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Analysing Image Quality via Color Spaces

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Abstract

Color space is the mathematical representation of a set of colors. A large amount of color spaces have been proposed for different purposes. But the RGB color space is a basic and widely used color space, and other color spaces are usually defined by transformation of the RGB color space. This paper focuses on the application of Other color spaces in images by transforming the RGB color space. Also a statistical analysis of the sensitivity and consistency behavior of objective image quality measures are performed. So that resulting the image qualities can be decided that which Color space is better without the interference of RGB color space.

Keywords: Color Space, Image Quality, *RGB color space.*

1. Introduction

Color is the brains reaction to a specific optical input signals from the eye. The retinas in our eyes though have three types of color receptors in the form of cones. We can actually only detect three of these visible colors - red - blue and green. These colors are called primary color space. In this three colors that are mixed in our brain to create several different "sensations" of the color. These sensations have been defined by the CIE different Measuring Color like Brightness, Hue, Colorfulness, Lightness, Chroma, and Saturation. So this measuring color combination to produce the different color space from primary color space.

A color space is a method of representing each color in terms of a combination of several numeric values. It is a method by which we can specify, create and visualize color. Different color spaces are better for different concerned applications. Now days we can use several color space. Some of the color spaces are,RGB, CMY,XYZ,xyY,|1|2|3|,UVW,LSLM,L*a*b,L*u*v, LHC,LHS,HSV,HSI,YUV,YIQ,YCbCr. All these color spaces under the category of **primary spaces:** It is based on the trichromatic theory which states that any color can be expressed as a mixture of three primaries. **Luminance-chrominance:** It represents colors in terms of luminosity and two chromaticity components. **Perceptual spaces**: It is based on the human visual system and commonly strives for being perceptual uniform. **Independent axis spaces**: It results from other spaces by applying mathematical operations that aim at decor relating individual components.

This work proposes that, RGB color space are transformed into different color spaces and applied in images. Next, separate images have to be analyzed, to find the certain image quality factors. Image qualities should be better with another that color space is good. The impact of this proposed work is all are known RGB is the first and best color space. But what is the next color space we are not known. In this proposed work to analyze which color space better and provide rank of color space depends upon the quality factors. This work is an extension of Jian Yang, ChengjunLiu, and LeiZhang which used Color space normalization techniques used in face recognition. Here, we introduce the new method for color space apply in whole image and detect the quality of the image. In the general way, the simplicity of implementation, the low processing cost and the high quality of results can be considered as the main contributions of our work. Also, we verified that our methods are more robust than other implemented methods.

This paper is organized as follows. In Section 2 we present a related works. In Section 3 we propose a color space conversion. In Section 4 we propose a quality measures to find the image quality. In section 5 gives my proposed works in this paper. In Section 6 we report on a experimental analysis for both color space conversion result and comparative analysis for all color spaces. Some conclusions and a summary of future works are given in Section 6.

2. Related Works:

Jian Yang, ChengjunLiu, LeiZhang paper presents the concept of color space normalization (CSN) and two CSN techniques for enhancing the discriminating power of color spaces for face recognition. The experimental results reveal that some color spaces, like RGB and XYZ, are relatively weak for recognition, where as other color spaces, such as I1I2I3, YUV, YIQ and LSLM, are relatively powerful.

İsmail Avcıbas, Bülent Sankur statistical analysis of the sensitivity and consistency behavior of objective image quality measures. We categorize the quality measures and compare them for still image any applications. The measures have been categorized into pixel difference-based, correlation-based, edge-based, spectral-based, context-based and HVS-based (Human Visual System-based) measures.

3. Color space conversion

Color space conversion is the translation of the representation of a color from one basis to another. This typically occurs in the context of converting an image that is represented in one color space to another color space, the goal being to make the translated image look as similar as possible to the original. All the image get color information from which contains only RGB values. In the RGB color space each color appears as a combination of red, green, and blue. RGB is a basic color space for computer graphics because color displays use red, green, and blue to create the desired color. This model is called additive, and the colors are called primary colors. Basically the color space value of RGB is to be known for formulating the other color space conversion. In this paper we concentrate following color space conversion.

3.1. RGB to YIQ conversion

The YIQ color space was formerly used in the National Tele-vision System Committee (NTSC) television standard. The Y component represents the luma information, and is the only component used by black-and-white television receivers. I and Q represent the chrominance information. The YIQ system, which is intended to take advantage of human color-response characteristics, and can be derived from the corresponding RGB space as follows.

$$\begin{aligned} Y &= 0.299 \times R + 0.587 \times G + 0.114 \times B \\ I &= 0.596 \times R - 0.274 \times G - 0.322 \times B \\ Q &= 0.212 \times R - 0.523 \times G + 0.311 \times B \end{aligned}$$

3.2. RGB to XYZ conversion

The XYZ color space was derived from a series of experiments in the study of the human perception by the International Commission on Illumination.The transformation from the RGB color space to the XYZ color space is as follow

$$X = 0.618R + 0.177G + 0.205B$$

$$Y= 2.299R + 0.587G + 0.114B$$

$$Z=0.56G+ 0.944B$$

3.3. RGB to HSI conversion

HSI means Hue ,Saturation ad Intensity for human perception. It represents color s similarly how the human eye senses colors.The conversion starts form RGB to HIS as follows. First, we compute chroma, by multiplying saturation by the maximum chroma for a given lightness or value. Next, we find the point on one of the bottom three faces of the RGB cube which has the same hue and chroma as our color (and therefore projects onto the same point in the chromaticity plane). Finally, we add equal amounts of *R*, *G*, and *B* to reach the proper lightness or value.

$$\begin{cases} H = arctan(\frac{\beta}{\alpha}) \\ S = \sqrt{\alpha^2 + \beta^2} \\ I = (R+G+B)/3 \end{cases}$$

with

$$\begin{cases} \alpha = R - \frac{1}{2}(G+B) \\ \beta = \frac{\sqrt{3}}{2}(G-B) \end{cases}$$

3.4. RGB to YCbCr conversion

It is used as a part of the color image pipeline in video and digital photography systems. Y is the luma component and C_B and C_R are the blue-difference and red-difference chroma components. The equations of the RGB to YCbCr are formed in a way that rotates the entire nominal RGB color cube and scales it to fit within a (larger) YCbCr color cube.

$$\begin{aligned} Y &= 0.2989 \times R + 0.5866 \times G + 0.1145 \times B \\ Cb &= -0.1688 \times R - 0.3312 \times G + 0.5000 \times B \\ Cr &= 0.5000 \times R - 0.4184 \times G - 0.0816 \times B \end{aligned}$$

3.5.RGB to L*a*b

It is more often used as an informal abbreviation for the **CIE 1976 (*L**, *a**, *b**) color space** , whose coordinates are actually (*L**, *a**, and *b**). The color spaces are related in purpose, but differ in implementation. *Perceptually uniform* means that a The L*a*b* color space includes all perceivable colors which means that its gamut exceeds those of the RGB and CMYK color models. One of the most important attributes of the L*a*b*-model is the device independency. This means that the colors are defined independent of their nature of creation.

$$\begin{cases} L^* = 116\left(\frac{Y}{Y_0}\right)^{\frac{1}{3}} - 16 & \text{if } \frac{Y}{Y_0} > 0.008856 \\ L^* = 903.3\left(\frac{Y}{Y_0}\right) & \text{if } \frac{Y}{Y_0} \le 0.008856 \\ a^* = 500\left[f(\frac{X}{X_0}) - f(\frac{Y}{Y_0})\right] & \\ b^* = 200\left[f(\frac{Y}{Y_0}) - f(\frac{Z}{Z_0})\right] & \end{cases}$$

with

$$\begin{cases} f(U) = U^{\frac{1}{3}} & \text{if } U > 0.008856 \\ f(U) = 7.787U + 16/116 & \text{if } U \le 0.008856 \end{cases}$$

and

$$U(X,Y,Z) = \frac{4X}{X+15Y+3Z} \quad \text{et} \quad V(X,Y,Z) = \frac{9Y}{X+15Y+3Z}$$

4. Quality Measures

Conversion of an image in each color space the quality may be differing from one color space to other depending on the color space. In the case of conversion image, it is important to reproduce the image close to the original image so that even the smallest details are readable. Conventional measures are designed to quantify the error, sensitivity between the original image and the converted one, while keeping most of the signal characteristics intact. Imaging systems may introduce some amounts of distortion or artifacts in the signal, so the quality measures are an important problem. There are several techniques and metrics that can be measured objectively and automatically evaluated by a computer program. Therefore, they can be classified as full-reference (FR) methods and no-reference (NR) methods. In FR image quality assessment methods, the quality of a test image is evaluated by comparing it with a reference image that is assumed to have perfect quality. NR metrics try to assess the quality of an image without any reference to the original one. In this paper we are using FR methods to measure the quality from original RGB color space Image to Converts Other color spaces images.

4.1 Mean Square Error

In the image processing the most frequently used measures are deviations between the original and reconstructed images of which the mean square error (MSE) or signal to noise ratio (SNR) being the most common measures. The reasons for these metrics widespread popularity are their mathematical tractability and the fact that it is often straightforward to design systems that minimize the MSE but cannot capture the artifacts like blur or blocking artifacts. The effectiveness of the coder is optimized by having the minimum MSE at a particular conversion. Calculated MSE in color space image into original image to use the Table(1).

4.2 Peak signal-to-Noise Ratio

Larger SNR and PSNR indicate a smaller difference between the original (without noise) and reconstructed image. The main advantage of this measure is ease of computation but it does not reflect perceptual quality. An important property of PSNR is that a slight spatial shift of an image can cause a large numerical distortion but no visual distortion and conversely a small average distortion can result in a damaging visual artifact, if all the error is concentrated in a small important region. This metric neglects global and composite errors PSNR is calculated using Table(1).

4.3 Average Difference

A lower value of Average Difference (AD) gives a “cleaner” image as more noise is reduced and it is computed Using Table(1)

4.4 Maximum Difference

Maximum difference (MD) is calculated using Table(1) and it has a good correlation with MOS for all tested conversion images so this is preferred as a very simple measure as a reference for measuring conversion image quality in different color spaces. Large value of MD means that the image is of poor quality.

4.5 Normalized Correlation

The closeness between two digital images can also be quantified in terms of correlation function. These measures measure the similarity between two images like a original color space in the image other one converted color space image, hence in this sense they are complementary to the difference based measures. All the correlation based measures tend to 1, as the difference between two images tend to zero. As difference measure and correlation measures complement each other, minimizing Distance measures are maximizing correlation measure and Normalised Correlation is given Table(1).

4.6 Normalized Absolute Error

Normalized absolute error computed by table(1) is a measure of how far is the conversion image from the original image with the value of zero being the perfect fit . Large value of NAE indicates poor quality of the image.

4.7 Structural Content

Correlation, a familiar concept in image processing, estimates the similarity of the structure of two signals. This measure effectively compares the total weight of an original signal to that of a coded or given. It is therefore a global metric; localized distortions are missed .This measure is also called as structural content. The Structural content is given by Table(1) and if it is spread at 1, then the converted image is of better quality and large value of SC means that the image is poor quality .

Table 1. Picture quality measures

Mean Square Error	$MSE = \frac{1}{MN}\sum_{j=1}^{M}\sum_{k=1}^{N}\left(x_{j,k} - x'_{j,k}\right)^2$
Peak Signal to Noise Ratio	$PSNR = 10\log\frac{(2^n-1)^2}{MSE} = 10\log\frac{255^2}{MSE}$
Normalized Cross-Correlation	$NK = \sum_{j=1}^{M}\sum_{k=1}^{N} x_{j,k}\cdot x'_{j,k} \Big/ \sum_{j=1}^{M}\sum_{k=1}^{N} x_{j,k}^2$
Average Difference	$AD = \sum_{j=1}^{M}\sum_{k=1}^{N}\left(x_{j,k} - x'_{j,k}\right) \Big/ MN$
Structural Content	$SC = \sum_{j=1}^{M}\sum_{k=1}^{N} x_{j,k}^{\;2} \Big/ \sum_{j=1}^{M}\sum_{k=1}^{N} x'^{\;2}_{j,k}$
Maximum Difference	$MD = Max\left(\left\lvert x_{j,k} - x'_{j,k}\right\rvert\right)$
Normalized Absolute Error	$NAE = \sum_{j=1}^{M}\sum_{k=1}^{N}\left\lvert x_{j,k} - x'_{j,k}\right\rvert \Big/ \sum_{j=1}^{M}\sum_{k=1}^{N}\lvert x_{j,k}\rvert$

5. Methodology

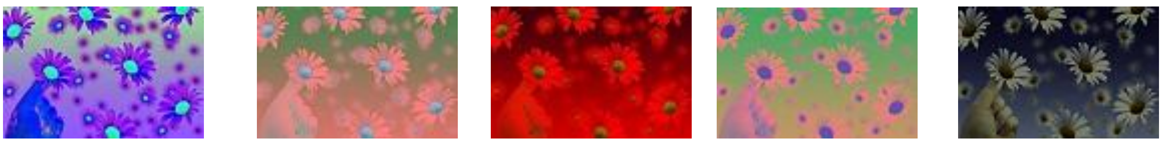
Hundred images, twenty images each in RGB to YIQ color space, RGB to YCbCr color space , RGB to HSI color space , RGB to L*a*b color space and RGB to XYZ color space, of size converted each image equal size for the analysis. The conversion ratio and other quality measures are computed using the original and coded images. In an our analysis original image is RGB color space image and converted other color space image. If the quality of the image should be calculated above quality measure for each color space along with the image. So we obtain the quality wise image for each color space ,the high quality of the image should be identified. That image color space better for other color spaces. In this proposed techniques we are conversion from five color spaces each color space calculated quality measure.

6. Result and Discussion

6.1 Experimental Results:

In this section, we show the result for RGB color space into different color spaces applying for original image.

Figure 1: Original RGB color space Image



RGB to HSI RGB to L*a*b RGB to YIQ RGB to YCbCr RGB to XYZ

Figure 2: Conversion of other color space Images

6.2.Comparative Analysis Result:
Table 2.gives computed values of the Conversion different color space values and other objective quality measures obtained.
Conversion from RGB color space into

7. Discussions and Conclusions:

The conversion ratio for RGB to YIQ color space, RGB to YCbCr color space, RGB to HSI color space, RGB to L*a*b color space and RGB to XYZ color space obtained MSE and PSNR image quality factor is better in RGB to L*a*b color space the result is 7308.84 for MSE and 9.49 PSNR with low value indicates a good quality image and that is observed with the value. Average difference of the each color space is varying from one to other color spaces. The RGB to L*a*b color space obtained value is very low for 5.02 so the result gives a "cleaner" image as more noise is reduced and better quality of the image.

The Structural content result smaller value of SC means that the image is good quality . In an our result obtained SC value is 1.00 in RGB to L*a*b color space is smaller value. So in SC depends upon the Image quality better color space is RGB to L*a*b.Large value of Normalized Absolute Error indicates poor quality of the image. In an our result obtained NAE value is 0.17 in RGB to L*a*b color space is smaller value so better quality. Also in NAE depends upon the Image quality better color space is RGB to L*a*b.So our main contribution result is overall image applied any color spaces is better quality obtained for RGB to L*a*b.

From this work, we observed that the color space conversion present an perfect image quality for each color space and basis for future developments such as: (i) we are implemented only 5 color space from RGB color spaces; but now a days there are several color spaces used .so convert all the color space from the RGB color space that is more effective (ii) we are implemented only some quality measure to find the quality of the image, so implemented different quality factor to be used in future enhancement and obtain the better quality result.

References:

[1] Rafael C. Gonzales. Digital Image Processing. Tom Robbins, 2 edition, 2002.
[2] Users Guide Statistics Toolbox 7. MathWorks Matlab. MathWorks Matlab, 2010.
[3] Jian Yang , ChengjunLiu , LeiZhang ,2009," Color space normalization: Enhancing the discriminating power of color spaces for face recognition".
[4] I. Avcibas, B. Sankur, K. Sayood, "Statistical Evaluation of Quality Measures In Image Compression", J. of Electronic Imaging, (in review).
[5] Adrian Ford and Alan Roberts August 11, 1998(b)," Colour Space Conversions".
[6] Bauer S., Zovko-Cihlar B. and Grgic M. (1996a) 'Objective and Subjective Evaluations of Picture Quality in Digital Video Systems',Multimedia Technology and Digital Communication Services, ICOMT 1996, pp. 145-150.
[7] Hamid Rahim Sheikh, Muhammad Farooq Sabir and Alan C. Bovik (2006) 'A statistical evaluation of recent full reference image quality assessmentalgorithms', IEEE Trans Image Processing, Vol. 15, No. 11, pp. 3440-3451.
[8] Richard Dosselmann and Xue Dong Yang (2005) 'Existing and emerging image quality metrics', CCECE/CCGEI, pp. 1906-1913.
[9] Sonja Grgic, Mislav Grgic and Branka Zovko-Cihlar (1996) 'Objective and subjective measuruments for video compression system',Proceedings of the International Conference of Multimedia Technologies, ICOMT 1996, pp. 145-150.
[10] Tomas Kratochvil and Pavel Simicek (2005) 'Utilization of MATLAB for picture quality evaluation', Institute of Radio Electronics, Brno University of Technology, Czech. Republic.

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