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Understanding Color Models: A Review

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ABSTRACT

Colors are important for human for communicating with the daily encountered objects as well as his species, these colors should be represented formally and numerically within a mathematical formula so it can be projected on device/ computer storage and applications, this mathematical representation is known as color model that can hold the color space, by the means of color's primary components (Red, Green, and Blue) the computer can visualizes what the human does in hue and lightness. In this paper; a review of most popular color models are given with the explanation of the components, color system, and transformation formula for each other, application areas and usages are also included in this work with the classification of color models according to its dependence and independence on the hardware device used in specific application, a summary of the advantages and disadvantages of the color models are also demonstrated in this work.

Keywords: *Color model, color model applications, Luminance, Chromaticity.*

1. INTRODUCTION

One of the interesting fields that developed instantaneous is digital image processing, which its applications meet various life requirements such as communications, tracking signals, television, space, intelligent transportation systems etc. [1]. The main two application areas of digital image processing as mentioned in [2]are to improve the picturing information for better human understanding as well as processing image information for machine representation [2] which means to establishing a bridge between human-machine communication by improving both ends. Using the color spectrum in image processing provides an interesting tool for objects recognition and extraction from the scene[2] and to enable the extension of the domain space compared with gray images. Color model explains how the colors are represented and specifies the components of color space accurately to learn how each color spectrum looks like[3].Color models are used for different applications such as; computer graphics [4], image processing [4], TV broadcasting [4][6], and computer vision [3][4].

With knowledge of color models and different color formats we can represent the color information of the input digital image acquired by a camera or scanner that can recognize three primary ingredient spectrums; red, green, and blue from the light beam [2] that considered the primary components. The properties that used to distinguish different colors are brightness, hue, and saturation; these parameters are classified into two components; luminance (the brightness) and chrominance (hue and saturation), so each color is represented with two characteristic components luminance and chrominance [2] that are suitable for human interaction [4] since they can represent the human skin pigment regardless the lightning used. Color model is a mathematical model that briefly convert the light color coordinates position into three color components [5] in the three dimensional space using some mathematical functions [6].We have prepared a global review paper for different color models used as well as the mathematical representation of each with their corresponding advantages and disadvantages and their suitable application area.

This paper is organized as follows; Section 2 explains common color model systems. Section 3 demonstrates color models applications, classifications, and their taxonomy. A summary of color model advantages and disadvantages is given in Section 4. Finally conclusion is illustrated in Section 5.

2. COLOR MODELS

We can define the color model as the digital representation of possibly contained colors, a different definition is found in [7] that defines it as the way that we can recognize color, where human can visualize color through its attributes such as; hue, and brightness [7]. Color models is a system for measuring colors that can perceived by human, and a process of combining different values as a set of primary colors [8]. Typically color models have three or four color components [5]. Different color spaces are available for different applications [7]. Color models can be divided into three categories according to image processing applications;

1. Device-oriented color models: Also called device dependent color models that relates and affected by the signal of the device [4], and the resulted color affected by the tools used for displaying [7].These models are used widely in many applications that demand the color be consistent with hardware tools used [4], examples are any hardware devices that used for human vision perception such as TV [1] and video system [6].
2. User-oriented color models: Considered as a path that existed between the observer and the device handles the color information[4], these models enable the user to describe and approximate what he percepts from presenting the color [4].
3. Device-independent color models: The color model not affected by the given device properties [4], and the same color will be resulted from the set of parameters without any

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consideration for the devices performance [7].This type of color models are useful in network transmission information so that the visual data has to traverse through different hardware devices [4].

Table 1: Illustrates the distribution of different color models according to latter mentioned classification.

Table 1: Color models classifications.

Color Model	Classifications
Munsell	Device independent
RGB, CMY(K)	Device dependent
YIQ,YUV, YCbCr	Device dependent
HSI, HSV, HSL	User oriented-Device dependent
CIE XYZ, CIE L*U*V*, CIE L*a*b*	Device independent, color metric

3. THE MUNSELL COLOR SPACE

The earliest organization of color perception into color space was Munsell color model [4] created by Professor Albert H. Munsell[5], and most familiar device independent color space [9].Munsell color model represented as a cylindrical shape with three dimensions equals to value (lightness), hue, and saturation (color purity)[4][5], and it was the first model that isolates the three color components into disciplinary independent, regular, and three dimensional space[5].

The principal of equality spacing between the model components is the main idea of Munsell color model [4],these components are hue, value and chroma, the hue is represented by a circular shape broken down into ten sectors defined as; red, yellow-red, yellow, green-yellow, green, blue-green, blue, purple-blue, purple and red-purple [4] which means the hue range is [1, 10],the value divided into eleven sections refer to lightness (white) at value ten or darkness (black) at value zero[4] which means the range is [0, 10] and perpendiculars the Munsell color model,and the chromare presents the saturation of the corresponding selected combination of each of hue and value parameters and its range is [0, 12] as seen in Figure 1.

4. CIE COLOR MODELS

This color models has different combination as listed below:

I) CIE XYZ color Model

One of the first color space defined is CIE XYZ, also referred as X, Y, and Ztristimulus functions, and as CIE color space; XYZ is created by international commission on illumination 1931[5].These models are created manually with the help of human judgment ability of visualization and appearances matching, and the chosen colorimetry is based on this matching procedure[4].Figure 2(A) explains the color matching function. The shapes of the sensitivity curves parameters X, Y and Z are measured with some plausible accuracy [5].Mathematically speaking, the model can be described as luminance component Y along with two chromaticity coordinates X and Z[4], however, sometimes the XYZ color model is represented by its luminance parameter Y [5], furthermore, a normalized tristimulus (chromaticity coordinates) can be used as a representative for such model and calculated as in (1) and (2)(denoted by small case xyz).

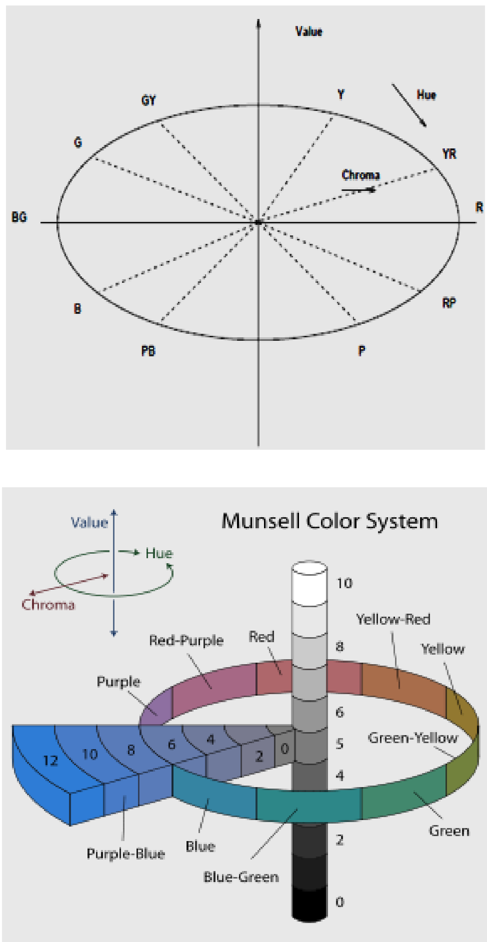

Figure 1: Munsell color system [4]. Right side shows the hues circle at value 5, chroma 6; along the vertical V value from 0 to 10 [5].

$$x = \frac{X}{X+Y+Z} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$y = \frac{Y}{X+Y+Z} \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

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Since only two coordinates used for color match description, the model represented with on xy-plane and the z implicitly evaluated as $z = 1 - (x + y)$.

II) CIE L*u*v* Color Space

The first uniform color space derived from CIE XYZ space with white reference point as shown in Figure 3[4] where the white reference point (Xn, Yn,Zn) is the linear RGB (1, 1, 1) values. L* represents the lightness, and u* and v* represent the correlates of chroma and hue [4]. The details of conversion from CIE XYZtoCIEL*u*v and the inverse from CIEL*u*v to CIE XYZ color models are available in reference [4].

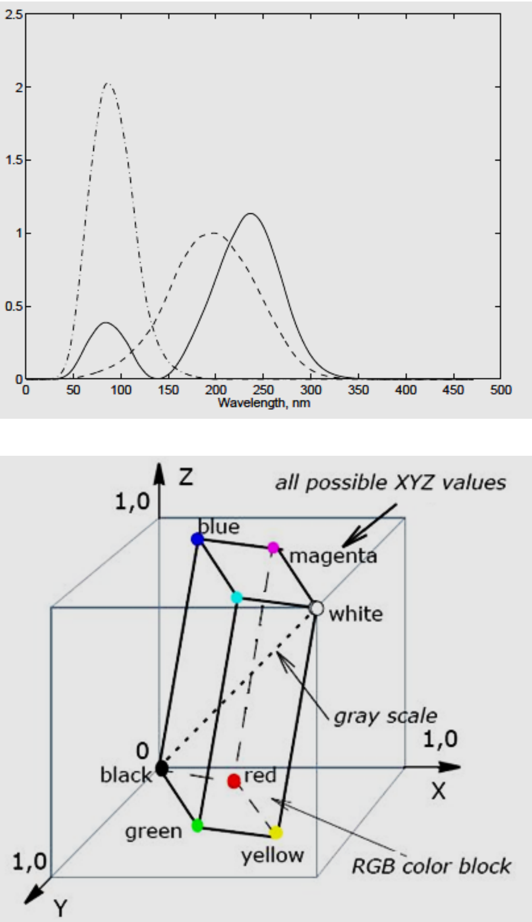

Figure 2: CIE XYZ color model.A: The CIE XYZ color matching functions [4]. B: RGB cube in the XYZ cube[10].

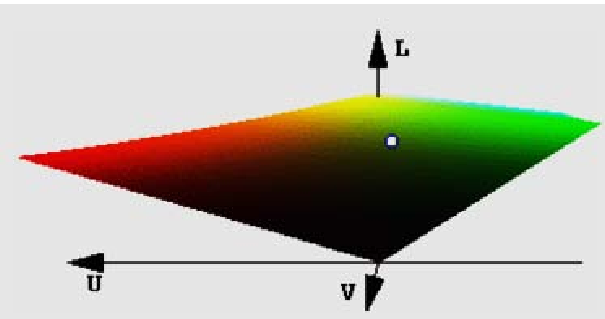

Figure 3: CIE L*u*v* Color Space [4].

III) CIE L*a*b* Color Space

Also called CIELAB color model the second uniform color space derived from CIE XYZ space in1976, with white reference point [4]. L*a*b* color model determines the color depending on its position in a3D color space [11], the L* components is the lightness of the color (when L* =0 means black and when L* =100 referred to while) and the chroma*(for positive values indicate red and for negative values indicate green) and the hue b* (positive values refer to yellow while negative values refer to blue) [4] as illustrated in Figure 4. CIELAB is device independent and considered very important for desktop color [10].The details of conversion from CIE XYZ to CIEL*a*b*and the inverse from CIEL*a*b*to CIE XYZ color models are available in reference [4].

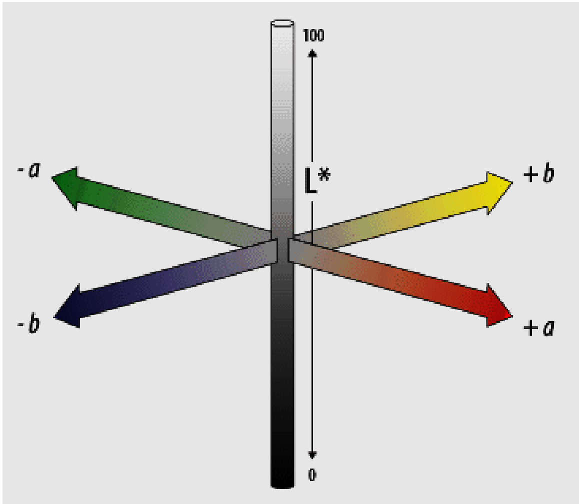

Figure 4: CIE L*a*b* color model [10].

5. RGB COLOR MODEL

From the three additive primary colors (red, green, and blue) the name of the model has been derived,and in a light spectrum they combined together as one color, and can be mixed to produce newspectrum colorsas in Figure 5 (A)[6][5].

The RGB color space as described in [3] [5] [7]could be represented as a cube by normalized RGB color values in the range [0,1] with gray values on the main diagonal of the black values (0,0,0) and on the opposite corner the white values (1,1,1)[7]. It is considered as the base color model for most image applications since the acquired image does not need any further transformation for displaying in the screen [7].

RGB color model is classified into two types according to [4]; Linear RGB Color Space, and Non-linear RGB Color Space. Referring to linear RGB color model as (RGB), and to nonlinear RGB color model as (R'G'B'), which will be explained in the following subsections:

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I) Linear RGB Color Space

Linear RGB space attains color consistency via various appliances using color management system [4].Linear RGB not suitable for numerical analysis and seldom used for image representation [4], it is used for computer graphics applications [4]. The mapping to nonlinear done using gamma correction factor γ_C of the camera or any input device, in the range [0,1] for both of the models [4].

II) Non-linear RGB Color Space

The data of input image captured with a camera or scanner are the R'G'B' values represented in the range from 0 to 255 [4]. These data then stored for using in image processing applications, JPEG, MPEJ standard [4]. The transformation from linear to nonlinear values, and from nonlinear back to linear RGB values within the range [0, 1] is defined in definition 1and 2 [4] :

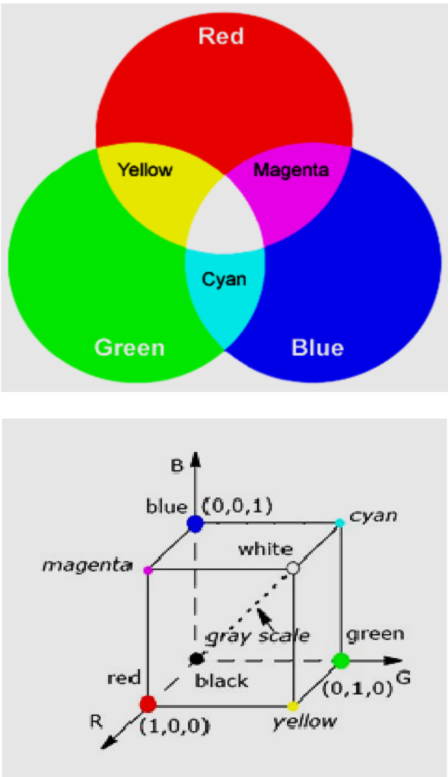

Figure 5: RGB color Model [3][5].A: Primary colors representation. B: Primary colors cube.

Definition 1: From linear to nonlinear conversion

$$R' = \begin{cases} 4.5\,R & if\ R \le 0.018 \\ 1.099 R^{\frac{1}{\gamma_C}} - 0.099 & \text{other wise} \end{cases}$$

$$G' = \begin{cases} 4.5\,G & if\ G \le 0.018 \\ 1.099 G^{\frac{1}{\gamma_C}} - 0.099 & \text{other wise} \end{cases}$$

$$B' = \begin{cases} 4.5\,B & if\ B \le 0.018 \\ 1.099 B^{\frac{1}{\gamma_C}} - 0.099 & \text{other wise} \end{cases}$$

End Definition 1

Definition 2: From nonlinear to linear conversion

$$R = \begin{cases} \frac{R'}{4.5} & if\ R' \le 0.018 \\ \left(\frac{R' + 0.099}{1.099}\right)^{\gamma_D} & \text{other wise} \end{cases}$$

$$G = \begin{cases} \frac{G'}{4.5} & if\ G' \le 0.018 \\ \left(\frac{G' + 0.099}{1.099}\right)^{\gamma_D} & \text{other wise} \end{cases}$$

$$B = \begin{cases} \frac{B'}{4.5} & if\ B' \le 0.018 \\ \left(\frac{B' + 0.099}{1.099}\right)^{\gamma_D} & \text{other wise} \end{cases}$$

End Definition2

The values of power function for the CRT or display device are expalined in Figure 6 for the linear RGB and nonlinear R'G'B' values [4]:

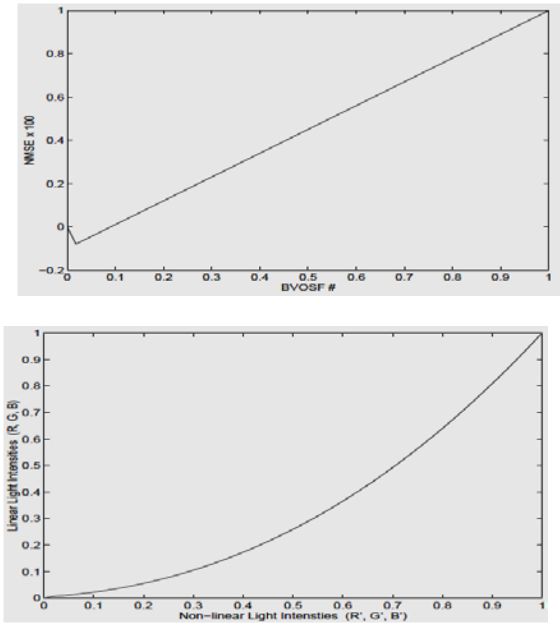

Figure 6: Linear to nonlinear transformations [4]. A: Linear to Nonlinear B: Nonlinear to Linear

The transformations the explains the process of mapping from linear to nonlinear values from image capturing to image display are demonstrated in Figure 7[4].

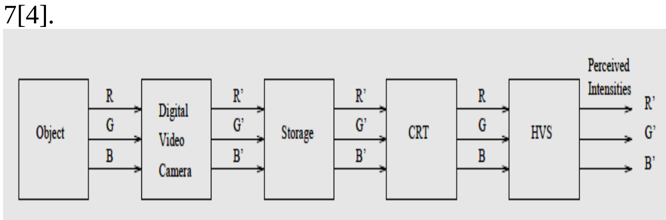

Figure 7: image transformations from input image to display image [4].

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6. CMY (K) Color Model

CMY (K) model is a subtractive model based on complementary colors (Cyan, Magenta, Yellow, and (Black)) with respect to additive color in RGB color model [6]. Generally used for output devices such as printers. The representation of the model is shown in Figure 8, and the transformation regarded CMY, RGB, and CMYK are expressed in definitions from 3 to 6:

Definition 3: RGB to CMY

$$Cyan = 1 - Red$$
$$Magenta = 1 - green$$
$$Yellow = 1 - Blue$$

End Definition 3

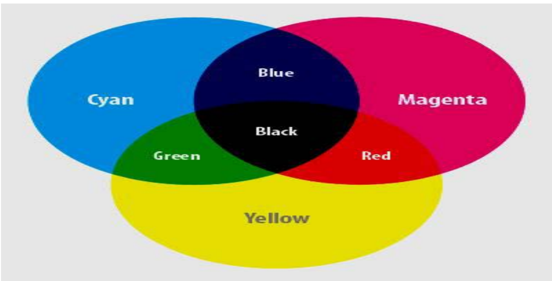

Figure 8: CMY (K) subtractive color model representation [5].

Definition 4: CMY to RGB

$$Red = 1 - Cyan$$
$$green = 1 - Magenta$$
$$Blue = 1 - Yellow$$

End Definition 4

Definition 5: CMY to CMYK

$$Black = minimum\ (Cyan, Magenta, Yellow)$$
$$Cyan = (Cyan - Black)/(1 - Black)$$
$$Magenta = (Magenta - Black)/(1 - Black)$$
$$Yellow = (Yellow - Black)/(1 - Black)$$

End Definition 5

Definition 6: CMYK to CMY

$$Cyan = minimum(1, Cyan * (1 - Black) + Black)$$
$$Magenta = mimum(1, Magenta * (1 - Black) + Black)$$
$$Yellow = minimum(1, Yellow * (1 - Black) + Black)$$

End Definition 6

7. HSI COLOR MODEL FAMILY

The HSI, HSL, HSV color models based on the idea of human visual system [6]. The HSI family of color models uses cylindrical coordinates for the representation of RGB points [4].The importance of HSI color model relies on two main aspects; the I component is separated from the hue H and saturation S which are the chrominance components, and secondly these chrominance components depend on how human perceive this color spectrum[4].

HSL and HSV color spaces are nearly similar except that HSL assigns the high color values for colors that approaching to the white color with a bounded saturation [12]. This property would increase the complication degree of the model [12]. HSV color model is represented in a single cone, while HSI or HSV is represented in double cone [5].

I) HSI Color Model

The H referred to hue that measures color purity, S indicates the saturation (the degree of white color embedded in specific color), and I referred to the intensity [6].this color model also known as HSL, where L indicates the lightness. The conversion between each of RGB and HSI demonstrated here in below in definitions 7 and 8, and Figure 9 explains the HSI color model[4].

Definition 7: From RGB to HSI

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

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

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

$$if\ B\ is\ greater\ than\ G,\ then\ H = 360^{\circ} - H$$

End Definition 7

Definition8: From HSI to RGB [2]

$$B = I\,(1 - S)$$
$$R = I\left[1 + \frac{S\cos H}{\cos(60^{\circ} - H)}\right]$$
$$G = 3I - (R + G)$$

GB sector$(120^{\circ} \leq H < 240^{\circ})$: if the given value of H is in this sector, first subtract 120° from it:

$$H = H - 120^{\circ}$$

The RGB components are:

$$R = I\,(1 - S)$$
$$G = I\left[1 + \frac{S\cos H}{\cos(60^{\circ} - H)}\right] \quad (10)$$
$$B = 3I - (R + G)$$

BR sector$(240^{\circ} \leq H \leq 360^{\circ})$: if H is in this range, subtract 240° from it:

$$H = H - 240^{\circ}$$

The RGB components are:

$$G = I\,(1 - S)$$
$$B = I\left[1 + \frac{S\cos H}{\cos(60^{\circ} - H)}\right]$$
$$R = 3I - (G + B)$$

End Definition 8

II) HSV color model

In this model the V denoted the value. HIS and HSV are used for computer vision and image analysis for segmentation process [5] [13]. The conversion between each of RGB and HSV can be found in algorithm 1 and 2.

Algorithm 1: Conversion from RGB to HSV

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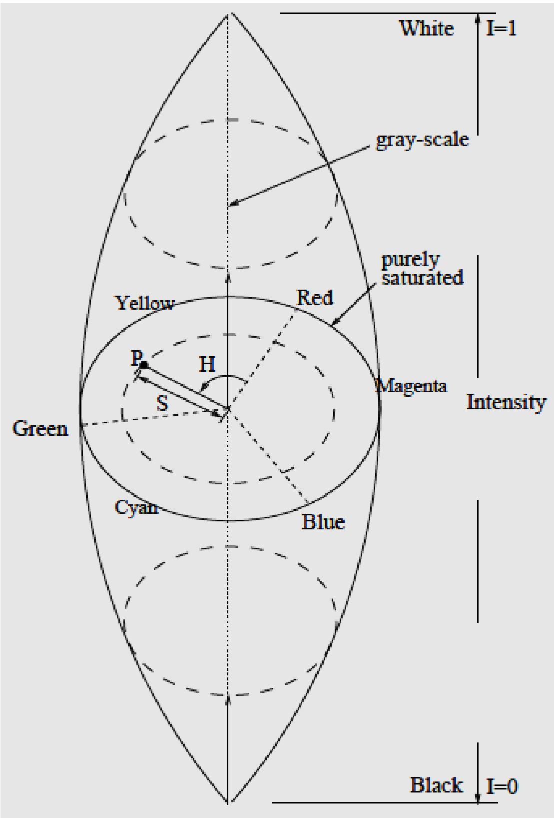
Input: RGB
Output: HSV
Method:
Step1: *[Find the max and min values]*
M = max(R, G, B), m = min(R, G, B)
Step2: *[normalized the RGB values to be in the range [0, 1]]*
r = (M-R)/(M-m)
g = (M-G)/(M-m)
b = (M-B)/(M-m)
Step3: *[Calculate V value]*
V = max(R, G, B)
Step4: *[Calculate S value]*
if M = 0 then S = 0 and H = 180 degrees
if M <> 0 then S = (M - m) / M
Step5: *[Calculate H value]*
if R = M then H = 60(b-g)
if G = M then H = 60(2+r-b)
if B = M then H = 60(4+g-r)
if H >= 360 then H = H - 360
if H < 0 then H = H + 360
Where H in the range [0,360], S and H in the range[0,100]
Step6: *[output HSV]*
The calculated H, S, and V are the output of the algorithm.
End



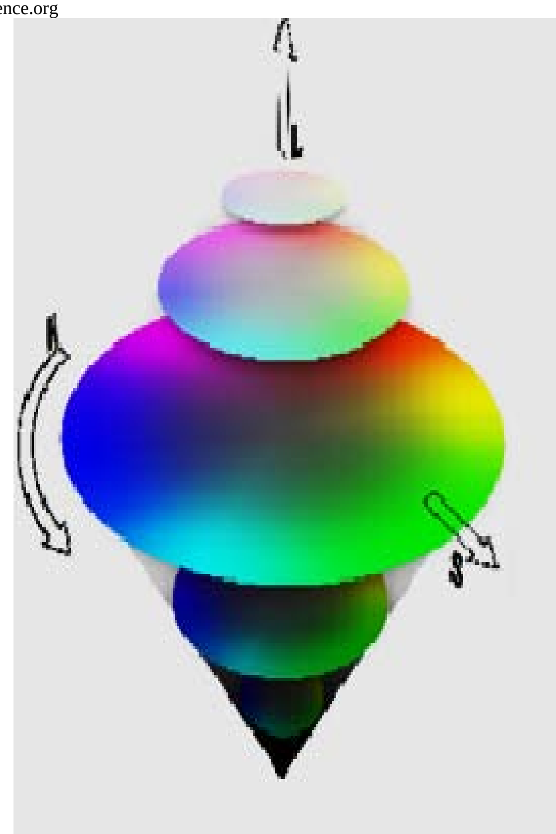


Figure 9: HSI color space different representation [4][1].

Algorithm 2: Conversion from HSV to RGB [7]:
Input: HSV
Output: RGB
Method:
Step1*: [Find Hue H value]*
H value in the range 0 to 360 and divide by 60:

$$Hex = \frac{H}{60}$$

Step2: *[Calculate the values of primary color and secondary color]*
the values of primary color and secondary color, a, b, and c are calculated. The primary color is the integer component of Hex

$$secondary\ color = Hex - primary\ color$$
$$a = (1 - S)\ V$$
$$b = (1 - (S * secondary\ color))V$$
$$c = (1 - (S * (1 - secondary\ color)))\ V$$

Step3: *[Calculate RGB values]*

If primary color =0 then
$R = V, G = c, B = a$
If primary color =1 then
$R = b, G = V, B = a$
If primary color =2 then
$R = a, G = V, B = c$
If primary color =3 then
$R = a, G = b, B = V$
If primary color =4 then
$R = c, G = a, B = V$

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If primary color =5 then

$$R = V, G = a, B = b$$

Step4: *[output RGB]*
The calculated R, G, and B are the output of the algorithm.

End

8. YUV Color Model Family

YUV, YIQ, YCbCr, YCC, YES color models are used in color TV broadcasting [7]. YIQ and YUV are analogue models for NTSC and PAL systems while YCbCr model is a digital standard [7].Since human vision can recognize two forms of images; the RGB images and black and white images, YUV color model developed to provide compatibility between these two forms for television systems [15].These color models are useful in compression applications as well[7].

I) YUV Color Model

The Y component referred to the luminance of the color, and the U and V components determine the color itself (chromaticity). The transformation between each of RGB and YUV can be found in definition 9 and 10[15]:

Definition 9: From RGB to YUV

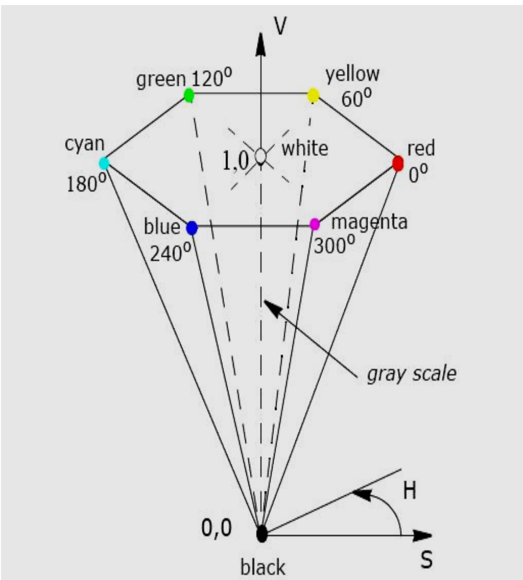
$$Y = 0.299\,R' + 0.587\,G' + 0.114\,B'$$
$$U = -0.147\,R' - 0.289\,G' + 0.436\,B' = 0.492\,(B' - Y)$$
$$V = 0.615\,R' - 0.515\,G' - 0.100\,B' = 0.877\,(R' - Y)$$

End Definition 9

Definition 10: From YUV to RGB

$$R' = Y + 1.140\,V$$
$$G' = Y - 0.395\,U - 0.581\,V$$
$$B' = Y + 2.032\,U$$

End Definition 10



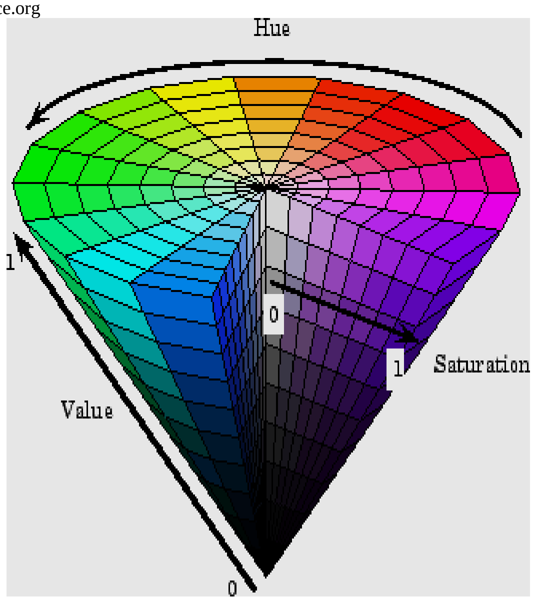


Figure 10: HSV color model single hex cone [10][14].

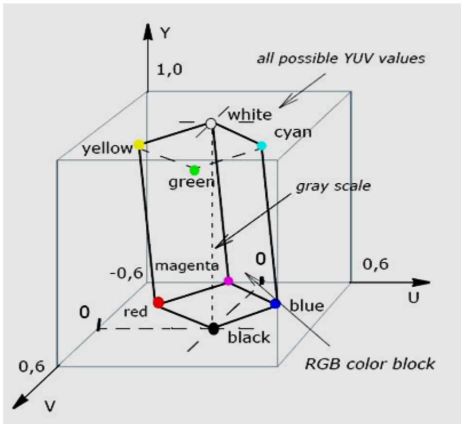


Figure 11: RGB color cube in the YUV color model [10].

II) YIQ Color Model

The YIQ color model was adopted in 1950 by the national Television Standard committee (NTSC) for color TV broadcasting and video systems [4]. Since YIQ color model was designed to utilize the visual system sensitivity in luminance change than hue or saturation changes [4], for this reason the video system represented with the luminance (lightness) y component and I component corresponds to the orange-cyan axis, and Q component corresponds to magenta-green axis, the latter two components represent the hue and saturation values respectively [4] [16]. The [6] Referred to I and Q as the hue values only, where the “I” stands for “in-phase” and the “Q” for “quadrature”. YIQ color space derived from YUV color space [15]. The representation of YIQ is explained in Figure 12 and the relation between YIQ and RGB is expressed in definition 11 and 12.

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Definition 11: From YIQ to RGB

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} .30 & .60 & .21 \\ .59 & -.28 & -.52 \\ .11 & -.32 & .31 \end{bmatrix} \begin{bmatrix} Y \\ I \\ Q \end{bmatrix}$$

End Definition 11

Definition 12: From RGB to YIQ

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} .299 & .587 & .114 \\ .586 & -.275 & -.321 \\ .212 & -.528 & .311 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

End Definition 12

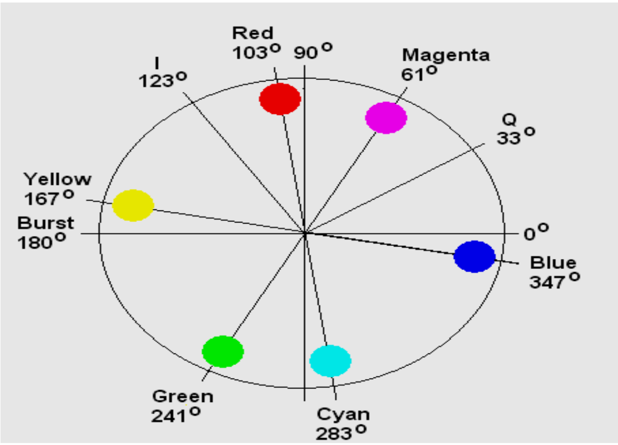
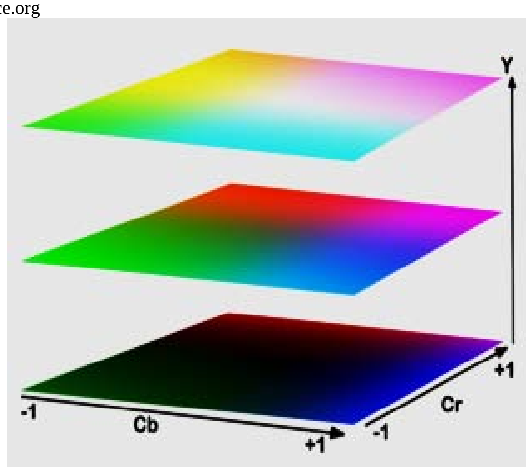


Figure 12: YIQ representation [16].



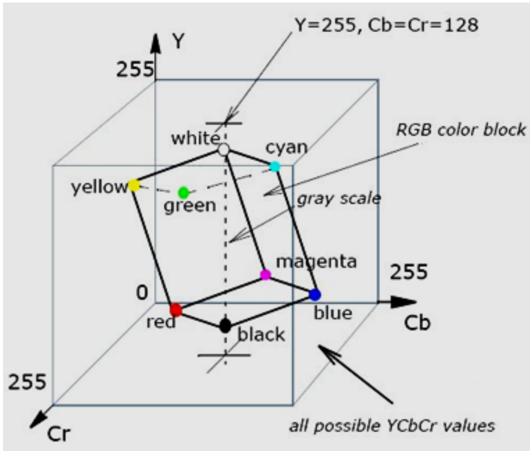


Figure 13: RGB cube in the YCbCr color space [10].

III) YCbCr Color Model

YCbCror Y'CbCr Color Model used for digital video, and was defined in the ITU-R BT.601 standards of ITU (International Telecommunication Union) which is the widely used European TV signal and represents the encoding form of non RGB signal [17].The Individual components of YCbCr color model are; luminance Y component and chroma components where Cb and Cr components stand for difference of the blue and red with the reference value respectively [14][18].

YCbCr is not absolute color space; it is an offset model of YUV color model [4].The transformation from RGB to YCbCr color model is given in definition 13:

Definition 13: From RGB to YCbCr

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ -0.169 & -0.331 & 0.500 \\ 0.500 & -0.419 & -0.081 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

End Definition 13

9. COLOR MODEL APPLICATIONS, CLASSIFICATIONS AND TAXONOMY

Different color models have different applications according to their parameters that are convenient for the application field. Table 2 explains different applications for each color model ranging from Television broadcasting and video system to image processing, analysis, and virtual environments. The taxonomy of color models was recently developed by [4], a slightly modified version of the taxonomy is given in Figure 14. The taxonomy illustrates the relations between the colors models and the possibility of transformation between them.

10. COLOR MODELS ADVANTAGES AND DISADVANTAGES

Table 3 explains the advantages and disadvantages of the discussed color models with the illustration of the parameters of each color model and the effective parameters used in that model for specific application.

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Table 2: Application Areas of Color Models.

Color Model	Application Area
Munsell	Human visual system
RGB	Computer graphics, Image processing, Analysis, Storage
CMY(K)	Printing
YIQ, YUV	TV broadcasting, Video system
YCbCr	Digital video
HSI, HSV, HSL	Human visual perception, Computer graphics, processing, Computer Vision, Image Analysis, Design image, Human vision, Image editing software, Video editor
CIE XYZ ,CIE L*U*V*, CIE L*a*b*	Evaluation of color difference, Color matching system, advertising, graphic arts, digitized or animated paintings, multimedia products

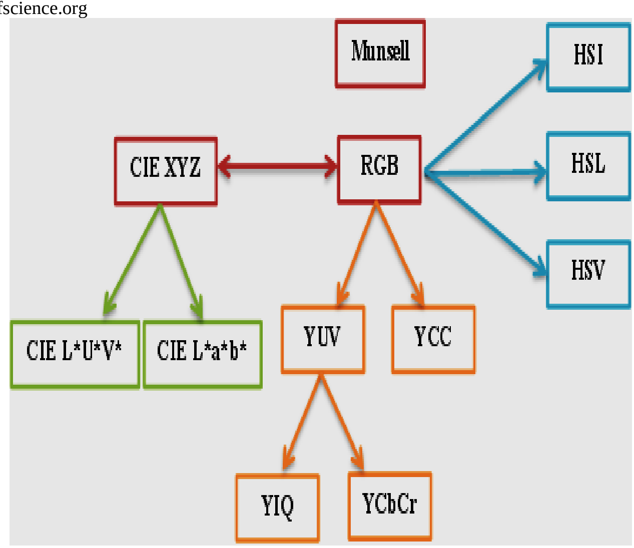

Figure 14: Color Models Taxonomy.

As seen by Table 3, there are different color models listed with their applications along with the effective parameter, however, these colors should be visualized by a device for understanding and carrying out the action specified by the presence of this color, for example, for gesture recognition system and when communication with a robot or a camera stationary on a laptop or computer, the presence of specific object is detected by the presence of the color corresponds to that object, and via visualization of that color; the computer or the robot can analyze the meaning of this gesture by segmenting the hand object first and then carrying out the action specified by this gesture, this is the same can be done when remote to a TV by a hand gestures to control the TV different action as well as the video actions.

Table 3: Models Effective Parameters with the Advantages and Disadvantages.

Model	Parameters	Effective Parameter	Advantages	Disadvantages
Munsell	Value, Hue, and Saturation	H	(1) Due to its nature, the boundary is not restricted, and differences of the color are regular.	(1) Highly interpolated causes erroneous. (2) Not suitable for some applications.
RGB	Red, Green, Blue.	R, G, B.	(1) No transformations required to display information on the screen, for this reason it considered as the base color space for various applications. (2) Used in video display because of additive property. (3) Considered as computationally practical system.	(1) Non useful for objects specification and recognition of colors. (2) Difficult to determine specific color in RGB model. (3) RGB reflects the use of CRTs, since it is hardware oriented system.
CMY(K)	Cyan, Magenta, yellow, and Black	-	(1) Commonly used for production printer color.	(1) Since it is a subtractive model, the components are pigments or inks not colors.

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CIE XYZ	Y lightness, X and Z are color information	Y	(1) Used for mixing color by transform representation. (2) Perceived as uniform.	(1) The model shape is difficult to visualize. (2) Device independent.
CIELab	L Luminance, A red to green B blue to yellow	L	(1) Perceived as uniform	(1) Device independent. (2) Suffer from unintuitive
CIELUV	L Luminance U Saturation V Hue angle	L	(1) Perceived as uniform	(1) Device independent. (2) Suffer from unintuitive
HSL/ HSI	Hue, Saturation, Lightness/ Hue, Saturation, Intensity	L/ I	(1) Preferable for users view since the components are correlated better with human perception of color. (2) The chrominance components (H and S) are associated with the way humans perceive, it became perfect for image processing applications. (3) The (Hue) component can be used for performing segmentation process rather than the three components which fasts the algorithm. (4) Separate the chromatic from achromatic values.	(1) Undefined achromatic hue points are sensitive to value deviations of RGB and instability of hue, because of the angular nature of the feature. (2) Does not supply with insight for color manipulation. (3) Not uniform.
HSV	Hue, Saturation, Value	V	(1) HSV colors defined easily by human perception not like RGB or CMYK.	(1) Undefined achromatic hue points are sensitive to value deviations of RGB and instability of hue, because of the angular nature of the feature.
YUV	Y luminance, and (U and V) are the chrominance	L	(1) The ability to decouple the luminance and color information where the image can be processed with no effect on other color components.	(1) The color range is restricted in the color TV images because of the information compression required for the displayed image. (2) Due to the limitation of the YUV standard the image displayed in computer cannot be recreate in TV screen.
YIQ	Y luminance, I, and Q chrominance (color information)	L	(1) The ability of separation gray scale information from color data property enables to represent the same signal for both color and (black and white) sets, using luminance component (which represent the gray scale information). (2) Used in video system for determining color components because of its human visual system characteristic. (3) The component Y might represent noise in processing, transferring, and storage at shallow level.	(1) The color range is restricted in the color TV images because of the information compression required for the displayed image. (2) Due to the limitation of the YIQ standard the image displayed in computer cannot be recreate in TV screen.
YCbCr	Y Luminance, (Cb and Cr) are	L	(1) Perfect in image compression. (2) Used in saving images as a file format for image. (3) Y luminance can be use separately for	(1)The color range is restricted in the color TV images because of the information compression required for the

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	chrominance blue difference, and red difference		storage in high resolution and the chromaticity components treated separately to improve the performance.	displayed image. (2) The displayed color depends on the primaries RGB that displayed the signal.

11. CONCLUSION

Some of the color model characteristics are utilized in different fields of application in our life, such as RGB, YIQ,YCbCr, HSI, HSV, HSL, CIE Lu*v*, and CIE La*b*.Each color model has its own representation space and components, with the ability of transforming from one color pace to another through standard formula. In this paper a review of some color models recently used with the demonstration of each color system characteristics. The selection of proper color model for a specific application depends on the properties of the model and theapplication nature,some application areas of the popular color models are explained in Table 1. Finally the advantages and disadvantages of the most common color models are given in Table 3. These color modes are classified mainly into two kinds: device independent and device dependent, further classification is analog use or digital use, these classifications can be further broken down like user based in which the user has to interfere to decide the parameters of the color space.

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