

# Image Enhancement Using New Color Model

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**Abstract**—The paper presents the approach and the experimental results of the new color model. The color model helps to process the image with least time delays. Also, this new color model can be used in real time video processing and communication systems. The experimental results show that the new color model RBL processes the image approximately four times faster than the HSL color models.

**Index Terms**— HSL color model , Image Processing, Image Enhancement, New Color Model, RGB color model.



## 1. INTRODUCTION

Image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Digital image processing is the use of computer algorithms to perform image processing on digital images and it finds application in various information and technical systems such as: radar-tracking, communications, television, astronomy, etc. [1]. This can be done with various methods such as histogram processing, local enhancement, smoothing and sharpening, a digital image filtration and edge detection. Initially, these methods were designed especially for gray scale image processing [2]. The RGB color model is the basic color model and is not suitable for all its applications. Hence, it becomes difficult to execute the algorithms of image processing.

The main aim of the paper is to develop a new color model which takes less time delays. We have divided the paper in five sections. The section two, we describe the basic color models used for image processing. Section three describes the new methodology for object identification. Section four shows the new approach towards digital image processing which is the main aim of the paper. The result of the experiment has been discussed in section five and section six presents the conclusion.

## 2. RGB AND HSL COLOR MODEL

The RGB color model is an additive color model in which red, green, and blue light are added together in various ways to reproduce a broad array of colors. The name of the model comes from the initials of the three additive primary colors, red, green, and blue.

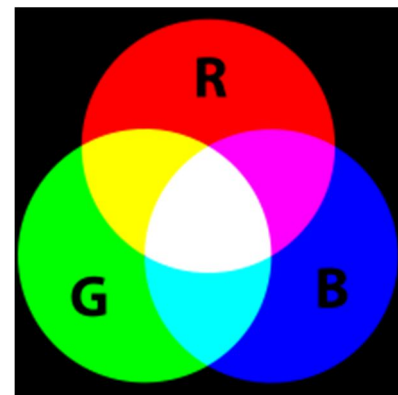


Fig 1(a): The RGB Color Model

HSL is a cylindrical geometry model with hue, and its angular dimension, starting at the red primary at  $0^\circ$ , passing through the green primary at  $120^\circ$  and the blue primary at  $240^\circ$ , and then wrapping back to red at  $360^\circ$ . Also, the central vertical axis comprises the *neutral, achromatic, or gray* colors, ranging from black at lightness 0 or value 0, the bottom, to white at lightness 1 or value 1, the top [3].

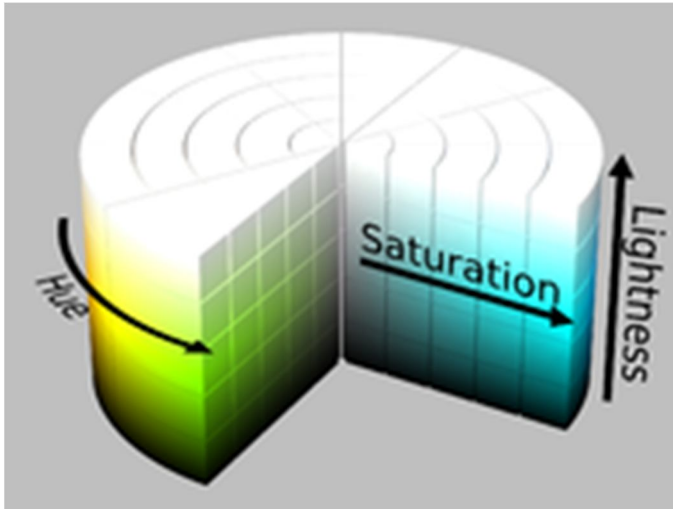


Fig 1(b): The HSL Color Model

RGB to HSL Conversion:

$$L = \frac{1}{3} (R+G+B) \quad (1)$$

$$S = 1 - \frac{3}{(R+G+B)} [\min(R, G, B)] \quad (2)$$

$$H = \cos^{-1} \left( \frac{0.5[(R-G)+(R-B)]}{\sqrt{(R-G)^2 + (R-B)(G-B)}} \right) \quad (3)$$

If B is greater than G, then  $H = 360^\circ - H$ . (4)

These are the formulas required for the conversion of HSL color model to RGB color model.

HSL to RGB Conversion:

For the RG Sector, ( $0^\circ \leq H \leq 120^\circ$ ) we have the following equations to convert RGB to HSL format:

$$B = L (1 - S) \quad (5)$$

$$R = L \left[ 1 + \frac{S \cos H}{\cos(60^\circ - H)} \right] \quad (6)$$

$$G = 3L - (R + B) \quad (7)$$

For the GB Sector, ( $120^\circ \leq H \leq 240^\circ$ )

$$H = H - 120^\circ \quad (8)$$

$$R = L (1 - S) \quad (9)$$

$$G = L \left[ 1 + \frac{S \cos H}{\cos(60^\circ - H)} \right] \quad (10)$$

$$B = 3L - (R + G) \quad (11)$$

For the BR Sector, ( $240^\circ \leq H \leq 360^\circ$ )

$$H = H - 240^\circ \quad (12)$$

$$G = L (1 - S) \quad (13)$$

$$B = L \left[ 1 + \frac{S \cos H}{\cos(60^\circ - H)} \right] \quad (14)$$

$$R = 3L - (R + G) \quad (15)$$

Hence, nine formulas are required for the conversion of RGB to HSL color model. As a result, a lot of time is spent in the conversion. So, it is required to reduce these time delays [5],[6],[7],[8].

### 3. NEW METHODOLOGY FOR OBJECT RECOGNITION

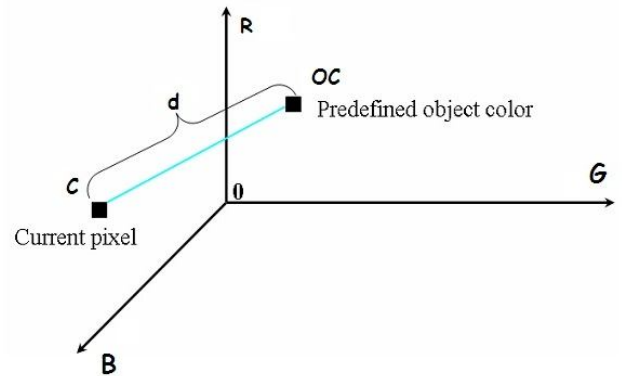


Fig. 2: The direct comparing of RGB colors

The process of Object Recognition is done using the direct true color comparing of the current image pixel with the predefined pixel. Let us refer OC as the predefined pixel and C as the current image pixel. Since any color pixel can be represented in system as composition of R, G and B components, direct color comparing can be done using 3D RGB color space.

In the figure 2, the distance between the current pixel and the predefined pixel is d and a small value of d refers to similar color of the two color pixels. It can be shown mathematically as:

$$d = \sqrt{(OC.r - C.r)^2 + (OC.b - C.b)^2 + (OC.g - C.g)^2} \quad (16)$$

The decision about matching of the current pixel with the predefined pixel can be based upon some factor, say e, and can be accepted if the value of d is less than e, else it is rejected. The mathematical representation of factor e can be done as:

$$e = \sqrt{10\%(\text{Max } R)^2 + 10\%(\text{Max } G)^2 + 10\%(\text{Max } B)^2} \quad (17)$$

where the max value for R, G and B is 255. Hence,

$$e = \sqrt{(25)^2 + (25)^2 + (25)^2} = 43.3$$

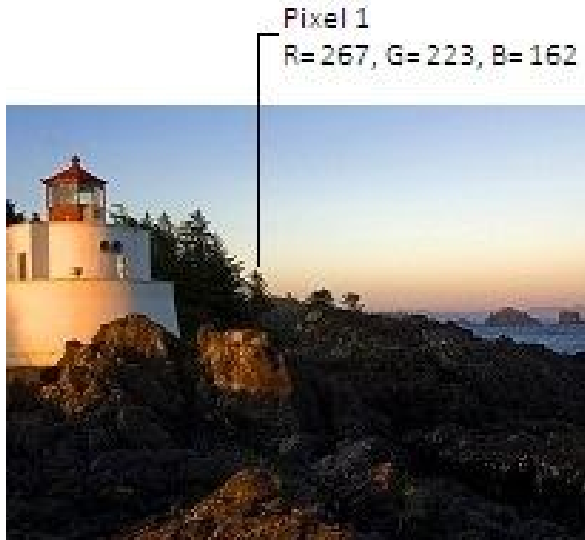


Fig. 3: Two RGB images: a) acquired during day and sunlight b) During evening and values of pixel components

Color image can be obtained in different brightness, like photo registered during day and evening as shown in Fig. 3.

Just for example, we got only one pixel. So, pixel in image 3.a will be recognized as object color. But pixel in image 3.b

is same pixel; just brightness of image is less. But it cannot be recognized as the same object. So, directly color comparing produces mistakes according to brightness of image. To avoid mistakes, we normalize the colors using the following formulas:

The original colors are:

$$C.r$$

$$C.g$$

$$C.b$$

The normalized colors are:

$$C'_r = \frac{C.r}{C.r+C.g+C.b} \cdot 100\% \quad (18)$$

$$C'_g = \frac{C.g}{C.r+C.g+C.b} \cdot 100\% \quad (19)$$

$$C'_b = \frac{C.b}{C.r+C.g+C.b} \cdot 100\% \quad (20)$$

Where C.r, C.g, C.b are the original colors; C'.r, C'.g, C'.b are the normalized colors. These colors show how much each components contained in color (in %). According to the example shown above, we can show that for image shown in Fig.3.a:

$$R' = (267/652) \cdot 100 = 41\%, \quad G' = (223/652) \cdot 100 = 34\%, \quad B' = (162/652) \cdot 100 = 25\%$$

Whereas in figure 3.b:

$$R = (177/433) \cdot 100 = 41\%, \quad G = (148/433) \cdot 100 = 34\%, \quad B = (108/433) \cdot 100 = 25\%$$

As we can see from the above R', R Equations, 2 images, one obtained during day, second during evening, have the same normalized color. So this methodology is better to be applied in object detection systems because system is not sensible to image brightness. Our investigations show that variability of parameter e for steady object detection can be around ten times less to comparing with direct colors comparing.

#### 4. NEW APPROACH FOR IMAGE PROCESSING AND ENHANCEMENT

The main motive behind the development of a new method is to decrease the time of image processing and to provide the possibility of real video processing. It is known that majority of methods in image processing have been working only with lightness part of color model [9],[10],[11]. The color model must be in full basis, it mean that model must allow to transform image to new color model, using the lightness component for image processing, then return image back to RGB after processing [12]. The method must be a few times faster to comparing with standard HSL transformation.

As we can see from the formulas, we have normalized form of RGB color model. So, in the new color model, we can exclude one of the component of the model, say green (C.g'), and add the lightness component to convert the model to full basis. The formulas to convert the RBG image to R'B'L are as follows:

$$R' = \frac{R}{(R+G+B)} \tag{21}$$

$$B' = \frac{B}{(R+G+B)} \tag{22}$$

$$L = \frac{R+G+B}{3} \tag{23}$$

Where R, G, B is source RGB components of current pixel, R', B', L are three components of same pixel in new color model. Let's here and in future denote this color model as RBL.

Inverse transform to return R'B'L color model to basic RGB can be done as:

$$R = 3 \cdot R' \cdot L \tag{24}$$

$$B = 3 \cdot B' \cdot L \tag{25}$$

$$G = 3 \cdot (1 - (R' + B')) \cdot L \tag{26}$$

The idea of implementation is done with a real example: Suppose there is color pixel in some x, y position of image and color components of these pixels are R=35, G=55, B=80. Then any simple image processing operation on this pixel, such as brightness increment of 70 is done. So, first

operation is conversion from RGB color space to RBL according with equation: R'=0.20, B'=0.47, L=56.66. Second operation is image processing can be brightening the image with 50. Hence, new lightness component become L=L+50=106.66. The last one operation is inverse conversion to return the pixel to standard RGB model, according with equations, we can calculate the new pixel color as R=64, G=106, B=150.

The graphical representation of R'B'L color space can be shown as a 3D cube in color space as shown in Fig. 4.

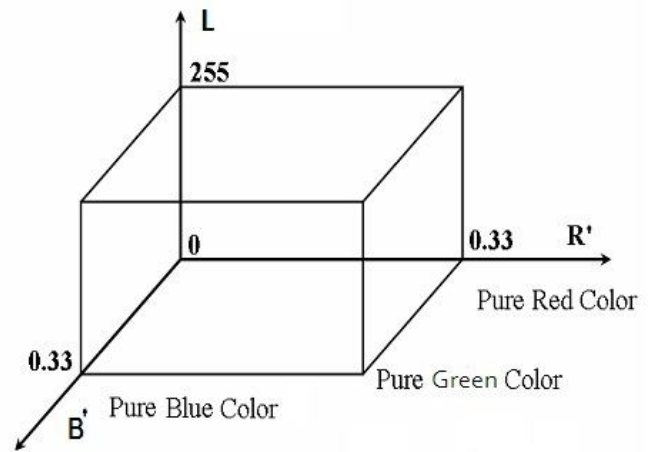


Fig. 4 Graphical Representation of R'B'L Color Space

#### 5. RESULTS

To examine the practical approaches of the new color model especially in image processing field, the RBL model and standard HSI model (for comparing) has been created with using Borland Delphi 6.0 compiler. The graphical user interface of program that we created is illustrated in Fig. 5.

Produced by Borland International, Delphi is a powerful development environment used primarily to build client/server applications for Microsoft Windows, with an emphasis on databases. Based on Object Pascal, it is object-oriented and was designed to give developers the ability to build applications easily, with minimal coding required. As we can see from the figure, the program of image processing was created using both methods of conversion: HSL and RBL. The program implemented such method of image processing as brightening, contrast stretching and histogram equalization. The results were satisfactory because our aim was to analyze the new model's execution time.



Fig. 5: Graphical User Interface of the developed program



(a)



(b)



(d)





(e)

Fig. 6: a) The source Image, b) the result image after histogram equalization with using HSL color model, c) the

(c)

We can see from the images that the processing using both models produce the same results. To estimate a time of image conversion, we create the test image represented as array, and filled with random function. After that, the time for conversion was measured. The test result is shown in the table 1.

**Table 1:** Calculation of Conversion Time

Number of Test	Method of Conversion	Time of Conversion (ms)
1.	RGB to HSL	1047
2.	HSL to RGB	927
3.	RGB to R'B'L	291
4.	R'B'L to RGB	200
5.	Total time of image processing (brightening) with using HSL (standard) method of conversion	2091
6.	Total time of image processing (brightening) with using RBL (suggested) method of conversion	698
7.	Total time of image processing (contrast stretching) with using HSL(standard) method of conversion	2332
8.	Total time of image processing (contrast stretching) with using RBL(suggested) method of conversion	796
9.	Total time of image processing (histogram equalization) with using HSL(standard) method of conversion	1100
10.	Total time of image	2467

result image after histogram equalization with using RBL model, (d) the result of brightening with using HSL model, (e) the result of brightening with using RBL color model.

	processing (histogram equalization) with using RBL (suggested) method of conversion	
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## 6. CONCLUSION

In this paper, we propose a of new color model that can be used in color image processing techniques as well as in the field of image recognition. The results of the test show that the time spent during HSL conversion method was approximately 4 times more to compared to the RBL color model conversion. Also, carried out experimental results of RBL color model for image recognizing and image processing show their efficiency that allows recommending including developed method in software of modern digital image processing systems.

## References

1. F. van der Heijden, Image Based Measurement Systems,Wiley, 1994.
2. Gonzalez, R.C. and R.E. Woods, Digital Image Processing. 1992, Reading, Massachusetts: Addison-Wesley.
3. R. E. Blake, Development of an Incremental Graph Matching Device, Pattern Recognition Theory and Applications, NATO ASI Series, Vol 30, pp.355-366, Springer, Berlin, 1987.
4. T. Pavlidis, Algorithms for Graphics and Image Processing, Computer Science Press, 1982.
5. Giardina, C.R. and E.R. Dougherty, Morphological Methods in Image and Signal Processing. 1988, Englewood Cliffs, New Jersey: Prentice-Hall.
7. P. Boros and R. E. Blake, The Calculation of the Aspect Graph from a CAD model. Proceedings of the Second Asian

Conference on Computer Vision, Singapore, December 1995.

8. Dudgeon, D.E. and R.M. Mersereau, Multidimensional Digital Signal Processing. 1984, Englewood Cliffs, New Jersey: Prentice-Hall.

9. Papoulis, A., Systems and Transforms with Applications in Optics. 1968, New York: McGraw-Hill.

10. Russ, J.C., The Image Processing Handbook. Second ed. 1995, Boca Raton, Florida: CRC Press.

11. R. E. Blake, Partitioning Graph Matching with Constraints, Pattern Recognition, Vol 27, No.3, pp 439-446, March 1994.

12. J. Foley, A. van Dam, S. Feiner and J. Hughes, Computer Graphics: Principles and Practice, Second Edition, Addison-Wesley, Reading, MA, 1990.

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