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Type of Vehicle Recognition Using Template Matching Method

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Abstract–**This paper describes about type of vehicle recognition using camera as a sensor to recognize moving object, i.e. car.**

There are three main stages in this process; they are object detection, object segmentation and matching using template matching method.

The experiment was done for various types of vehicle during daylight and at night. The result shows a good similarity level, it's about 0.9 to 0.95 during daylight and 0.8 to 0.85 at night.

Keywords–template matching, recognition, object detection, object segmentation

I. INTRODUCTION

People use sensor to count the number of car that enter to park area. The sensor must detect the car and classified it from other object. The conventional sensor cannot do it well. So, this research will use a camera as a sensor to recognize the car visually. In this case, the car is moving to enter park area.

Generally, there are three stages in car recognizing, i.e. object detection, object segmentation and matching. The first stage gives information whether the camera captures the car or not. The second one does the image segmentation to get the detected car and discard the other. The last stage is to recognize car type by matching it to each image template. This will result similarity value. The highest value will determine the car type. The block diagram of this system is shown at figure 1.

II. OBJECT DETECTION

Before object detection process, the system will do image preprocessing. This process will minimize error of the image. Image preprocessing consists of converting image from RGB to gray scale, histogram equalization and noise removal.

The converting image process uses equation:

$$Gray = 0.299R + 0.587G + 0.114B \quad (1)$$

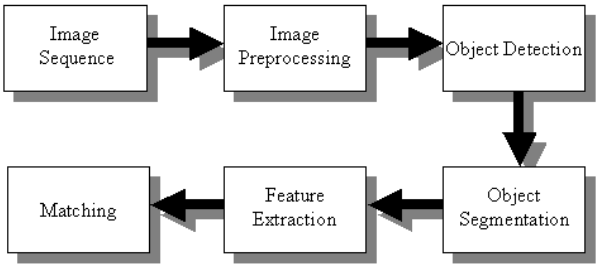


Fig 1. Block diagram of the system

After converting image to gray scale, system will do histogram equalization process. This process will adjust brightness and contrast of the image. Histogram equalization uses equation:

$$g(x,y) = c.f(x,y) + b \quad (2)$$

$f(x,y)$ is original gray level image, $g(x,y)$ is result of histogram equalization process, c is contrast constant and b is brightness constant.

Then the system will do noise removal process using low pass filter with 3x3 neighborhood. The result is obtained by convolving low pass filter kernel with original image. This process is represented by equation:

$$g_{x,y} = h_{x,y} * f_{x,y} \quad (3)$$

Where $h_{x,y}$ is low pass filter kernel.

After image preprocessing, the system will do object detection process. This process is done in predefined area of the image. To detect the existence of the car, the system will subtract background image from the image. If the color of image is different from the color of background image then

there is an object in the image. On the contrary, if the image and background image has the same color, there is no object in the image. This process is represented by equation:

$$g(x,y)=\begin{cases}0 & if\ |f(x,y)-b(x,y)|<error\\ f(x,y) & for\ others\end{cases} \quad (4)$$

Figure 2 shows the object detection area and an example of object detection result.

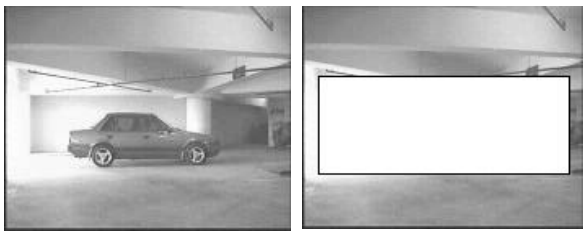
(a) (b)

Fig 2. a) Object detection area b) Object detection result

III. OBJECT SEGMENTATION

Object segmentation process does the image segmentation process to get the detected car and discard the other part. This process is done in the predefined area of image where the car is certainly in that area.

There are two stages in object segmentation process. The first stage will discard image background, so that the image will show the object only. To discard image background, the system will do subtraction as well as in object detection process by using equation 4 and then morphology operation.



(a) (b)

(c)

Fig 3. a) The object b) Object segmentation area c) Object segmentation result

Type of morphology operation used in this research is opening operation. This operation will smooth edge of the object. Opening operation is represented by equation:

$$G=(X\otimes B)\oplus B \quad (5)$$

Equation 5 shows opening operation of image X by structuring element B.

In the second stage, system will seek the optimal position of object in the image. It is done by calculate the cumulative histogram value for each possible existence of object in the image. The area with maximum cumulative histogram value shows the optimal position of object. Figure 3 shows example of object segmentation result. After this process, system will clip the object at that optimal area.

IV. MATCHING

This research uses template-matching method to recognize car type. This method will compare the image with several template images. The image and template image must have the same dimension. The image will have similarity values for each template image. The system will identify type of the car using the highest similarity value.

Similarity value of simple template matching can be calculated using following equation:

$$S=\sum I(x,y)\cdot T(x,y) \quad (6)$$

Where I is the image and T is template image.

Similarity value of template matching for gray scale image can be calculated using this equation:

$$S=1-\frac{\sum_{x=0}^{X-1}\sum_{y=0}^{Y-1}|I(x,y)-T(x,y)|}{L\cdot X\cdot Y} \quad (7)$$

Where L is maximum gray level (255), X and Y is dimension of template image. The S varies from 0 to 1. If the image and template image are same, value of S is one.

V. EXPERIMENT RESULT

This research uses three types of car, i.e. sedan, van and pickup and 12 images for template image.

The experiment was done for various type of car during daylight and at night. Table 1, 2 and 3 show experiment result of the similarity value of unknown object for each template images. We can see from those tables that similarity value varies from 0.78124 to 0.93988. template matching method results high similarity value for image that similar to its template, but it will also happen to other

images those are not similar to the template at all. Table 4 shows the same experiment result at night.

Table 5 shows several experimental results of unknown objects. We can see from this table that the system can recognize the type of the car well.

Table 1. Similarity value of an unknown object for each template

Unknown object 

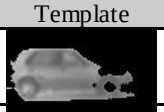
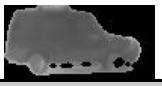
Template	Similarity
	0.85395
	**0.92499**
	0.80402
	0.82019
	0.84744
	0.82592
	0.85190
	0.80719
	0.80378
	0.84302
	0.85034
	0.82101

Table 2. Similarity value of an unknown object for each template

Unknown object 

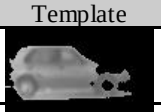
Template	Similarity
	0.81846
	0.85585
	0.78214
	0.78772
	0.80338
	0.92269
	**0.93988**
	0.80592
	0.84431
	0.89173
	0.86272
	0.80151

Table 3. Similarity value of an unknown object for each template

Unknown object 

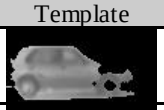
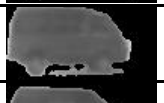
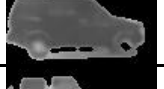
Template	Similarity
	0.83585
	0.84993
	0.78124
	0.77979
	0.80591
	0.83593
	0.85056
	0.78249
	0.80164
	0.80847
	**0.92759**
	0.81063

Table 4. Similarity value of an unknown object for each template at night

Unknown object 

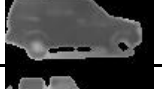
Template	Similarity
	0.81346
	0.85519
	0.79605
	0.81264
	0.81819
	0.84011
	**0.85956**
	0.83062
	0.80086
	0.85590
	0.80570
	0.80631

Table 5. Several experimental results of unknown object

Unknown object		Template		Similarity
	Van		Van	0.87383
	Sedan		Sedan	0.92451
	Pickup		Pickup	0.98260
	Van		Van	0.94358
	Sedan		Sedan	0.92512

VI. CONCLUSION

Template matching method gives a good result in recognizing the type of the car. It results high similarity value for image that similar to its template, but it will also happen to other images those are not similar to the template at all. For the next step, this method can be combined to feature extraction method like gabor filter to get a better result.

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