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Image Representation using RGB Color Space

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Abstract:
There is an ever-increasing demand for attaining full color digital images. Color is an inevitable property in recognizing certain objects in an image. The growth in color imaging technology has led to the emergence of different color management techniques. These techniques require color models so that images produced in one medium and viewed in a certain background may be reproduced in a second medium and viewed under a different condition. This paper presents a method for determining color pixel intensity in an image using RGB color model. The model helps us understand the distribution of colors within an image. This is important in image processing techniques where color representation is the major problem that has remained unresolved for decades. The algorithm first extracts color pixels from a bitmap image; the luminance value is then computed to get the brightness of the image. The third step splits RGB color into color plane, if the color plane is equal to or greater than three, color image is extracted else a grayscale tone is extracted. The algorithm proposed in this paper is suitable for all kinds of image enhancement techniques.

***Keywords**: RGB Color model, Pixel intensity and Luminance value*

1. Introduction

For decades, image processing techniques have become more important in a wide number of research and industrial fields. Image processing is based on the acquisition and manipulation of digital raster images which is composed of a rectangular grid of pixels with assigned color values. Most of the tools used in image processing are not sufficiently developed as they cannot handle full color images. Color is a key element of visual information and is a real problem that has been addressed by a number of authors but still far to be exhaustively worked out. One typical simple question may be whether each pixel of an image has variable intensity. To answer this question one needs to have an effective method for determining pixel intensity.

In this paper, we analyze how an image is represented on output devices. We use RGB color model; we then propose a method for determining pixel intensity based on our data analysis.

2. Related Work

Kamboj et al., 2012, presents an algorithm that extracts the edge information of color images in RGB color space with fixed threshold value. The algorithm uses an automatic threshold detection method based on histogram data to estimate the threshold value. The algorithm can detect major portions of the image. However, the algorithm produces black and white images.

Brown et al. (2012) presents color strength information which is a combination of saturation and intensity to determine when hue in information in a scene is reliable. They verified that color strength information can be used to improve color correction accuracy.

Gijsenij et al. (2012) presents a method that extends existing algorithms by applying color constancy locally to image patches rather than globally to the entire image. After local (patch-based) illuminant estimation, the estimates are combined into more robust estimations, and a local correction is applied based on modified diagonal model. Their technique reduces the influence of two light sources simultaneously present in one scene.

Moreno et al. (2010) presents an approach that is based on the angular distance between pixel color representations in the RGB space. The method is invariant to intensity magnitude, implying high robustness against bright spots produced by specular reflections and dark regions of low intensity.

3. Methodology

This study employs descriptive research design for it to portray an accurate profile of situations. Normally what one wants to study is the entire population. However, it is unfeasible to do this and therefore one must settle for a sample. The target population for this research comprised of academic authors of image processing techniques. The study used secondary data from selected scholarly work. The collected data contributed towards the formation of background information needed for the reader to comprehend the study outcome. The data collection was administered over a period of four months, between February and May 2014. Eight pixels were randomly selected from a bitmap image (flower.bmp). The researchers then used image J and VischeckJ1 software to analyze how pixels are displayed on the screen. An algorithm for extracting pixel intensity from image was then proposed based on the data analysis. Data collection and analysis were organized as follows:

- Color image formation using RGB model
- RGB Color Luminance
- Splitting colors according to color plane

3.1. Color image formation using RGB model

The RGB color model is an additive color model in which each pixel is represented as three numerical values. First value is the amount of red, second stands for green and the third one is blue. Those values are used to create color presented on the screen. Every other mix of values stands for different color. The most basic rule of mixing in RGB color cube is as follows (Koirala, 2009):

- **R+G+B** = White
- **R+G** = Yellow
- **R+ B** = Magenta
- **G+B** =Cyan

Mixing the colors forms an image that is made up of different colors as shown in Figure 1.

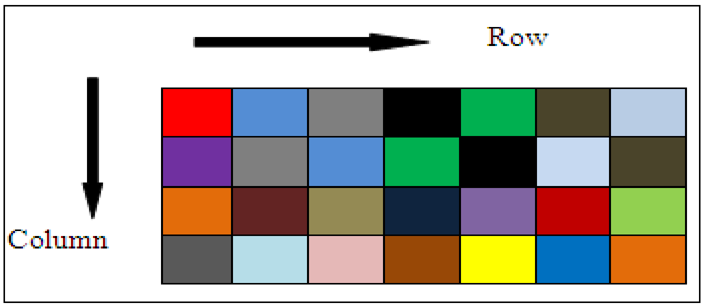


Figure 1: A digital image of a two dimensional array of pixels

Each pixel has an intensity value represented by a digital number and a location address referenced by its row and column numbers. The diagram was drawn to show how a digital image is formed.

Figure 2 shows two portions of the image (flower.bmp) that we analyzed. The image was extracted from the internet, courtesy of Lai et al., (2009).

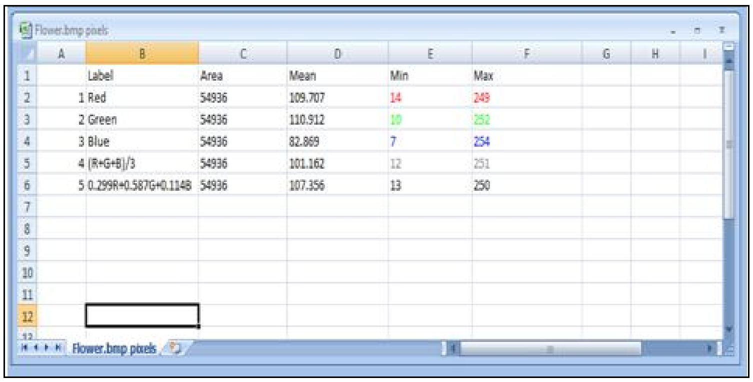
Figure 2: Parts of flower.bmp

Eight pixels were randomly picked within the marked regions (Yellow and Green) and their values are shown in Table 1.

No	Pixel size	Color	Red	Green	Blue
1.	150 *177	Portion of yellow color	205	198	086
2.	153*178		211	200	073
3.	271*233		219	201	061
4.	153*173		207	192	062
1.	28* 213	Potion of green color	028	048	032
2.	35*213		022	048	029
3.	38*207		024	045	023
4.	44*203		013	031	013

Table 1: pixels color for a portion of flower.bmp image.

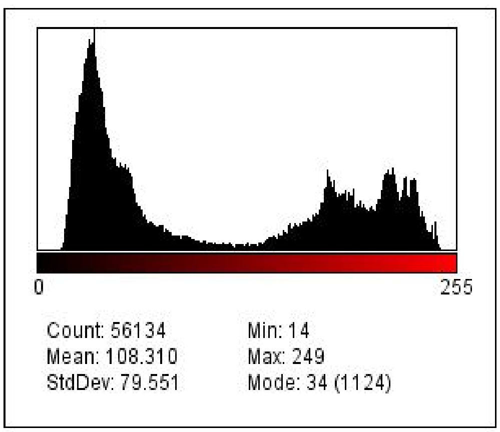
Color variations in RGB are represented in a scale of values ranging from 0 to 255 with 0 having the least intensity and 255 having the greatest. When the 3 components are combined, there are 256 x 256 x 256 possible combinations or 16,777,216 possible colors for a 24bit color (Besser, 2003). From table 1, note that each portion is represented by a combination of different colors. It is also evident that when an image is displayed on a screen, its colors are reduced. For instance, the first pixel (150*177) has a total of 3,490,740 (205*198*086) colors. This means that its color has been reduced by 13,286,476(16,777,216 - 3,490,740) colors. Figure 3 illustrates the analysis of a bitmap image (flower.bmp)

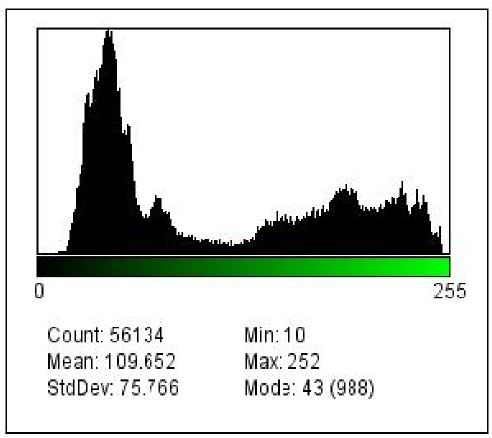


	Label	Area	Mean	Min	Max
1	Red	54936	109.707	14	249
2	Green	54936	110.912	10	252
3	Blue	54936	82.869	7	254
4	(R+G+B)/3	54936	101.162	12	251
5	0.299R+0.587G+0.114B	54936	107.356	13	250

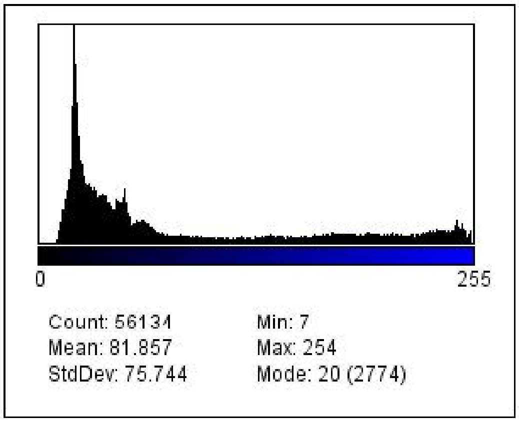
Figure 3: Analysis of pixels color on a bitmap image

The image was analyzed with image J software which is open source software (Rasban, 2010). The histograms for the total pixel value for red, green and blue are given below:

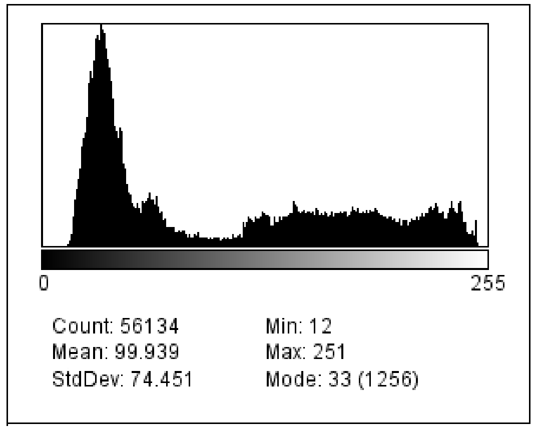




(a) Red histogram of flower.bmp *(b) Green histogram of flower.bmp*



(c) Blue histogram of flower.bmp



(d) Gray scale histogram of flower.bmp

Figure 4: Histogram of the three channels (R, G, B) and grayscale for flower.bmp

From the analysis, we can see some gray scale values in the image, area of the pixels, minimum and maximum values of RGB colors and the mean of the colors that make up the image. This affirms that an image contains shades of gray and color.

3.2. RGB Color Luminance

Luminance is the measure of light radiating from a source, measured in candela per square meter (Hiscocks, 2011). Human viewer perceives luminance as the brightness of a light source. In other words, brightness is the perception obtained by the luminance of visual target which is subjective property of an object being observed. The computer display has a certain luminance based on how much light it is able to throw onto your retina. We have to control this light in order to get the color of the image. To determine the RGB color luminance in an image, we sample 8 random pixels from the image (flower.bmp). We then use the standard relative luminance formula from En-Nasr (2012) and from our analysis to get the values.

Y= (0.299 * R) + (0.587 * G) + (0.114 * B) (1)

Table 2 shows the luminance intensity of the eight pixels

Color	Pixel Size	RGB Color	Luminance Intensity RGB Luminance value= 0.3 R + 0.59 G + 0.11 B			
			r	g	r	Total
	150 *177	205 198 086	62	117	9	188
	153*178	211 200 073	63	118	8	189
	271*233	219 201 061	66	119	7	192
	153*173	207 192 062	62	113	7	182
	28* 213	028 048 032	8	28	4	40
	35*213	022 048 029	7	28	3	38
	38*207	024 045 023	7	27	3	37
	44*203	013 031 013	4	18	1	23

Table 2: RGB Luminance value

For each input pixel from the image, we compute RGB color luminance and then normalize its intensity using formula (2) from Finlayson et al., 1998.

$$r = \frac{r}{r+g+b}, g = \frac{g}{r+g+b}, b = \frac{b}{r+b+g} \quad (2)$$

From Table 2, we can plot a graph for color distribution using formula (2). The formula shows the color distribution in an image.

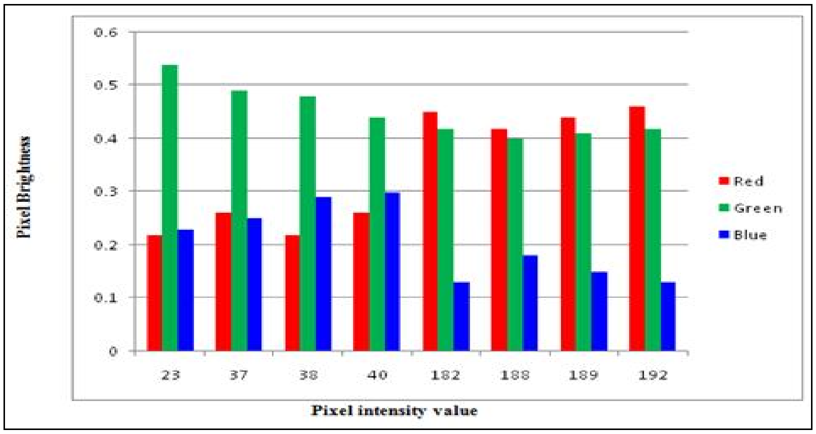


Figure 5: A graph of pixel intensity verses pixel Brightness

From the graph, we can say that human beings are capable of distinguishing shades of green than any other color.

3.3. Grayscale Image

For gray scale images, the pixel value is one number that represents the brightness of the pixel. RGB color for grayscale has equal red, green and blue values, that is, R = *G* = *B*. The same gray scale level can be achieved by getting the average of RGB values (R + G + B) / 3(En-Nasr, 2012).

3.4. Splitting colors according to color plane

Image in RGB color model consist of three independent image planes one for each primary color (Khotre, 2012). To enhance an image we subject each of the three image plane to histogram modeling separately. From Figure 3, we derive an algorithm that determines pixel intensity in an image.

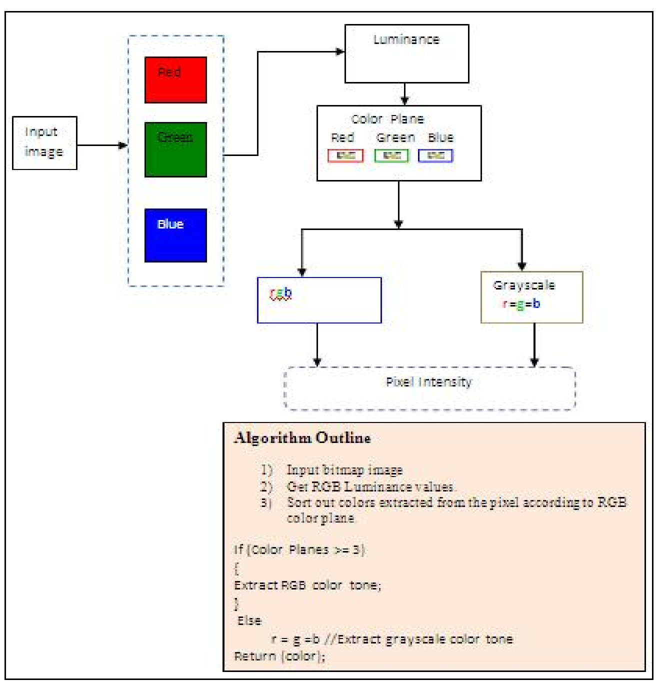


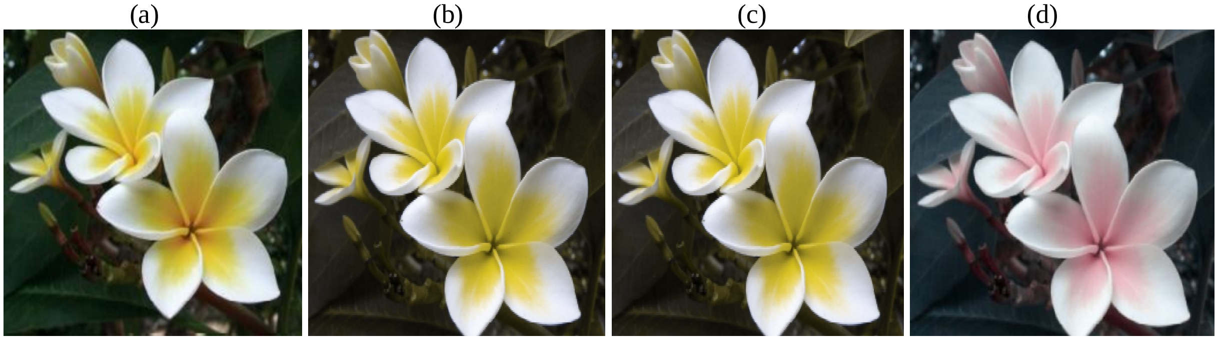
Figure 6: Proposed algorithm for extracting color intensity from a raster image

4. Discussion

Normally, a picture or image has got so many pixels. Each pixel for a 24 bit image has got 16,777,216 possible colors. Most output devices cannot handle all these colors in an image. Therefore, images are displayed on output devices with fewer colors as illustrated in Table 1.

Digital images are enhanced so as to extract the additional information that is not by itself perceivable prior to enhancement. It is believed that the human eye has Red, Green and Blue cones that sense color. From Figure 5, it is evident that human beings perceive Green and Red colors more than Blue. For that reason, image processing algorithm should sense colors as human beings do. This can be a bit tricky since the ability to distinguish colors varies from individual to individual. This disparity is credited to factors such as the presence of color blindness. For example Figure 7(b) shows how a person with a red/green color deficit (deuteranopia) views the original image (flower.bmp), Figure 7(c) shows how the picture looks to a person with green/red deficit (Protanope) and Figure 7(d) shows how the same image looks to a person with blue/yellow color deficit (Tritanope).

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

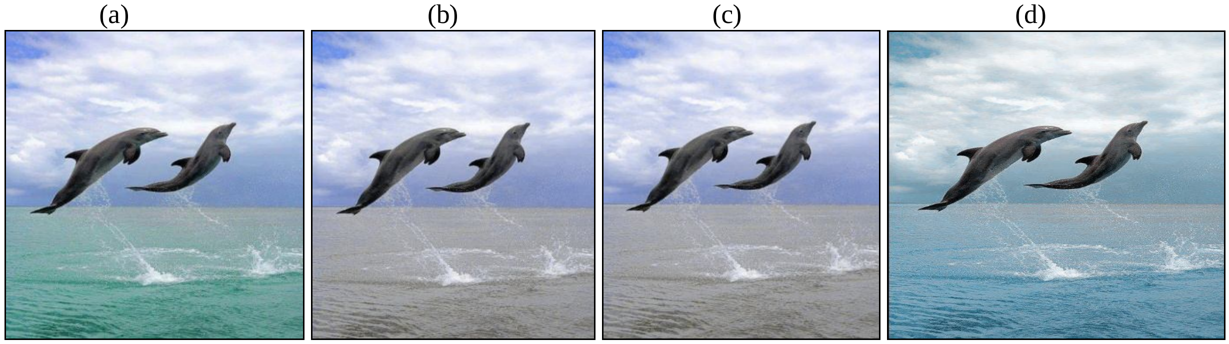


Original image (flower.bmp) Deuteranopia Protanope Tritanope

Figure 7: Illustration of how image is viewed by people with RGB deficiencies

The same test was done using a different image (Dolphin.bmp) and Figure 8(b) shows how a person with a red/green color deficit (deuteranopia) views the original image, Figure 8(c) shows how the picture looks to a person with green/red deficit (Protanope) and Figure 8(d) shows how the same image looks to a person with blue/yellow color deficit (Tritanope)

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

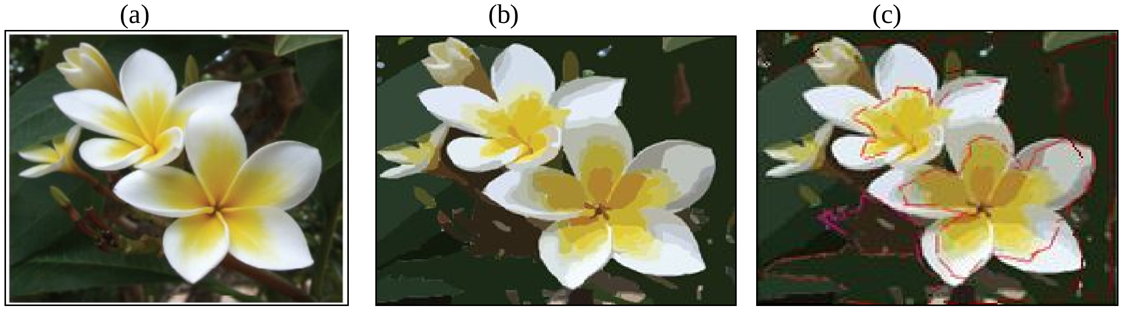


Original image (Dolphin.bmp) Deuteranopia Protanope Triatanope

Figure 8: Illustration of how image is viewed by people with RGB deficiencies.
The original picture was extracted from the internet (Information from the amazing pictures).

The proposed algorithm was used to enhance a bitmap image and our result is shown in Figure 9(b).

(a) (b) (c)



Original image Reconstructed image Color bleeding effects

Figure 9: Illustration of the image reconstructed using the proposed method

The algorithm reproduces color bitmap image. However, there is still color bleeding effects as shown in Figure 9(c). The red marks indicate the most affected areas of the image.

5. Conclusion

The goal of this study was to investigate pixel intensity in an image. The proposed method first extracts pixel color from input image; the luminance value is then computed to get the brightness of the image. The third step splits RGB color into color plane, if the color plane is equal to or greater than three, color image is extracted else a grayscale tone is extracted. The proposed method may be handy in any computer vision technique that enhances image color. It was observed that enhancing image color can significantly improve image quality. However, it can produce an image that is worse than the problem due to light variations in images. Further research should be carried out to eliminate the color bleeding effects on reconstructed bitmap images.

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