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Comparative Study for Different Color Spaces of Image Segmentation Based on Prewitt Edge Detection Technique

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Abstract:

Image segmentation is one of the main step for images processing and analysis. It is the process of recognizing objects in images and may consist of two related processes, recognition and delineation. Edge detection removes and reduces the quantity of unnecessary data and information and give its significant information. In digital images, there are several representations of colors which have its own characteristics. In this paper, the Prewitt edge detection was applied as segmentation technique of color images in four different color spaces. These color spaces are RGB, HSV, YCbCr and YIQ respectively. Structural similarity index matrix (SSIM), entropy and elapsed time are used as measures to compare between the segmented images of the four color spaces. Experimental results showed that several differences among segmented images for spaces by Prewitt technique. The RGB images have batter resulst for SSIM, entropy and elapsed time values when comparing with YCbCr, HSV, and YIQ spaces. Analysis of the obtained results of the RGB, HSV, YCbCr and YIQ color spaces are given in this paper.

Keywords: *Image Segmentation, Color Spaces, Prewitt Edge Detection, Structural Similarity Index Matrix*

1.Introduction:

Color is a feeling organized to response and excitation for our visual system using electromagnetic radiation known as light which using wavelengths for the region by 400 nm into 700 nm, event above of the human eye [1]. More specific, it is a visual perceptual property of things. It is used in several important applications in image coding, computer graphics, image, video processing, such as computer vision. In different needs of those application areas, several techniques are applied for color explanations , each based on several mathematical ideas with many benefits with restrictions. The oldest attempts at representing color seem to have been inspired by the change of night to day and involve a linear (one-dimensional) color scale ranging from black to white with all colors between them [2].

Athanasius Kircher's 1646 has presented five-member color scale that demonstrate a change from black, over blue, red, and yellow, into white. In addition, radiometry presented that different wavelengths for light could generate different perceptions of color. Also, the established an association to certain colors

with certain wavelengths [3]. Color spaces have a different property could be efficiently taken in order to make the final combined color spaces more reliable than the individual color space. In the color segmentation, these spaces are quantized (for each of the three color channels) in Nb=5 x 5 x 5 = 125 bin descriptor computed on an overlapping squared fixed size (Nw=7) neighborhood centered on the pixel to be classified under clustering techniques. Image segmentation is a way for dividing the images into many important, so it is a tool for classifying the pixels of an image correctly in a decision oriented application. Many spaces segmentation of gray scale images, e.g., content based image retrieval with the increase for strength of bonds [5].

The result is a set of segments that collectively cover the whole image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture [6]. Famous techniques of segmentation which are remain being used by the researchers which are respectively, Edge Detection, Threshold, Histogram, Region based methods, and Watershed Transformation. In this paper, the basic types of color spaces are explained in the next section then the edge detection techniques are showed by section three. The fourth section shows the experimental data set, methodology with results for color segmented images given are by section five. Finally, section six has presented the conclusion [7].

1.Spaces of Color:

A color spaces are a way that determine, create and visualize color. It is an abstract mathematical model describing the way colors can be represented as tuples of numbers; however, a color model with no associated mapping function to an absolute color space is a more or less arbitrary color system with no connection to any globally understood system of color interpretation [8]. A color space may be arbitrary, with particular colors assigned to a set of physical color swatches and corresponding assigned names or numbers. There are several different spaces of colors which proposed in the literature, each one has its own characteristics, benefits, restrictions, and areas of application [9].

All color spaces have its own emerged in history with some due to the importance of extract images on different infrastructures or devices. The RGB is a color space which has until now been difficult to visualize of color television screens and computer monitors. Moreover, modern technologies are changing quickly, these products mostly include the appropriate mixing for three monochromatic spectra of light for creating the color. Because of its importance the RGB type uses additive color and consider most commonly used. It is represented by three chromatists which are "red (R), green (G) and blue (B)" [10]. The combination for three mainly colors which is leads to create final color of those three primary colors. All color has an its components which consist of three beams which could have its own an arbitrary intensity that is come from fully off into fully on with a mixture. The Hue, Saturation, and Value (HSV) color space divides the intensity from the quality of color and represents them spritely. It tries to describe perceptual color relationships more properly than RGB.The YCbCr spaces mostly used to represent types of schemes in several formats sush as MPEG and JPEG. In addition, YIQ color spaces each I and Q are indicating to coordinates X and Y respectively and Y component indicates to the black-and-white colors of an image separately and Y value changes from 0 to 255 [11].

3. Background of Preprocessing and Clustering Algorithm:

Several techniques of image segmentation which are still being used by the researchers such as Edge Detection, Threshold, Histogram, Region based techniques, and Watershed Transformation. Basically, the digital images are separated into two types on the basis of their color, i.e. gray scale and color images [12]. Edge detection consist of a several different mathematical techniques which aim at identifying points

in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. There are many techniques for edge detection, but most of them can be grouped into two categories, search-based and zero-crossing based. Three famous frequently edge detection techniques are used for comparison which are Roberts Edge Detection, Sobel Edge Detection and Prewitt edge detection [13].
Soft computing approaches like Fuzzy and Prewitt edge detection operators has discussed [14] which consider as the oldest and best understood operator which detect the image's edges. It is relevant technique for calculating the image's magnitude and its direction. In addition, Prewitt is comparably same with Sobel operator which is widely used to discover the edges vertical and horizontal in the image. The possible eight orientations are the operator of a Prewitt's technique that mean the operators are limited. Therefore, most direct orientation supposes have not much more valid based edge detector is supposed in the 3x3 neighborhood to 8 directions [16].

1	1	1
0	0	0
-1	-1	-1

G_x

-1	0	1
-1	0	1
-1	0	1

G_y

Figure 1: Prewitt Operator

Prewitt edge is used to detect edges from flowers images together with Sobel edge. The performance is judged by computing the image pixels to show which one works better. It is showed that the Prewitt edge detection technique works better when compared to Sobel edge detection [17]. A new fast method proposed to identify the vehicles on the highways based on the image processing techniques, like background subtraction, and Prewitt edge detection filter and several morphological techniques.

The results expressed the high accuracy with low time complexity of proposed method. The Prewitt technique have used to brain segmentation of human head scans by using magnetic resonance images. In addition, Mofrad et al applied Prewitt edge detection to utilize cellular automata and cellular learning automata with performance and superior accuracy [18]. The figure below shows a process for Prewitt edge detection operator.

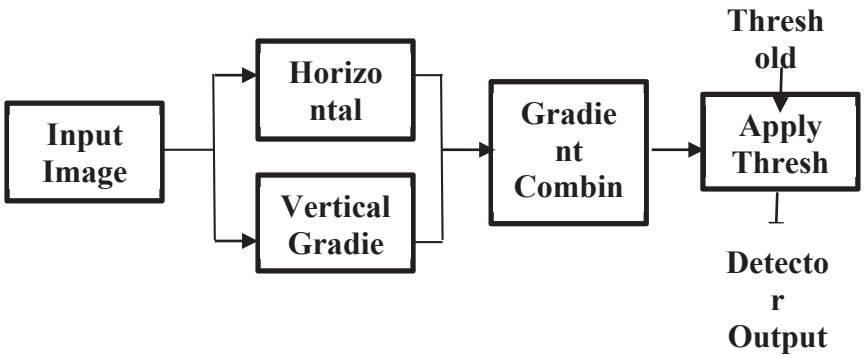

Figure 2: Process of Prewitt Edge Detection

4. Methodolgy:

Edge detection is a way of image segmentation which used of data extraction in many fields like, machine vision, computer vision with image processing. Edge maps are one of the popular ways to represent input images and its features. In this paper the Prewitt has applied on four color spaces images which are namely, RGB, HSV, YCbCr and YIQ respectively to find the results using MATLAB software. one among four Therefore, calculate value of SSIM, entropy and elapsed time for each resultant edge detected images. Finally, images are compared to choose best color spaces using Prewitt edge detection. The general Methodology for this paper is as follows in:

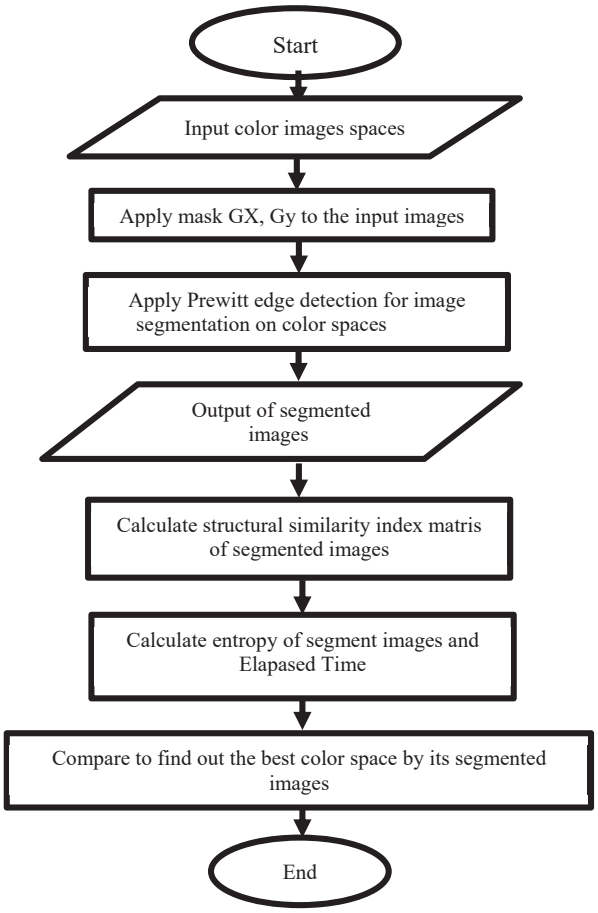

Figure2: Scheme of the presented method

For discover the difference and similarities among several segmented images in four color spaces, The Structural Similarity Index Matrix (SSIM), Entropy with elapsed time have achieved. The SSIM is usually used to find the image quality with differences between the main image and the processed image [19]. The quality metric is a famous way which have used for measuring the similarity between two images. Wang has developed the SSIM and used to be connected with the human visual system (HVS) and its quality perception. Instead of using traditional error summation techniques, the SSIM is designed by modeling any image distortion as a combination of three factors that are loss of correlation, luminance distortion and contrast distortion according to the following formula [20].

$$SSIM\ (f.g) = I(f.g)\ c(f.g)\ s(f.g\ ) \qquad \ldots\ldots\ldots (1)$$

$$I(f.g) = \frac{2u_f u_g + C_1}{u^2_f + Y^2_g + C_1}$$

$$c(f.g) = \frac{2\sigma_f\sigma_g+C_2}{\sigma^2{}_f+\sigma^2{}_g+C_2} \quad .....(2)$$

$$s(f.g) = \frac{\sigma_{fg}+C_3}{\sigma_f\sigma_g+C_3}$$

The terms I(f.g) in above equations (1), are the luminance comparison function that measures the closeness for mean luminance of two images (μf and μg). This factor is maximal and equal for lonely if $\mu f=\mu g$. The second term is the contrast comparison function which measures the closeness of the contrast. Here, the contrast is measured by the standard deviation σf and σg. This term is maximal and equal to 1 only. The third term is the structure comparison function which measures the correlation coefficient between the two images f and g. Note that σfg is the covariance between f and g.
The positive values of the SSIM index are in [0,1]. A value of 0 means no correlation between images, and 1 means that f=g. The positive constants C_1, C_2 and C_3 are used to avoid a null denominator. In additional, entropy and elapsed time are used to estimate the image performance between the original images and segmented images by Prewitt edge detection.

5. Experimetal Results

This part shows the relative performance for various color spaces. Four color spaces have been chosen to achieve Prewitt edge detection of image segmentation which have named, RGB, HSV, YCbCr and YIQ respectively. Real buzzle images have been taken as dataset for apply Prewitt edge detection for color spaces types. The images captured by digital camera and stored as JPEG format with dimensions 520*520 pixels. Totally, there are 10 buzzle images in the dataset. The MATLAB R2017a software with window XP operating system have been achieved to compare between all segmented images. Samples of dataset images as shown in below figure.

Figure 3: Dataset Samples

The second stage holder's equal's term with unequal list," typically examples is a "similar" stem differs somewhat in meaning giving to the suffixes initially trailed it. From the analysis of SSIM values of spaces color in Table (1) It have been seen that the YCbCr images produces higher SSIM in segment of objects value as compared to other color spaces.

Table 1: SSIM Values of Four Color Spaces

Image	RGB	HSV	YCbCr	YIQ
1	0.9254	0.8644	0.8511	0.8736
2	0.9118	0.8758	0.8321	0.8694
3	0.9359	0.8928	0.9151	0.8664
4	0.8923	0.8207	0.8520	0.8538
5	0.9098	0.8121	0.8352	0.8458
6	0.8951	0.8144	0.8780	0.8521
7	0.9119	0.8936	0.8525	0.8522
8	0.8900	0.8714	0.8261	0.8862
9	0.8986	0.8710	0.8350	0.8719
10	0.9259	0.8949	0.8540	0.8723

Also, the performance has been measured in terms of calculating the value of entropy and elapsed time. We analysis that RGB color spaces images has produced the maximum entropy values and YIQ has a less values among four color spaces. Moreover, depending of elapsed time RGB has a higher elapsed time while YIQ detects takes less elapsed time execution when compared with other color spaces. The statistical analyses for all the color spaces are shown in below tables (2) and (3).

Table 2: Entropy values of Four Color spaces

Image	RGB	HSV	YCbCr	YIQ
1	2.4881	2.3995	1.4576	1.9670
2	2.4775	2.2375	1.6615	1.9834
3	2.5395	2.0565	1.8120	2.0424
4	2.7015	2.6533	2.0236	2.1090
5	2.6671	1.9827	1.6587	2.0894
6	2.6814	2.1271	2.0449	2.0906
7	2.6466	1.8468	1.4197	2.1003
8	2.3719	2.0893	1.6945	1.9003
9	2.5731	2.3269	1.6616	2.0406
10	2.4221	1.7377	1.3802	1.9164

Table 3: Elapsed Time of Four Color Spaces

Image	RGB	HSV	YCbCr	YIQ
1	6.020234	8.223702	7.746996	7.923457
2	5.117178	6.067352	6.727037	7.364190
3	3.652728	5.521337	5.745856	7.187481
4	3.726996	5.909741	4.527790	7.551501
5	4.248811	6.238901	6.489122	9.562568
6	3.824311	5.008961	4.722856	6.005162
7	1.646610	3.014022	3.787888	8.558969
8	3.080427	5.298717	5.179127	3.684145
9	3.772317	6.233742	5.215061	7.935070
10	2.057689	3.308790	4.753504	3.303659

The four spaces colors have showed different results according to SSIM and Entropy values figure (4). The RGB color spaces images was the best in reaching the highest values. Also, figure (5) explain the elapsed time for four color spaces images as be clear RGB color spaces has recored lowest elapsed time.

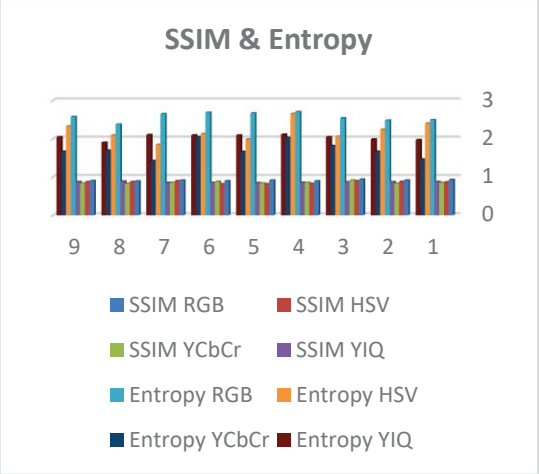

Figure 4: SSIM & Entropy Values

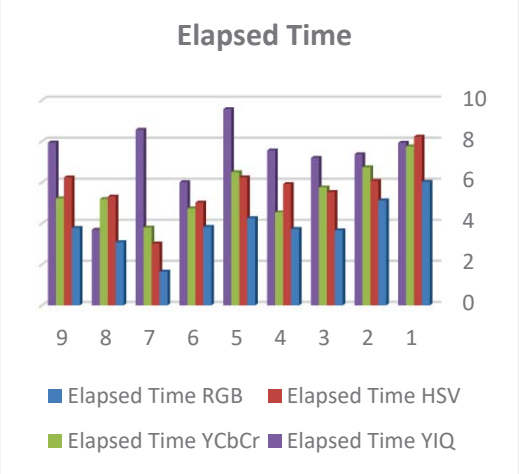

Figure 5: Elapsed Time Values

6. Conclusion:

In this paper we presented a comparision for four color spaces that are RGB, HSV, YCbCr and YIQ which segmented using Prewitt edge detection. The comparison and analysis based on Structural Similarity Index Matrix (SSIM), Entropy and elapsed time as segmentation performance measure parameters. The Matlab software used for carry out a Prewitt Edge detection for segmentation. The statistical results observed that RGB color space produces higher SSIM values in detection of edges and takes less elapsed time. Also the maximum values for entropy and lower elapsed time values have showed in segmented RGB color space images when compared with other color spaces.

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