Color Measurement and Color Spaces Analysis for Medical Images of DICOM Evaluation

Yaroub Ghazi
MSc

Riyadh Meteb Mahmood
MSc

Shakeer Mahmood
MSc

Abstract:

Digital Imaging and Communications of Medicine (DICOM) standard is oriented to work with digital imag from medical equipment. It offers specific possibilities for more efficient use of medical images for diag therapeutic purposes. Throughout the development of this system, much attention was devoted to establishi relationships with related standards initiatives throughout the world (Europe and Japan), so the analyses of color i images are very necessary to have a strong relationship with other standards by the converter among the diffe systems. The first step in the color specification process is the identification of standard to use for color analyzi determine another standards. In our work we need the contribution deals with the (Matlab) application to be u spaces analysis .The application allows selection of input color image, direct and backward transformation into t space including standards of DICOM diagram picture analysis and other systems. The results of the color spaces outputs are introduced on various test pictures.

Keywords: DICOM Standard, Medical Imaging, RGB(Red, Green and Blue), YBR (Tri-Incentive Spectral Colo DICOM).

Introduction:

The American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) formed a joint committee in 1983 to develop a standard to[1]:

1. Promote communication of digital image information, regardless of device manufacturer
2. Facilitate the development and expansion of picture archiving and communication systems that can also interface with other systems of hospital information
3. Allow the creation of diagnostic information data bases that can be interrogated by a wide variety of devices distributed geographically.

This Standard, which is currently designated Digital Imaging and Communications of Medicine (DICOM), embodies a number of major enhancements to previous versions of the ACR-NEMA Standard. The DICOM is a global Information standard that is used in virtually all hospitals worldwide[1] , it conformance ensures that every medical imaging facility is a potential customer, because the equipment can work with any workflow or electronic health record systems and is used in: radiology, cardiology, dentistry, surgery, neurology, radiotherapy, oncology, ophthalmology and pathology.

Improving the technologies in medicine introduces modern diagnostic medical equipment producing images such as X-rays, ultrasound, MRI etc [2].

The DICOM has many types of image; the existence of an Imaging Service Request will typically result in the creation of one or more Imaging Service Reports and the distr Imaging Service Reports to one destinations. The true color Image In Object Definition (IOD) **(Figure.1**) spe color images that are converted from a no ***** format to a modality independent DICO so the color's analyses is necessary for of medicine [3] .

Materials & Methods:

Human vision is sensitive to the spectr of light, giving the property we know Although an exact physical reproduction light would require a wavelength-for-w matching of the spectrum of the light t necessary to produce a reproduction to human observer. Only three attributes matched and there are many systems parameters that can be used. This exam spectra and systems of matchin [4].International Commission on Il CIE(Commission Internationale de l' defined standards for color matching fun a diagram of chromaticity (Figure 2) imaginary nonphysical primary colors X chosen because they could match all the the spectrum without using negativ Primaries X and Z were chosen to luminance, meaning that value Y of p carries all the luminance of color being The other two values X and Z thus repr the chromaticity of the color. Normalize and y of X and Y, called chromaticity co can create chromaticity diagram Luminan

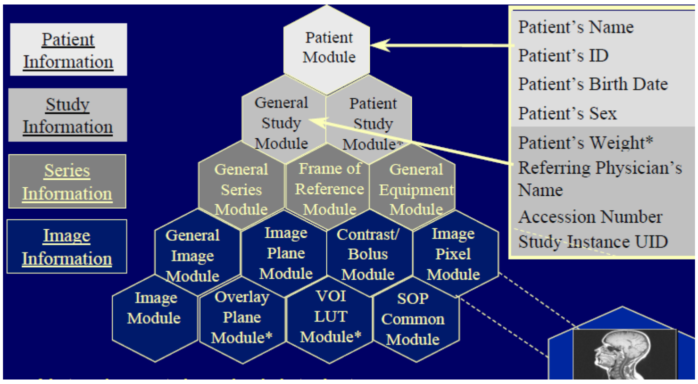
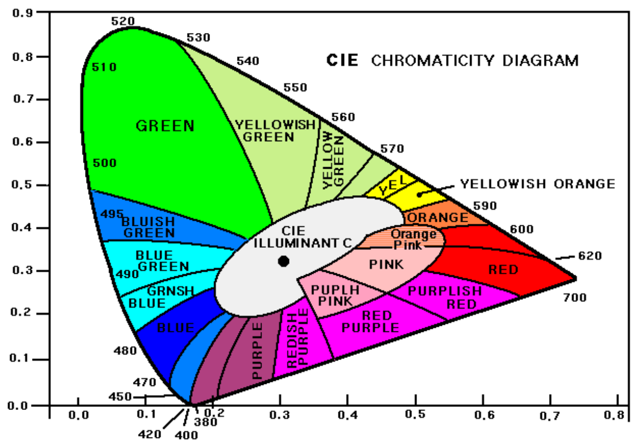


Figure (1) Image Information Object Definition (IOD) [3]

***The other standards in the world like European Electrical Manufacturers Association(ESC), College of cardiology (ACC), Societe Francaise de Radiology (SFR), Deutschen Rontgenegesel ophthalmology (DRG), American academy of ophthalmology(AAO), American academy of der (AAD), College of American pathology (CAP), Japaneese Radiology Vendors Associatio European Radiology Vendors Association (COCIR).**



Color

Figure (2) CIE Chromaticity diagram

The triple red/green/blue (RGB) signals delivered by the TV camera had to be transformed into a signal which, on the one hand, could be displayable without major artifacts on current receivers, the basic idea was to transform [5], by a linear combination, the three (RGB) signals into three other equivalent components Y, Cb & Cr (or Y, U& V) and given by:

$Y = 0.299R + 0.587G + 0.1145B$ …………….... (1)

Is called the luminance *signal*. $Cb = 0.564\,(B-Y)$ or $U = 0.493(B-Y)$ ……... (2) Is called the blue *chrominance*.

$Cr = 0.713\,(R-Y)$ or $V = 0.877(R-Y)$..

Is called the red chrominance.

$R-Y = R-(0.299R+0.587G+0.114B) = 0.587G-0.114B$

$B-Y = B-(0.299R+0.587G+0.114B) = 0.587G+0.886B$

Rearranging the equations yields:

$Y = + .29900R + .58700G + .11400B$ ……………………………….……………...

$Cb = - .16875R - .33126G + .4998\ B$ ……………………………………...…...

Cr = + .50000R - .41869G - .08131B ………………………………………..…... (6)

The combination used for the luminance (or "luma") signal has been chosen to be as similar as possible to the output signal of a monochrome camera, which allows the black and white receiver to treat it as a normal monochrome signal [6]. The two chrominance (or "chroma") signals represent the "coloration" of the monochrome picture carried by the Y signal, and allow, by linear recombination with Y, the retrieval of the original RGB signals in the color receiver. Studies on visual perception have shown that the human eye's resolution is less acute for color than for luminance transients.

This means, for natural pictures at least, that chrominance signals can tolerate a strongly reduced bandwidth (one-half to one-quarter of the luminance bandwidth), which will prove very useful for putting the chrominance signals within the existing video spectrum. The Y, Cb, Cr combination is the common point to all color systems [7].

Palette color by photometric interpretation for (DICOM)

Samples per Pixel are the number of separate planes in this image. One and three image planes are defined. Other numbers of image planes are allowed, but their meaning is not defined by this Standard For monochrome (gray scale) and palette color images, the number of planes is 1. For RGB and other three vector color models, the value of this attribute is 3. All image planes shall have the same number of Rows, Columns, Bits Allocated, Bits Stored, High Bit, Pixel Representation, and Pixel Aspect Ratio [6].

The data in each pixel may be represented as a "Composite Pixel Code". If samples per pixel is one, the composite pixel code is just the "n" bit pixel sample, where "n" equal bits allocated, If samples per pixel is greater than one, composite pixel code is a "k" bit concatenation of samples, where "k" equal bits allocated multiplied by Samples Per Pixel, and with the sample representing the vector color designated first in the photometric interpretation name comprising the most significant bits of the composite pixel code, followed in order by the samples representing the next vector colors, with the sample repres vector color designated last in the pl interpretation name comprising the least bits of the composite pixel code, for ex photometric interpretation equal "RGB" significant "bits allocated" bits contair sample, the next contain the Green samp least significant contain the Blue sample[8

For palette color pixel data describe a c with a single sample per pixel (single ima the pixel value is used as an index into e Red, Blue, and Green palette color, this be used when samples per pixel has a valu

For RGB Pixel data represent a co described by red, green, and blue image p minimum sample value for each cc represents minimum intensity of the c value may be used when Samples per P value of 3.

The values of equivalent components, for DICOM Standards

1.The YBR_FULL equal to Pixel data r color image described by one luminanc two chrominance planes (Cb and photometric interpretation may be used Samples per Pixel has a value of 3. represented by Y equal to zero. The a color is represented by both Cb and equal to half full scale.

In the case where bits allocated has a then the following equations convert betv and Y Cb Cr Photometric Interpretation.

Y = + .2990R + .5870G + .1140B ………………………...……………………

Cb = - .1687R - .3313G + .5000B + 128………………………………………

Cr = + .5000R - .4187G - .0813B + 128………………………………………

The matrix becomes:

……………………………….….. (10)

$$\begin{bmatrix} Y \\ Cb+128 \\ Cr+128 \end{bmatrix} = \begin{bmatrix} 0{,}299 & 0{,}587 & 0{,}114 \\ -0{,}172 & -0{,}339 & 0{,}511 \\ 0{,}511 & -0{,}428 & -0{,}083 \end{bmatrix} \cdot \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

2. The YBR_FULL_422 equal to the same as YBR_FULL except that the Cb and Cr values are sampled horizontally at half the Y rate and as a result there are half as many Cb and Cr values as Y values. This Photometric Interpretation is only allowed with Planar Configuration equal to 0. Two Y values shall be stored followed by one Cb and one Cr value. The Cb and Cr values shall be sampled at the location of the first of the two Y values. For each Row of Pixels, the first Cb and Cr samples shall be at the location of t sample. The next Cb and Cr samples s the location of the third Y sample.

3. The YBR_PARTIAL_422 equal to the YBR_FULL_422 except that:

a. black corresponds to Y = 16.

b. Y is restricted to 220 levels (i.e. the ma value is 235).

c. CB and CR each have a minimum valu

Formatted: Font: (Default) Times New Roman, 10 pt, Complex Script Font: Times New Roman, 10 pt

Formatted: Right, Left-to-right

d. CB and CR are restricted to 225 levels (i.e. the maximum value is 240).

f. lack of color is represented by Cb and Cr equal to 128.

In the case where bits allocated has value of 8 then the following equations convert between RGB and YBR_PARTIAL_422 Photometric Interpretation.

$$Y = +.2568R + .5041G + .0979B + 16 \quad \ldots\ldots (11)$$

$$Cb = -.1482R - .2910G + .4392B + 128 \quad \ldots\ldots (12)$$

$$Cr = +.4392R - .3678G - .0714B + 128 \quad \ldots\ldots (13)$$

4. The YBR_PARTIAL_420 equal to the same as YBR_PARTIAL_422 except that the CB and CR values are sampled horizontally and vertically at half the Y rate and as a result there are four times less Cb and Cr values than Y values, versus twice less for YBR_PARTIAL_422.

5. The YBR_ICT (Irreversible Color Transformation) equal to pixel data represent a color image described by one luminance (Y) and two chrominance planes (Cb and Cr). This photometric interpretation may be used when samples per pixel has a value of 3. Black is represented by Y equal to zero. The absence of color is represented by both CB and CR values equal to zero. Regardless of the value of bits allocated, the following equations convert between RGB and Y, CB, CR photometric interpretation.

$$Y = +.29900R + .58700G + .11400B \quad \ldots\ldots (14)$$

$$Cb = -.16875R - .33126G + .50000B \quad \ldots\ldots (15)$$

$$Cr = +.50000R - .41869G - .08131B \quad \ldots\ldots (16)$$

6. The YBR_RCT (Reversible Transformation) equal to pixel data r color image described by one luminanc two chrominance planes (Cb and photometric interpretation may be u samples per pixel has a value of 3. represented by Y equal to zero. The a color is represented by both Cb and Cr va to zero. Regardless of the value of bits the following equations convert between YBR_RCT photometric interpretation [9].

$$Y = (R + 2G + B) / 4 \quad \ldots\ldots$$

$$Cb = B - G \quad \ldots\ldots$$

$$Cr = R - G \quad \ldots\ldots$$

Matlab Evaluation

The application called color spaces used v color spaces analysis. It contains RGB representation and resolution (256 x 256 p 24 bit color depth). For our example we ta Irreversible Color Transformation(YBR_I standard to convert between RGB and Y,C color spaces by matlab works[10] with inpu picture intersecting regions (**Figure 3**) .

Results

We can see the output pictures are e with different transformation first Y,Cb&Cr (Figure 3a,b&c), then the pictures inverse to (RGB) repr (Figure 3d,e&f) and this combination car saturation brightness (HSB) (Figure 3g,h three planes contain the hue, saturation, components for the image. All picture and transformed) are displayed on the scr

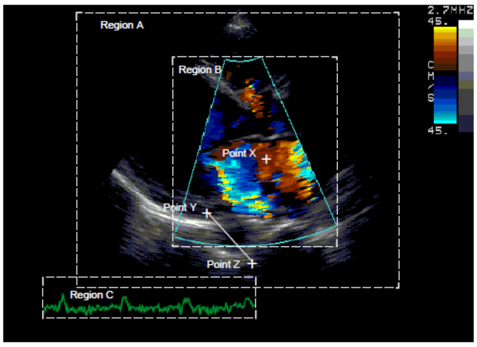


Figure (3) intersecting regions (full color).

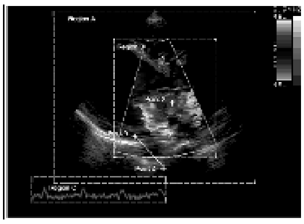


Fig.3a) Luminance Y.

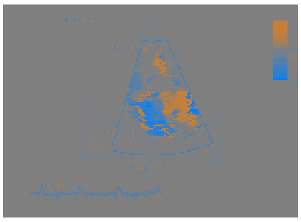


Fig.3b) Blue Chrominance Cb.

Fig.3c) Red Chrominance Cr.

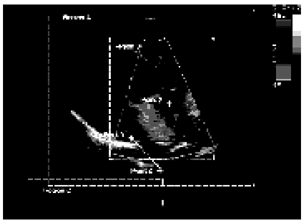


Fig.3d) Inverse Y.

Fig.3e) Inverse Cb.

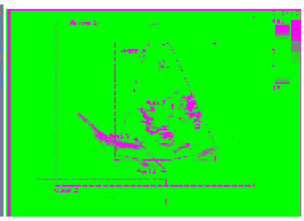


Fig.3f) Inverse Cr.

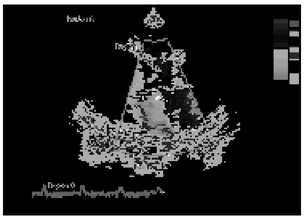


Fig.3g) Y in HSV

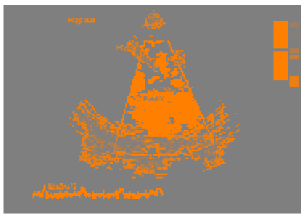


Fig.3h) Cb in HSV

Fig.3i) Cr in HSV

Discussion

The RGB color space is widely used throughout computer graphics. Red, green, and blue are three primary additive colors and are represented by a three-dimensional, Cartesian coordinate system. The YCbCr color space was developed as part of a world-wide digital component video standard. YCbCr is a scaled and offset version of the YUV color space. Y is defined to have a nominal 8-bit range of 16–235, Cb and Cr are defined to have a nominal range of 16–240, DICOM had chosen this color space representation to his medical color Standards to be easy converted to the non-DICOM-

Standards and reverse .our work in Matlab application prove that with different transformation between color spaces.

Conclusions

The DICOM standard has achieve universal level of acceptance amongs imaging equipment vendors and organizations. This Standard has been with an emphasis on diagnostic medical i practiced in radiology, cardiology ar disciplines; it is also applicable to a wid image related information exchanged in c other medical environments, it addr exchange of digital information betwee imaging equipment and other systems such equipment may interoperate w medical devices, the scope of this Standar overlap with other areas of medical infor the analyses of digital image (format ,ba is very important to convert from a non DICOM standard.

References:

[1] Foley J., A. van Dam, Fejner S. Hughes J., Computer graphics - principles and practice, Second edition, Addison-Wesley, 1996.
[2] National Electrical Manufacturers Association, Virginia 22209 USA, 2010.
[3] Digital Imaging and Communications of Medicine (DICOM) Part 1: Introduction and Overview. National Electrical Manufacturers Association. 2006.
[4] J. Keith. Video Demystified. A Handbook for the Digital Engineer. Newnes, 2004.
[5] K.N. Plataniotis, A.N. Venetsanopoulos. Color Image Processing and Applications. Springer, Berlin, Germany, 2000.
[6] M. Tkalčič, J. F. Tasič. Color perceptual, historical and ap background. In Eurocon 2003.
[7] J. Melo. Colorimetry and Color S TV Technique. Bachelor Thesis, Brno of Technology, 2006 (in Czech).
[8] R.C. Gonzalez. Digital Image Proce ed., Addison- Wesley, Reading, Mas 2002.
[9] Rumen Rusev A Module for Visualiz Analysis of Digital Images in DIC Format2009.
[10] John Wiley & Sons, Poynton, Technical Introduction to Digital Video1

Assistant Lecturers Electrical Eng. Dept. Univ Tikrit.

Formatted: Font: (Default) Times New Roman, 10 pt, Complex Script Font: Times New Roman, 10 pt

Formatted: Right, Left-to-right