Edge Detection in Different Color Spaces

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Abstract. The goal of the edge detection is to distinguish meaning features in an image where intensity varies rapidly. The edge detection has been normally applied in RGB channel. In this paper, we conducted this on different color spaces such as YIQ and HSV, and compare visual performances. The experimental results show that the HSV color space is the most appropriate color space out of three.

Keywords: color space, edge detection, color conversion.

1 Introduction

The purpose of edge detection is to distinguish features in an image at which the intensity alters abruptly. The edge detection is widely used in many image processing applications including deinterlacing and demosaicking [1-3]. The areas where image intensity varies rapidly are normally assumed as edges. This edge detection method is a basic technique in signal and image processing [4-6].

In this paper, we conduct Sobel method on different color spaces and compare the performance [3]. We assume there are three color spaces (RGB, YIQ and HSV). The Sobel method is applied in sub-channel of each color spaces, and finally the best color space for edge detection is arranged. This paper is arranged as follows. In Section 2, color space comparison between RGB, YIQ, and HSV is described. The Sobel method is explained in Section 3. The experimental results and visual performance comparison is shown in Section 4. The conclusions are made in Section 5.

2 RGB vs. YIQ vs. HSV

We assume a color is indicated by RGB intensities. The RGB color space can be transformed into HSV color space or YIQ color space. The hue component is specified as the fraction around the ring beginning from [1 0 0], which is red color; therefore the hue of red is 0. In the same manner, each color has different hue. Table 1 shows color-hue comparison.

Table 1. Color-hue comparison

Color	Red	Yellow	Green	Cyan	Blue	Magenta
Hue	0	0.1667	0.3333	0.5	0.6667	0.8333

We assume *R*, *G*, and *B* values are given, which has any values between 0 and 1. Then we define *V*, *δ* and *S* as shown in Eq. (1).

$$V = \max\{R, G, B\}$$
$$\delta = V - \min\{R, G, B\} \qquad (1)$$
$$S = \frac{\delta}{V}$$

The hue value is obtained as follows:

$$\text{If } R = V, \text{ then } H = \frac{1}{6}\left(\frac{G - B}{\delta}\right)$$
$$\text{If } G = V, \text{ then } H = \frac{1}{6}\left(2 + \frac{B - R}{\delta}\right) \qquad (2)$$
$$\text{If } B = V, \text{ then } H = \frac{1}{6}\left(4 + \frac{R - G}{\delta}\right)$$

The YIQ color space is employed for video and TV systems in North America including USA and Canada and some Asian countries such as Korea and Japan. The conversion equation RGB and YIQ color spaces is straightforward as shown in Eq. (3).

$$\mathbf{M}_1 = \begin{bmatrix} .299 & .587 & .114 \\ .596 & -.274 & -.321 \\ -.211 & -.523 & .311 \end{bmatrix} \qquad (3)$$

$$[\,Y\ \ I\ \ Q\,] = \mathbf{M}_1 [\,R\ \ G\ \ B\,]$$

$$[\,R\ \ G\ \ B\,]^{T} = \mathbf{M}_1^{-1} [\,Y\ \ I\ \ Q\,]$$

3 Sobel Method

To detect edges, Sobel method is widely used. The Sobel method can be described as discrete differentiation operator, which calculates an estimation of the image luminance gradients. The Sobel method is based on convolving the input original image with a separable and integer valued filters, which have horizontal (G_H) and vertical (G_V) direction. The calculation is quite simple, and the number of computation is low. There are many possible Sobel operator forms. However, following two 3-by-3 kernels are normally employed. Let us assume *Im* as the input image, and G_H and G_V are two images that are obtained by convolution between *Im* and horizontal and vertical filters. Note that '*' indicates the 2D convolution operation.

$$\mathbf{M}_2 = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \tag{4}$$

$$\begin{aligned} G_H &= \mathbf{M}_2 * Im \\ G_V &= \mathbf{M}_2^T * Im \end{aligned} \tag{5}$$

4 Experimental Results

The simulated results are shown in Fig. 1. The first two images are from LC imageset #44 and the other images are from LC imageset #52. For RGB channel case, the second image shows the detected edges which come from red (R channel), green (G channel), and blue (B channel). For YIQ case, red, green, and blue edges come from Y, I, and Q channels, respectively. In the same manner, for HSV case, red, green, and blue edges come from H, S, and V channels, respectively.

5 Conclusions

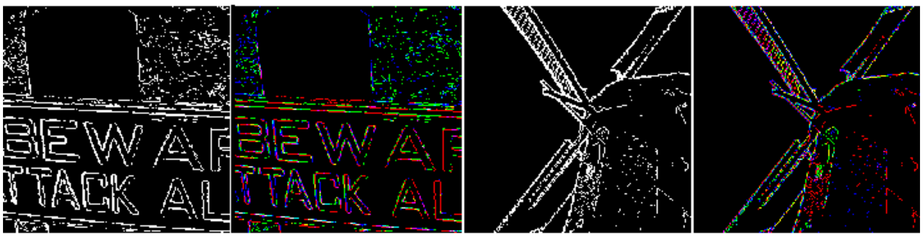
The edge detection is one of the fundamental image processing tools. In this paper we assumed there are three color spaces. We conducted Sobel method to each color space and compared the visual performance. From the simulation results, it was found that the HSV color space is the best when it was compared to the other two color spaces.

References

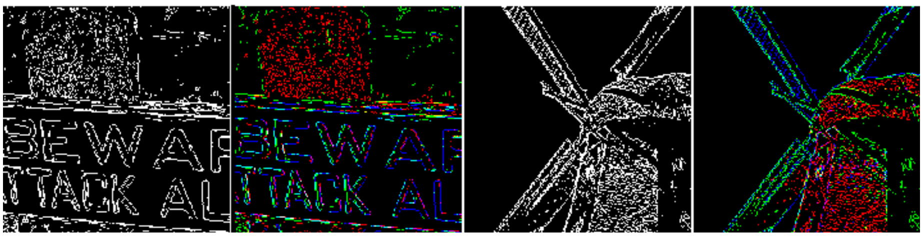
1. Z. Rahman, D. J. Jobson, and G. A. Woodell, "Multiscale Retinex for color rendition and dynamic range compression," in Proc. SPIE 2847, pp. 183, 1996.
2. M. Y. Lee, C. H. Son, J. M. Kim, C. H. Lee and Y. H. Ha, "Illumination-Level Adaptive Color Reproduction Method with Lightness Adaptation and Flare Compensation for Mobile Display," Journal of Imaging Science and Technology, vol. 51, no. 1, pp. 44-52, 2007.
3. R.C. Gonzalez and R.E. Woods, Digital Image Processing (second edition), Pearson Education Asia Limited, 2007.
4. A.K. Jain, M.N. Murty, and P.J. Flynn, "Data clustering: review," ACM Computer Surveys, vol. 31, ACM Press, pp. 264-323, 1999.

5.D. Ziou and S.Tabbone, “Edge detection techniques: an overview,” International Journal of Pattern Recognition and Image Analysis, vol. 8, no. 4, pp. 537-559, 1998.
6.S. Chen and D. Zhang, “Robust image segmentation using FCM with spatial constraints based on new kernel-induced distance measure,” IEEE Trans. Systems, Man and Cybernetics, Part B, vol. 34, no. 4, pp. 1907-1916, Aug. 2004.

(a)



(b)



(b)

Fig. 1. Detected edge by Sobel method on LC #44 and #52 images: (a) RGB color space, (b) YIQ color space, and (c) HSV color space.