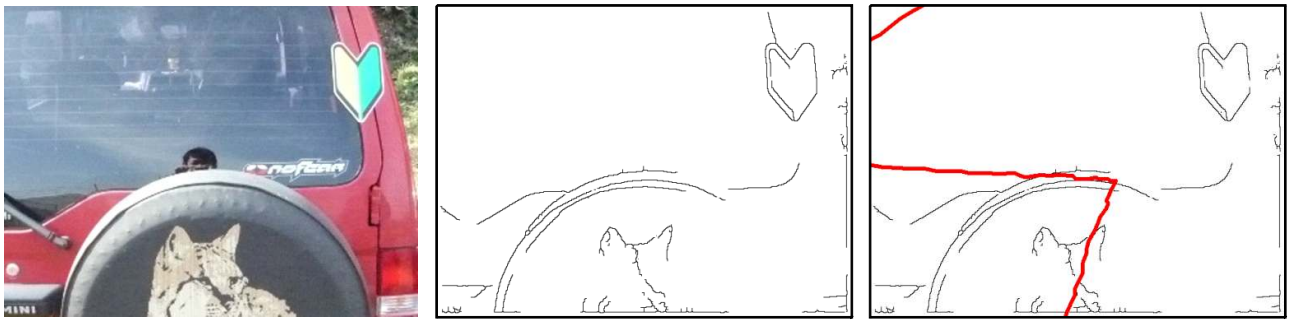


(d) Target image (e) Pretreatment image (f) Experiment result



(g) Target image (h) Pretreatment image (i) Experiment result

Fig.5. Experiment of extraction of driver symbol mark in a real environment.



(a) Target image (b) Pretreatment image (c) Experiment result

Fig.6. Experiment of unsuccessfully extraction of driver symbol mark.

Experimental result. The proposed method is evaluated on a set of 200 images acquired in the lab environment (Fig.4) and real environment (Fig.5 and Fig.6). Figures 4-6 show some obtained results. We can get 83% of good detection. However,the false negative rate is still high for practical use. We observed that with the increase in noise, the detection accuracy rate will be decline.We assume that if the pixels of the driver symbol mark is smaller than 25% of all the pixels in the image. We can not extract it accurately.

Conclusion

A method to extract driver symbol mark using one-dimensional histogram and the Polytope method are proposed in this study. It is relatively simple, because the voting to one-dimensional histogram is simple and the Polytope method is simple algorithm. Unlike conventional method, the memory space is very small, processing time is very short. In addition, this method is effective for an extraction of figure with different aspect ratio.

In this study, we proposed a method to extract mark detection using one-dimensional histogram figure extraction method. We will improve the accuracy of the method in the future.

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