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TARGET RECOGNITION WITH COLOR COMPONENTS AND SOBEL OPERATOR

Sertan AKARLAR[1], Mustafa YAGIMLI[2]

[1]Turkish Naval Academy, Naval Science and Engineering Institute, Electronics Systems Engineering, 34940, Tuzla, Istanbul, Turkey
[2]Turkish Naval Academy, Electrical and Electronics Engineering Department, 34940, Tuzla, Istanbul, Turkey

E-mail: ser1024@hotmail.com, myagimli@dho.edu.tr

Abstract- *The present study aims to develop a target recognizing software by comparing the image obtained through the camera and the images in the data base using a SOBEL operator and color components which are used to detect the shapes of objects. In the developed target recognition system, the image obtained through the camera and the images in the data base are first compared via SOBEL operator in terms of their shapes, and in case that the images are equal or highly similar to the determined similarity percentage, their color components are compared. If this comparison also provides expected similarity percentages, the target is considered to be recognized, thus enabling the control of both the shape and the color of the target. C# programming language is used in the developed software.*

Keywords: *Color Component, Target Recognition, Image Processing, SOBEL Operator*

1. INTRODUCTION

Objects are required to be recognized automatically in many fields such as security systems, industrial applications and defense technologies. Today, there are many methods and algorithms developed for target recognition.

Some characteristics of the target such as the color, motion, shape and texture are used for its recognition [1]. Background subtraction (BS) is a method commonly used for the detection of moving objects when the camera is fixed. In this method, a reference image is taken as the background and then compared to the next image, thus detecting the changes occurring at the reference background [2-3-4]. Optical flow subtraction is a generalized gradient model which uses the relationship between a series of two-dimensional image and the speed [5]. Temporal Difference Method [6] is based on the detection of the differences of the sequential video frames. Another method is the active contour model, which is an edge-based segmentation method [7-8]. This method is based on the framing of the edges of an object with a closed frame by the energy function within the object area [9]. Methods such as mean shift algorithm [10] which is based on the principle of analyzing the multiform property space and of using its property set are primary image processing methods used in target recognition. SOBEL operator is an edge detection operator which is used commonly in the detection of the edges of the objects in digital image processing applications [11-12]. This operator is based on a Gauss low pass filter gradient (first order derivative), and uses a 3x3 convolution core [13].

This study aims to use the target recognition software by making use of the colors and shapes of objects so that it can be used in a tracking system with video cameras. For this purpose, images obtained through the camera are compared to the target images in the data base, thus enabling the target recognition.

2. SYSTEM STRUCTURE

In the target recognition system, the camera monitors the medium where the possible targets are present, and the camera image is transmitted to the real-time target recognition system. The transmitted image is filtered via

SOBEL operator. The edges of the image are contoured as a result of the filtering, thus obtaining an overal data regarding the image of the object. Similarly, images in the data base are also filtered and then compared to the filtered camera image. If this comparison is successful, the original versions of the compared images are compared using RGB values. Otherwise, the whole process starts over. If the comparison of the colors is successful, the object in the camera image with the highest similarity rate is considered to be the same with the image in the data base to which it is compared, and thus target recognition is realized. Block diagram of the system structure is shown in Figure 1.

3. IMAGE PROCESSING

Image processing part is the part in which the image is transmitted to the computer and filtered so that they can be filtered via the developed software, thus obtaining the RGB values. The image is transmitted to the computer via a USB port through a 320x240 resolution webcam. A forge dynamic library developed to be used in image processing applications is used in transmitting and filtering the digital image obtained through the camera.

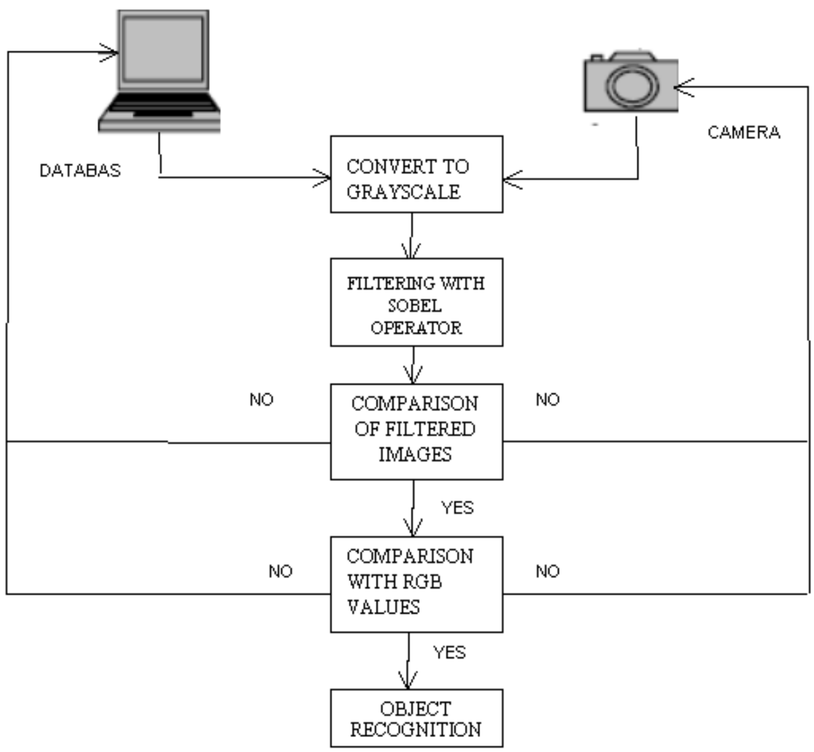

Figure 1. The structure of the system

3.1 SOBEL Operator

The shape of an object is detected using the edges via a SOBEL operator. SOBEL operator is a two-dimensional (horizontal and vertical) gradient operator which is used to determine the edges by detecting significant changes in the magnitude of the image. SOBEL operator uses two 3x3 masks on the X and Y axes [14].

These masks are shown in Figure 2. The image is subject to 3x3 G_x and G_y masks, and to the processes stated in the Equations 1 and 2.

$$G_x = (Z_7 + 2*Z_8 + Z_9) - (Z_1 + 2*Z_2 + Z_3) \quad (1)$$
$$G_y = (Z_3 + 2*Z_6 + Z_9) - (Z_1 + 2*Z_4 + Z_7) \quad (2)$$

Putting G_x and G_y in the Equation 3, the magnitude of the gradient vector is calculated.

$$G = (G_x^2 + G_y^2)^{(1/2)} \qquad (3)$$

Z_1	Z_2	Z_3
Z_4	Z_5	Z_6
Z_7	Z_8	Z_9

Z_1	Z_2	Z_3
Z_4	Z_5	Z_6
Z_7	Z_8	Z_9

-1	-2	-1
0	0	0
1	2	1

Figure 2. A 3x3 region of an image and Sobel Mask a. A 3x3 Region of an image b. G_x mask c. G_y mask

With the application of the operator to the whole image in 3x3 areas, the color of the unchanged areas deepens, while the color of the areas whose magnitudes have changed lightens. The image filtered via SOBEL operator is shown in Figure 3 and Figure 4.

Figure 3. The Orijinal image

Figure 4. The filtered version of the image with SOBEL Operator .

3.2 Target Recognition

After 20 target images which are previously uploaded to the computer via the developed software are compared to their filtered version via SOBEL operator, the equal or similar values are considered to be successful, and then they are compared using color components.

As a result of the comparison of the filtered version of the image obtained through the camera to their filtered version, the filtered images whose magnitudes are between +40 and -40 are considered to be equal. Therefore, the effect of noise in the images is reduced. If similar number of pixels is 70% or more of the total pixel number, the comparison is considered to be successful, and then they are compared with color components. In case that the comparison is unsuccessful, the image obtained through the camera is compared to the next data base image.

Successful images as a result of the comparison of shape are then compared in terms of their colors. In these comparisons, RGB values for pixels are obtained. The images are considered to be equal, if the RGB values of the image obtained through the camera are between the range of +40 and -40 of the RGB values of the image in the data base. If similar number of pixels is 70% or more of the total pixel number, the comparison is considered to be successful.

In case that more than one successful result are obtained as a result of both comparisons, the second comparison with the highest similarity percentage is taken into consideration. The

target in the image obtained through the camera is recognized as the target in the image in data base.
Equation 4 is used in order to determine the similarity percentages of both comparisons in the developed target recognition system.

$$B = \left(\frac{a}{c}\right) * 100 \qquad (4)$$

B, a and c represent the similarity percentage, pixel number and the total scanned pixel number, respectively.

Figure 5. Comparison of same objects

Images obtained through the camera and in the data base are compared first in terms of their shapes and then of their color components (Figure 5). Scanned pixel number of the most successful comparison is 76.800. Similar pixel number is 66.561, and different pixel number is 10.239. Similarity percentage was calculated to be 86.668% using Equation 4. Similarity percentage was calculated to be 86.668% using Equation 4.

$$B = \left(\frac{66561}{76800}\right) * 100 = \%86.668$$

As the images with a similarity percentage of 70% are considered to be the same, the system indicates that the images are the same.
Camera image of an object that is not in the data base in Figure 5 is subject to the processes mentioned above. Scanned pixel number of the most successful comparison is 76.800. Similar pixel number is 33.232, while different pixel number is 43.568. Similarity percentage is calculated to be 43.271% using Equation 4.

$$B = \left(\frac{33232}{76800}\right) * 100 = \%43.271$$

As the images with a similarity percentage of 70% are considered to be the same, the system indicates that the images are the same. In figures 6, left, middle and right images indicate to the camera image, the image in the data base and the filtered image via the SOBEL operator.

4. FURTHER STUDIES AND CONCLUSION

The success of the algorithm developed in the target recognition system depends on the richness of the data base used. Moreover, the more the number of the target images taken in different dimensions and angles, the more the system success. The developed system enabled target recognition, and further studies aims to follow the target. The use of such a system enables engagement by recognizing a target without the need of an operator. Moreover, such a system may be used in the automatic detection of a target using optic sensors in a command and control system.

Figure 6. Comparison of different objects

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