White Balancing to Minimize the Color Cast in Camera Caused by Illuminants

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Abstract

A mobile phone with an internet connection is used for many applications. Many investigations are based on color detection. In biomedical applications, for example, the color of nails can help to detect diseases but due to lighting conditions, a camera image can show a healthy nail looking unhealthy and vice versa. Also white balancing is required for many digital pathology tests. It is important to improve the camera functionality, especially on illuminant and white balance to remove unrealistic color casts. Also, digital cameras linearly perceive light whereas the human visual system is in a logarithmic fashion. The Hue Saturation Intensity (HSI) model, a useful tool for creating algorithms based on color descriptions and the logarithmic structure of light perception, is correlated in this study. Saturation of original and processed images is calculated and the difference in values at different temperatures shows that log- transformed image has less effect of change in illuminants. Existing modes are unable to satisfy the individual needs of the users. This work proposes a method on an individual image basis.

Keywords: *Hue Saturation Intensity (HSI) Model ;Human Visual System; Log transformed image; Biomedical application; White balance.*

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1Introduction

Human Eye works in a logarithmic fashion whereas the camera doesn't. Similar to how a camera lens concentrates light onto film, the cornea in the eye directs light onto the retina, a light-sensitive membrane [1,2]. The human eye works in a non-linear fashion whereas the camera is linear. Thus, to eliminate the difference between the image seen by the observer and the image taken by the camera, various research methods and techniques are going on in the field of digital image processing. This process is sometimes also referred to as image enhancement techniques. Giving the best enhance the digital image with fine details without contamination of data in the original image is essential and becomes a top priority, especially in many investigations based on color detection. These fields are biomedical image analysis, autonomous navigation, satellite data interpretation, and so on. Many factors create problems while enhancing the input raw images such as the type of input images, different elements such as reflectance and illuminance of an image,and environmental and lighting conditions.

One of the most basic estimating techniques is the gray world. Its fundamental principle is that in a typical, properly color-balanced image, the mean of all the colors is a neutral gray [5]. The existing methods such as Fourier transform, Logarithmic Enhancement, Alpha Rooting [6] are used in different temperatures (in Kelvin) images and their effect on these images were observed. Based on the detection and adjustment of the white point, [7] this work derives a connection between color temperature and white balance. In [8] author suggested a method for estimating the illumination that accounts for both internal illumination and each image pixel. An average of all the pixels is weighted to determine the estimate. The degree of gray determines a pixel's weight. In the YC_bC_r color space, a pixel's chroma C_b and C_r are used to determine how gray it is. Since the camera gain and exposure duration may be changed simultaneously, the simulated annealing white balance algorithm [9] based on the regression equation enhances performance. This enables more effective camera white balance modification.

Combining the gray world approach and the iterative gray point detection method [10] is used an illuminant estimation using a low-level statistics- based method, and image correction using a linear transformation method in digital pathology applications related to biomedical. In [11], utilization of the availability of two rear-facing cameras, which are frequently used in the design of contemporary smartphones, to carry out illumination estimates is discussed to take advantage of the variances in spectral sensitivity between the two cameras. Unlike ordinary camera AWB modules, which need illuminant estimation, the method [12] deviates significantly from conventional AWB. It suggests that the collected scene be rendered using a limited number of specified white-balance parameters. The technique teaches estimation for the weighting maps needed to blend the rendered images to produce the final corrected image from this batch of generated images. [13] Provide a new framework that enables interactive WB adjustment by directly connecting the nonlinear way of color-mapping methods to user-selected colors.

In this paper to understand the functionality in comparison with the human eye and the image captured by the camera, experiments are performed. The images are captured by the camera at different temperatures (K), the effect of temperatureis seen on these images whereas when seen by the human eye it is minimized. To understand why this happens, why the effects of temperature are minimized in the human eye, making things feel so realistic by the human vision. Different experiments on images were performed which are termed as "original images" taken at different temperatures (2400, 4000, 6500 in Kelvin) respectively. Because the human eye works logarithmically we have applied natural log on different temperatures (in Kelvin) image. The aim was to understand the effect of logarithmic transform on these images and how tofurther improve it. Further it is proposed that the log to the base 2 function works better in the enhancement of the image than the natural log function. Table 1 shows the effect of saturation on images taken at different temperatures.

2Proposed Methodology

Choosing the Optimal Technique for Image Enhancement

Figure 1 enlightens the procedure for finding the best logarithmic method for image enhancement. Natural log transform and log base 2 transform are applied to the input image. It is observed that quality of image is better in case of log base 2 transform. This transform is selected for further experimentation. These images are shown in Figure 3.

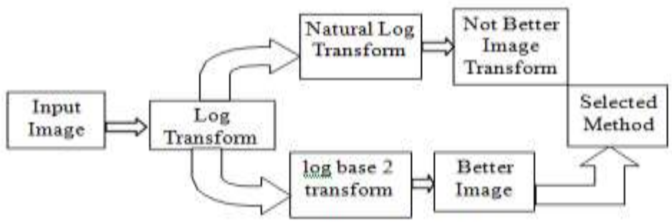


Figure 1: Optimal Technique for image Enhancement

Examining the impact of the proposed approach on the HSI model (especially on saturation values)

As performance of HSI model is near to Human Visual System, in this work HSI values of input image and transformed image are calculated and difference of saturation value at different temperatures is computed. Figure 2 shows the process of finding the changes in saturation values from the original to log 2 images, and there is a difference in temperature range 2700K-4000K, 4000K- 6500K.

Steps of proposed approach:

1. Calculate H,S,I value of input images at different temperature i.e. at 2700K, 4000K and 6500 K
2. Calculate H,S,I value of log transformed images at different temperature i.e. at 2700K, 4000K and 6500K
3. Difference between the saturation values at temperatures 2700-4000 and 4000-6500 is calculate for original image
4. Difference between the saturation values at temperatures 2700-4000 and 4000-6500 is calculate for log transformed image.
5. Comparison of difference values of saturation for original and log transformed images.

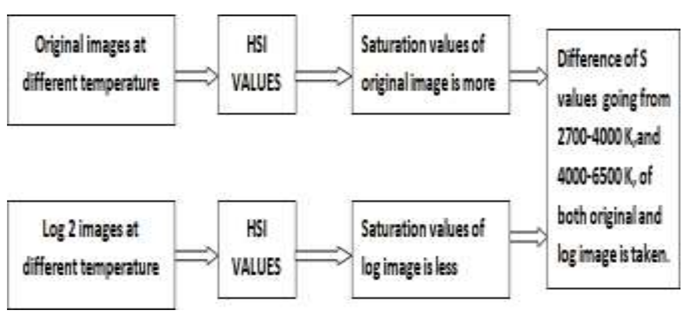


Figure 2: Analysis of change in saturation values with increase in temperature.

3 Experimental Setup and Results

Experimental Setup

The experimental setup uses the Samsung Galaxy Neo mobile digital still camera with a 5 Mp (Megapixels) back camera. The pixel density is 187 ppi (pixel per inch) for the digital still camera. All the images are taken at ISO Auto mode in the camera. The images are taken under different light conditions by a single bulb light source. So, for the test scenes, a single light source of the brand Surya NEO LED lamp is used, which has three different modes of temperature in Kelvin respectively. These three temperatures are 2700 K, 4000 K, 6500 K. Each temperature has its luminance (lm). The temperature with 2700 K has 800 lm, 4000 K has 950 lm, 6500 K has 900 lm. The Surya NEO LED contains 50 Hz, 10 Watt, and 220- 240 volts.

Result Analysis

The method which is applied together and the analysis is done in the post-study gives interesting findings of the application of different log functions on the images and the effect of the log 2 function on HSI model.

(a) (b) (c)

Figure 3: (a)Input image (b)Log transform image (c)Log base 2 transform image

Figure 3 shows the results of the effects of Log images on the input images taken at different temperatures.a)From top to bottom: input image at 2700 k, 4000 K, 6500 K. b) Log image, c) Log 2 image

Application of different Log transform on Image

In this experiment, images of the same object were taken and different log functions were applied to these images. The original input image taken at temperatures (2700K, 4000K, 6500K) is applied to the natural log and its results were observed. Then to find the best enhance image log to the base 2 is proposed. This was done to provide a better visual effect of the image. And in the last, the image with the power raised to power 2 was done and it was observed that the image has gone to the darker shade. After performing this experiment, it was observed that Log 2 gives better image enhancement to the original input image.

H, S, I Analysis at Different Temperatures

This paper aims to enhance the image taken at different temperatures (Kelvin) with the help of the log to the base 2 functions. The HSI model is a crucial and alluring color representation because it mimics how the human eye perceives color. H, S, I values for images are calculated at different temperatures. It is found that for most images change in the hue (H) component is negligible and brightness (I) is constant for some images. As the saturation (S) gives a measure of the degree to which a pure color is diluted by white.

The difference in saturation values of original images and transformed images for temperature increase is calculated and it shows that for log-transformed images difference is less as compared to original images. In this

section Table 1. shows H,S, I values for original images, and Table 2. shows H, S, I values for log-transformed images.
Then the difference in saturation for the rise in temperature for original images and log-transformed images is calculated as shown in Table 2. When compared it has been observed that the difference in Saturation (S) is less for log transformed images than the Original Image. Moreover, the resultant images are more enhanced when taken log to the base 2 functions.

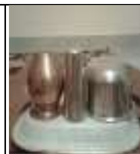
 **BAG IMAGE**	 **UTENSILSIMAGE**	 **PLASTIC STOOL IMAGE**
Pixel value1792* 1792	**Pixel value1452*1452**	**Pixel value1536*1536**
Temperature 2700		
H= 0.0833	H= 0.0386	H= 0.0303
S= 0.0662	S= 0.2027	S= 0.0571
I= 0.5333	I= 0.2902	I= 0.1373
Temperature 4000		
H= 0.9614	H= 0.0334	H= 0.8333
S= 0.0254	S= 0.1733	S= 0.1429
I= 0.2575	I= 0.2941	I= 0.1281
Temperature 6500		
H= 0.0763	H= 0. 0667	H= 0.1735
S= 0.1570	S= 0. 1449	S= 0.1735
I= 0.1582	I= 0.2797	I= 0.1281

Table 1*:* H, S, I components of original images at different temperature

Table 2: H, S, I components of Log transformed images atdifferent temperature

BAG IMAGE	**UTENSILS IMAGE**	**PLASTIC STOOL IMAGE**
Pixel value 1792*1792	**Pixel value1452*1452**	**Pixel value1536*1536**
Temperature 2700		
H= 0.0844	H= 0.0404	H= 0.0305

S= 0.0541	S= 0.1797	S= 0.0536
I= 157.8026	I= 93.7098	I= 47.4920
Temperature 4000		
H= 0.9612	H= 0.0348	H= 0.8333
S= 0.0227	S= 0.1531	S= 0.1352
I= 84.6226	I= 94.9088	I= 44.4942
Temperature 6500		
H= 0.0773	H=0.0682	H= 0.9075
S= 0.1467	S= 0.1291	S= 0.1642
I=54.1731	I= 90.9564	I= 44.4734

It was observed that when temperature changes from 2700 to 4000 K and 4000 – 6500K, the changes in the values of S for Log transformed image are less as compared to the original image, differentiation of values is taken as the modulus value.

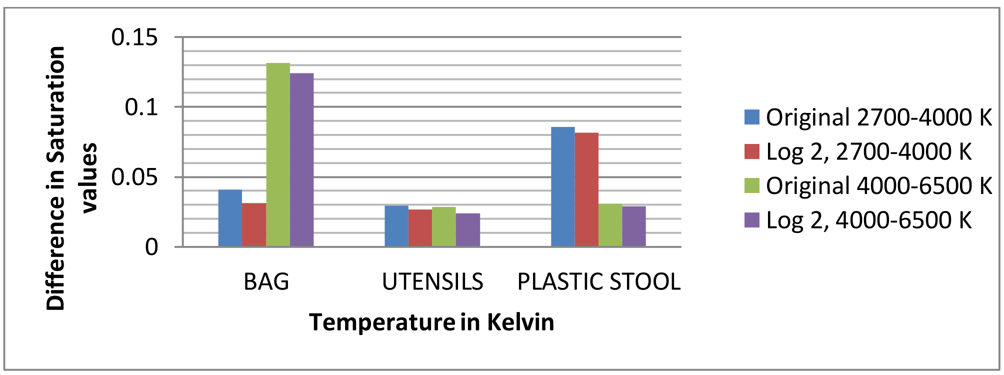


Figure 4: Comparison of saturation values.

Figure 4 represents the difference in saturation values of the original image and log-transformed image at different temperatures. The x-axis represents the temperature and the y-axis represents the difference in saturation values. For the utensils image and plastic stool image saturation value for the log, the image decreases with an increase in temperature. In the case of the Bag image when the temperature changes from 4000K to 6500K saturation value increases.

4 Conclusion

In this paper, the method for better illumination and visual effect of the input images is represented and is taken at different temperatures in Kelvin. The human eye works in a logarithmic fashion, so for the best enhance images using log transform to the base 2 gives a better result. Saturation is a key element and an important factor for any image. It was observed that there is a reduction in the values of saturation taken from input images and log transformed images at different temperatures. It is concluded that the effect of source temperature on the log transformed image is less as compared to the original image. The proposed method can be applied to biomedical applications where white balancing is important.

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Biography of Author

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