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Color Edge Detection using Variable Template Operator

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Abstract

This paper discusses an approach for detecting a new edge in color images. The color image is to be represented by a vector field, and the color image edges are detected as differences in the local vector statistics. This method is based on the calculation for the vector angle between two adjacent pixels. Unlike Euclidean distance in RGB space, the vector angle distinguishes the differences in chromaticity, independent of luminance or intensity. The proposed approach can easily accommodate concepts, such as variable template edge detection, as well as the latest developments in vector order statistics for color image processing. In this paper, it is used not a conventional fixed template operator but a variable template operator. The variable template is implemented and experimental results for digital color images are included.

Key Words : Color image, edge detection, local vector, variable template

1. Introduction

The In the computer vision, the detection and interpretation of edge features have found to play essential parts in extracting specific information from scene images. The latest advances in color edge detection apply vector order statistics to spatially locate edges in color images. There exists a number of equivalent three-dimensional color spaces with varying characteristics[1]. One group of spaces uses Cartesian coordinates to represent points in the space. Examples include the three primary illumination colors RGB, the complementary colors CMY, and the opponent color representation YCbCr. An alternative set of spaces employ polar coordinates and include the HIS and HSV spaces. This work presents a class of variable template operators designed to detect the location and orientation of edges in color images[2,3].

For color images, a number of approaches have been proposed. Most approaches have used the RGB space for their processing. The Sobel template operator has been applied successfully to all three planes in the RGB space and the gradients were summed to obtain the resultant edges in [4,5]. The Sobel template operator was also applied to each component of the HIS space, and the individual results were combined using a trade-off parameter between hue and intensity [6].

Certain transformations such as YUV an YCbCr can be performed very quickly while others such as HIS and CIE LUV are very cor.ˌ:ex.

In this paper, we propose a variable template operator for the obtaining illumination (Y) information for the purposes of intensity invariant segmentation from the RGB image. The experiment results show that the variable template operator is fast exactly and is less affected the Sobel and other conventional fixed template.

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2. Background Materials

2.1 RGB color model

The RGB color space consists of the three additive primaries: red, green, and blue. The spectral components of these colors combine additively to produce a resultant color. The RGB model is represented by a 3-dimensional cube with red green and blue at the corners on each axis (Fig.1) and RGB data image (Fig.2). Black is at the origin. White is at the opposite end of the cube. The gray scale flows the line from black to white. In a 24-bit color graphics system with 8 bit per color channel, red is (255, 0, 0). One the color cube, it is(1, 0, 0). RGB model simplifies the design of computer graphics systems but is not ideal for all applications. The red, green, and blue color components are highly correlated. This makes it difficult to execute some image processing algorithms. Many processing techniques, such as histogram equalization, work on the intensity component of an image only. These processes are easier implemented using the HIS color model and YCbCr color model[7].

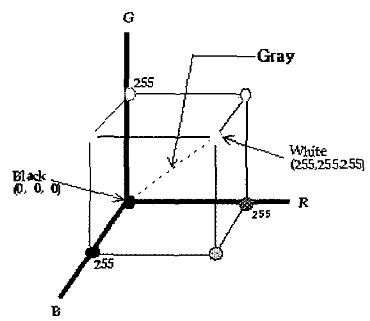
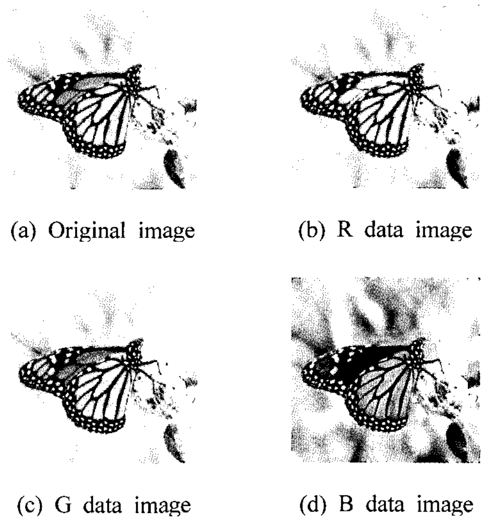


Fig. 1 RGB color cube



(a) Original image (b) R data image

(c) G data image (d) B data image

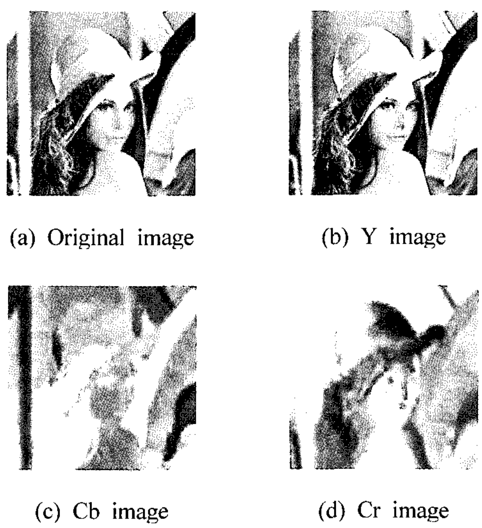
Fig. 2. RGB Data image

2.2 YCbCr color model

YCbCr is another color space that separates the luminance from the color information. The luminance encoded in the Y and the blueness and redness encoded in CbCr. It is very easy to convert from RGB to YCbCr by (1).

$$\begin{aligned} Y &= 0.29900R + 0.58700G + 0.11400B \\ C_b &= -0.16874R - 0.33126G + 0.50000B \\ C_r &= 0.50000R - 0.41869G - 0.08131B \end{aligned} \quad (1)$$

Here, Fig. 3 is applied to equation 1.



(a) Original image (b) Y image

(c) Cb image (d) Cr image

Fig. 3 YCbCr image

3. Proposed Variable Template Operator for Color Edge detection

One way to detect edges or variations within a region of an image is by using the gradient operator. For instance, the gradient, G, is a vector with two elements, Gx and Gy, where Gx is the gradient in the width direction and Gy is the gradient in the height direction. Since G is a vector, its magnitude Gm and direction Theta are given by (2)

$$G=[G_x G_y]\ ,\ G_m=\sqrt{G_x^2+G_y^2}\ ,\ \theta=\tan^{-1}(\frac{G_y}{G_x}) \quad (2)$$

There are several well known gradient filters. In this experiment use the Sobel gradients Fig 4, which are obtained by convolving the image with the following kernels.

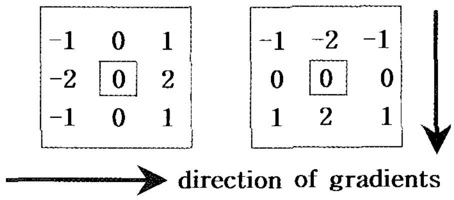


Fig. 4 Sobel Operators

Gx is the kernel on the right and Gy the one on the left. The kernel origin is located at the center and the arrows indicate the direction that each kernel measures. That is, the direction of Gx is from left to right (west-to-east), and Gy is from top to bottom (north-to-south). Fig. 5 shows how the Mask homo- geneity operator course.

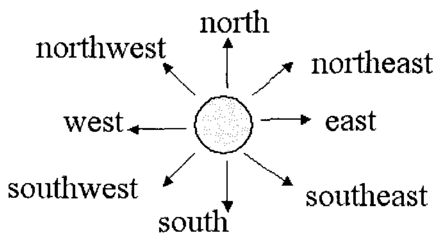
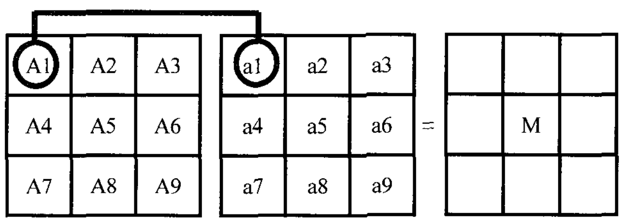


Fig. 5 Mask homogeneity operator course.

There are several gradient operators used for edge detection, and variations can be obtained by rotating the kernel values. In this operator method shown below Fig. 6.

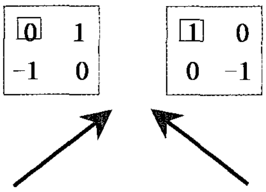


here, $M = A1\times a1 + A2\times a2 + A3\times a3 + \cdots\cdots + A9\times a9$

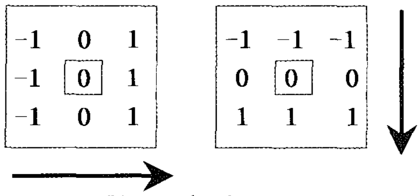
Fig. 6 Operator method for edge detection

In this experiment we will use the Roberts, Sobel, Prewitt and Isotropic gradient kernels shown below Fig. 7.

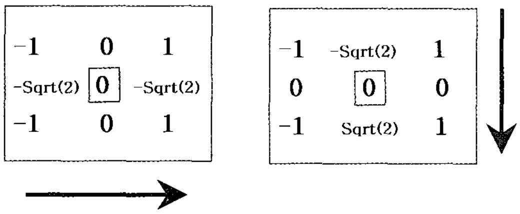
You Let $D(i,j)$ denote the first derivation of the color image $X(i,j)$, such that [8].



(a) Roberts Operator



(b) Prewitt Operator



(c) Prewitt Operator

Fig.7 Roberts, Prewitt and Isotropic gradient kernels

$$D(i,j)=\begin{bmatrix} \frac{\partial X_R(i,j)}{\partial i} & \frac{\partial X_R(i,j)}{\partial j} \\ \frac{\partial X_G(i,j)}{\partial i} & \frac{\partial X_G(i,j)}{\partial j} \\ \frac{\partial X_B(i,j)}{\partial i} & \frac{\partial X_B(i,j)}{\partial j} \end{bmatrix} \quad (3)$$

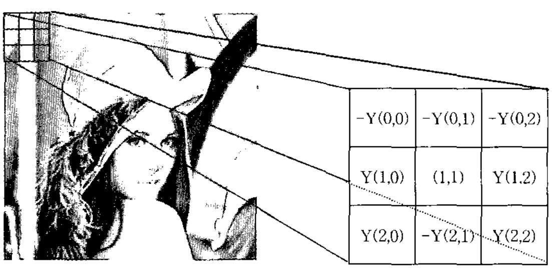
Variable template (VT) are defined to simplify the expression as in Fig. 5, 6, 7.

Stepl: Convert from RGB to YCbCr.

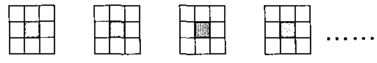
$$\begin{aligned} Y(i,j)= {} & 0.29900\frac{\partial X_R(i,j)}{\partial i} * \frac{\partial X_R(i,j)}{\partial j} \\ & + 0.58700\frac{\partial X_G(i,j)}{\partial i} * \frac{\partial X_G(i,j)}{\partial j} \\ & + 0.11400\frac{\partial X_B(i,j)}{\partial i} * \frac{\partial X_B(i,j)}{\partial j} \end{aligned} \quad (4)$$

Step 2: Proposed variable Template mask

$$VT=\begin{bmatrix} -Y(i,j) & -Y(i,j+1) & -Y(i,j+2) \\ Y(i+1,j) & (i,j) & Y(i+1,j+2) \\ Y(i+2,j) & -Y(i+2,j+1) & Y(i+2,j+2) \end{bmatrix} \quad (5)$$



Step 3: 3x3 template mask creating



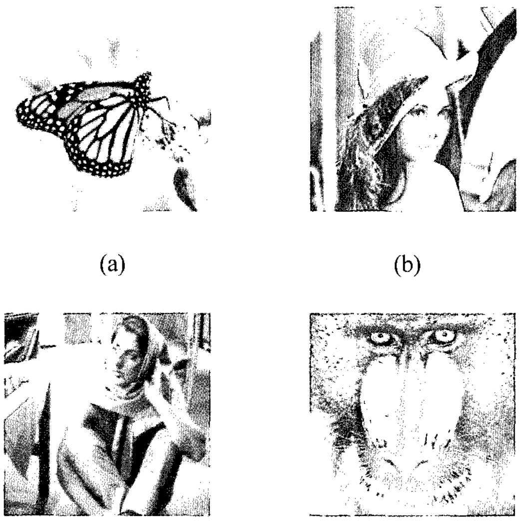
It is each pixel yard of according to difference of data value as variable 3x3 template created mask. And Y parameter is luminance, i column and j row is shown in equation (5).

4. Simulation Result and Analysis

The proposed variable template has been imple- mented and applied to several color images.

In this paper, it is confirmed that the result of an edge detection applying is variable template operator better than of the conventional Sobel operator. The test images use 20 pictures, 20 pictures have various object size.

The proposed template detects the region of a edge applying the Variable Template to YCbCr model in the quantizing 16, 32, 64 bit. The original test image is shown in Fig. 8. In Fig. 9, each converting from original test image to YCbCr image.

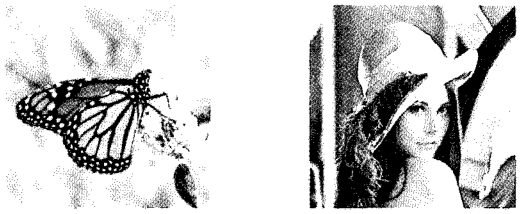


(a) (b) (c) (d)

Fig. 8 Original Color image: (a)Butterfly, (b)Lena, (c) Babara (d) Baron

In a computer simulation, we use the scalar sobel operator on the Y component of this color image. The edge map generated by Sobel vector operator is shown in Fig. 10 : (a), (c), (e), (g). Fig. 10: (b), (d), (f), (h) show the edge map generated by the variable template matching operator.

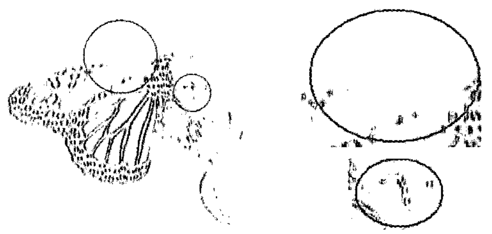
These indicate that the variable template matching operator offers performance advantages over the conventional template matching operator for the color image.



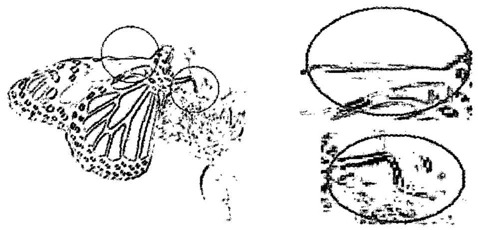
(a) (b)

(c) (d)

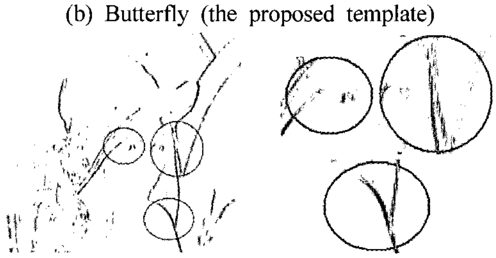
Fig. 9 converting from original color test image to YCbCr image : (a)Butterfly, (b)Lena, (c)Babara, (d)Baron



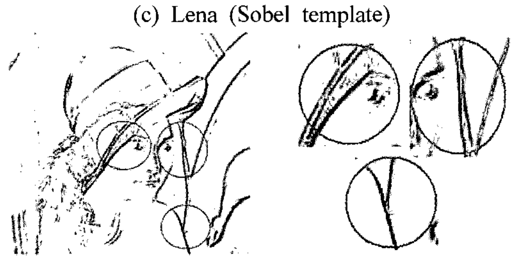
(a) Butterfly (Sobel template)



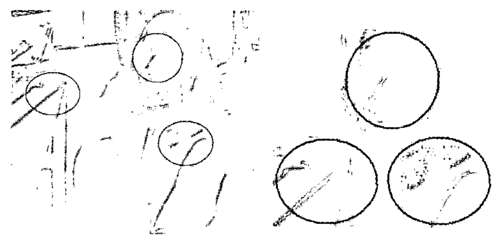
(b) Butterfly (the proposed template)



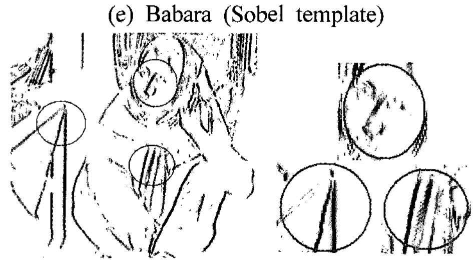
(c) Lena (Sobel template)



(d) Lena (the proposed template)



(e) Babara (Sobel template)



(f) Babara (the proposed template)

5. Conclusion

This paper applied the variable template operator, using the YCbCr model in color image.

The consuming computational time for the variable template operator matching is less than that of the conventional template operator method.

Especially, it is confirmed that the correct edge can be detected when be close to each edges, and the better result can be got at the place of having smoothly curved line. Here after, the proposal template operator will enhance edge or detect edge in image included noise.

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