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IMPROVED GRAY WORLD BASED COLOR CORRECTION USING ADAPTIVE HISTOGRAM EQUALIZATION ON L*A*B COLOR SPACE

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Abstract: ***The color constancy is a process that evaluates the control of dissimilar illumination sources on a digital image. The image captured by a camera based on three issues: the objective content of the view, the light incident on the scene, and the features of the camera. The goal of the computational color constancy is to account for the result of the illuminate. Various traditional methods as Grey-world method, Max RGB and learning-based method were used to estimate the color constancy of digital images affected by illumination. All these procedure have an observable disadvantage that the illumination source across the view is spectrally identical. This statement is often desecrated as there might be multiple light sources illuminating the view. For example, both indoor and outdoor light sources can affect the indoor sense, each having different spectral influence distributions. The overall objective of this paper is to propose a new improved gray world algorithm which will use adaptive histogram equalization on L*A*B color space to enhance the results of color constancy further. To validate the proposed algorithm the design and implementation of the proposed algorithm will be done in MATLAB using image processing toolbox.***

INDEX TERMS: COLOR CONSTANCY, ILLUMINATES, LIGHT SOURCE, GRAY WORLD AND NON LOCAL MEANS.

1. INTRODUCTION

An image [1] of a three-dimensional view depends on a number of factors. First, it depends on the physical properties of the imaged things, that is on their reflectance properties. But, it also depends on the form and direction of these objects and on the position, intensity, and color of the light sources. Finally, it depends on the spectral sampling properties of the imaging tool. It is [2] renowned that color is a dominant cue in the distinction and identification of objects. Segmentation based on color, rather than just intensity, provides a broader set of bias between material margins. Modelling the physical procedure of color image formation provides a sign to the object-specific parameters. To decrease some of the difficulty intrinsic to color images, parameters with recognized invariance are of prime importance. Existing methods for the measurement of color invariance need a fully sampled spectrum as input data usually derived by a spectrometer. The perceived color [3] of a surface depends on its spectral reflectance properties the amount of incident illumination reflected at each wavelength of the spectrum mediated by the long, medium, and short wavelength sensitive cone receptors of the eye. But, if a surface is regular and presented in isolation in a shady field, it is not possible to tell whether its perceived color is due to its own reflecting properties or to the spectrum of the illuminating illumination: a red piece of paper in white light can look the same as a white piece of paper in red illumination. The straightest approach [3] for measuring the, perceived surface color experiment; whether color names are used properly or not? Although the terminology is normally constrained to certain basic color terms or categories, the principle is common. For example, subjects given a free selection of names might label a surface with a strong light blue color under one illuminates as open blue. The level to which color constancy holds can then be determined by measuring how correctly they use the label copen blue for the similar surface under a dissimilar illuminant. The second major approach to measuring perceived surface color tests how well subjects can make matches between colored surfaces beneath different lights. Color constancy [4] is the capability to identify colors of objects invariant of the color of the illumination source. It commonly consists of two steps. Firstly, the illumination source color is estimated from the image statistics. Secondly, illuminant invariant descriptors are computed, which is usually completed by adjusting the image for the color of the light source such that the object colors look like the colors of the objects under a known light source. A straightforward color constancy technique, called max-RGB, estimates the light source color from the maximum response of the different color channels. One more renowned color constancy technique is based on the Grey-World hypothesis, which assumes that the average reflectance in the scene is achromatic. Although more detailed algorithms exist, methods like Grey-World and max RGB are still generally used because of their low computational costs. They have pursued color constancy by the Grey Edge hypothesis, which assumes the average edge difference in the scene to be achromatic. The technique is based on the surveillance that the division of color derivatives exhibits the biggest variation in the light source path. The average of these derivatives is used to estimate this path.

$$\left(\int \frac{d^n f^\sigma(x)}{dx^n}\right)|^p dx)^{1/p} = \mathrm{k}e^{n,p,\sigma}$$

i. The order n of the image structure is the parameter determining if the method is a gray-world or a gray edge algorithm.
ii. The Minkowski norm p which determines the relative weights of the multiple measurements from which the final illuminant color is estimated. A high Minkowski norm emphasizes larger measurements whereas a low Minkowski norm equally distributes weights among the measurements.
iii. The scale of the local measurements as denoted by sigma. For first- or higher order estimation, this local scale is combined with the differentiation operation computed with the Gaussian derivative. For zero-order gray-world methods, this local scale is imposed by a Gaussian smoothing operation.

Color Constancy [7] is a phenomenon that defines the human ability to estimate the actual color of a scene irrespective of the color of illumination of that scene. Since an image is a product of the illumination that falls on the scene and the reflectance properties of the scene, attaining color constancy is an ill posed problem and various techniques have been planned to address it. Our method is based on the observation that an image of a scene, taken under colored illumination, has one color channel that has significantly different standard deviation from at least one other color channel. The standard deviations of the color channels of an image with no color cast are very alike to each other. We discover the ratio of the maximum and minimum standard deviation of color channels of local patches of an image and usage as a prior to estimate the color of illumination and achieve color constancy. In order to purify [10] the acquired image as close as possible to what a human observer would have observed if placed in the original scene, the first stage of the color correction pipeline aims to emulate the color constancy feature of the human visual system (HVS), the ability to perceive relatively constant colors when objects are lit by different illuminants. The dedicated module is usually referred to as automatic white balance (AWB), which should be able to determine from the image content the chromaticity of the ambient light and compensate for its effects. The only information available are the camera responses across the image, color constancy in as under determined problem ; and thus further assumptions and/or knowledge are needed to resolve it. Typically, some information about the camera being used is exploited, and/or assumptions about the statistical properties of the expected illuminantes and surface reflectance. Color correction methods [12] are used to compensate for illumination conditions. In human perception such correction is called color constancy the capability to perceive a relatively constant color for an object even under changing illumination. Most computer methods are pixel based, correcting an image so that its statistics fulfil assumptions such as the average intensity of the scene under neutral light is achromatic, or that for a given illuminant, there is an inadequate number of expected colors in a real world scene. Various schemes have been proposed to use features instead of pixels including higher order derivatives or homogeneous color regions. These features [12] are selected based on their probability to best characterize the illuminant color and ignore the specific color of the objects in the scene. For example, higher order derivatives are used based on the assumption that the average of reflectance differences in a scene is achromatic. However, to the best of knowledge, none of the existing methods account for the fact that even at the level of the distinct pixels, the reliability of the color information varies. Introduce the notion of color strength, a measure of color information accuracy. Color [13] is an important cue for computer vision and image processing related topics, like feature extraction, human computer interaction, and color appearance models. Colors observed in images are determined by the intrinsic assets of objects and surfaces, as well as the color of the illuminant. For a robust color-based system, the effects of the illumination should be filtered out. Color Constancy is the ability to identify the correct colors, independently of the illuminant present in the scene. Human vision has a natural capability to correct the color effects of the light source. However, the mechanism that is involved in this capability is not yet fully understood. The same process is not trivial to machine vision systems in an unconstrained scene. A sights a set of illuminated things. In common the illumination has a multifaceted spatial distribution, so that the illuminant falling on one object in the scene may vary from that falling on another. None-theless,aof use point of departure is to judge the case where the illumination is consistent across the scene, so that it may be differentiated by its spectral power distribution, $E(\lambda)$.This functions specifies how much control the illuminant contains at each wavelength. The illuminant reflects off things to the eye, where it is gathered and centered to figure the retinal image. It is the image that is openlyavailable for determining the work of art of the scene.

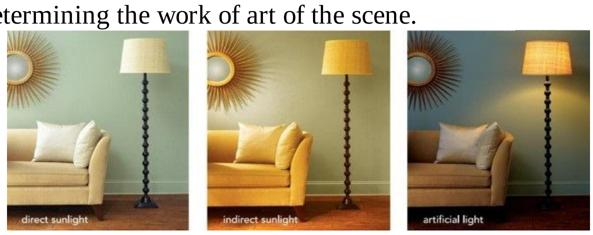

Figure 1.Image under different illuminations

However human eye has capability to exhibit color constancy to huge extent. Consider an instance concerning only lightness; get a page of black print on white paper seen initially under an indoor light and then beneathstraight sunlight i.e. achromatic illumination. The intensity of the light accomplishment the eye from the white region of the page in indoor illumination is approximately equal to the intensity of the illumination reaching the eye from the black print in daylight. In spite of this irregularfairness, the page looks white under the indoorlight and the print looks black beneathdaylight.

2. Related work

The problem of illuminant estimation [1] for given image of a sight is recorded under an unidentified light; they can recover an estimate of that light. Obtaining such an estimate is a vital part of solving the color constancy problem that is of recovering an illuminant self-governing demonstration of the reflectance in a scene. They start by determining which image colors can take place under each of a set of probable lights.For a constant visual world, the colours [3] of objects should appear the similar under different lights. This property of color constancy has been assumed to be elementary to vision, and lots of experimental attempts have been made to enumerate it.Awell-known color constancy method [4] is based on the Grey World assumption i.e. the average reflectance of surfaces in the world is achromatic. The Grey Edge hypothesis assuming that the average edge difference in a scene is achromatic. Based on this hypothesis, they projected an algorithm for color constancy.Color constancy [5] is the capability to compute colors of things independent of the color of the light source. A renowned color constancy method is based on the gray world assumption which assumes that the average reflectance of surfaces in the world is achromatic. Light, which is reflected from an object, varies with the kind of illuminant used. Nevertheless, the color of an object appears to be something like constant to a human observer. The ability to calculate color constant descriptors from reflected light is called color constancy. In order to solve the problem of color constancy, some assumptions have to be prepared.Natural scenes regularly have multiple illuminants. A room may be illuminated by artificial light as well as reflected sunlight. Even if there is only a single illuminant, the intensity of the illuminant usually varies across the image. In order to calculate color constant descriptors from the calculated data, one has to estimate the illuminant locally for each image pixel. A simple yet very efficient method is the use of local space average color.Images with color cast [7] has standard deviation of one color channel significantly different from that of other color channels. This observation is also valid to local patches of images and ratio of the maximum and minimum standard deviation of color channels of local patches is used as a prior to select a pixel color as illumination color.A color gradient [8]is presented with good color constancy preservation properties. The method does not need a priori information or variations in color space. It is naturally invariant to intensity magnitude, indicating high robustness against bright spots produced be specular reflections and dark regions of low intensity. Computational color constancy purposes to estimate the actual color in an acquired scene disregarding its illuminant. Many illuminant estimation solutions have been suggested in the last few years, although it is known that the problem addressed is actually ill-posed as its solution lacks uniqueness and stability. To handle with this problem, different solutions usually exploit some assumptions about the statistical properties of the estimated illuminants and/or of the object reflectance in the scene. Until now, most methods have been [11] based on physical constraints or statistical assumptions derived from the scene, whereas very little attention has been paid to the effects that selected illuminants have on the final color image representation. They describe the category hypothesis, which weights the set of possible illuminants according to their capacity to map the corrected image onto specific colors. Color information [12] is a significant feature for many vision algorithms including color correction, image retrieval and tracking. The limitations of color measurement accuracy and explore how this information can be used to improve the performance of color correction .The notion of color strength, which is a combination of saturation and intensity information to define when hue information in a scene is reliable. Image enhancement [13] issues are addressed by analyzing the effect of two well-known color constancy algorithms in combination with gamma correction. Those effects are studied applying the algorithms separately and in combination. The performance of the approaches is evaluated comparing the Average Power Spectrum Value of the test images and their corresponding outcomes, as a quality measure. According to the experimental results, it is observed that the application of the gamma correction after a color constancy algorithm results in an improved image quality.Gamma correction [13] illuminates dark areas in the image, allowing a more clearly distinction of colors. Gamma correction is mainly used in practical applications requiring a dynamic range correction, an effect that also color constancy produces. Image enhancement produced by a single algorithm, the combined application of a color constancy algorithm and afterwards the gamma correction, yields a better result.An improved color constancy approach [14] is obtainable by considering the drawback of the well-known max- RGB algorithm: Only the unreliable maximum intensities are taken for illuminant estimation.

3. Gaps in literature

The survey has shown that still much improvement is required in the color constancy algorithms. It has been found that the most of the existing research has following limitations:-

1. Color normalization has been neglected to balance the color artefacts which will be presented in the image produced by the color constancy algorithms; as the modification is done in the image according to measured light source.
2. Effect of the Human visual system is also ignored. Because the modification done by the color constancy is based upon the measured light source; which can be efficient some time or may produce poor results in certain cases. So adaptive histogram equalization on L*a*b is required to overcome this problem.
3. Most of the existing research has taken the results on the available data sets; not much work is done by taking real time color source affected images.

4. Problem definition

The color constancy is a procedure that measures the influence of different light sources on a digital image. The image recorded by a camera depends on three factors: the physical content of the scene, the illumination incident on the scene, and the characteristics of the camera. The goal of the computational color constancy is to account for the effect of the illuminate. Many traditional methods such as

Grey-world method, Max RGB and learning-based method were used to measure the color constancy of digital images affected by light source. All these methods have an obvious disadvantage that the light source across the scene is spectrally uniform. This assumption is often violated as there might be more than one light source illuminating the scene. For instance, indoor scenes could be affected by both indoor and outdoor illumination, each having distinct spectral power distributions. The main objective of this dissertation is to propose Improved Gray world algorithm using adaptive histogram equalization on L*a*b color space and light normalization. The problem is seem to be justifiable and will have great impact on vision application because as Gray world based color constancy will reduce the impact of the light but it also reduces the sharpness of the image and also may result in poor brightness; so to remove this problem we will use an integrated effort of the Gray world algorithm using adaptive histogram equalization on L*a*bcolor space and light normalization for efficient results. In order to validate the performance of the proposed algorithm design and implementation will be done in MATLAB using image processing toolbox. The comparison among state of art techniques will also be drawn by considering the well-known image processing performance metrics.

5. Proposed algorithm

The main motivation behind this research work is to improve the accuracy of the color constancy algorithms. Color processing is a procedure by which research teams and equipment are proficient to differentiate objects based on the dissimilar reflections of the light or illuminated, communicated, or produced by the given object. In human beings light is acknowledged by the eye where two kinds of photoreceptors known as cones and rods, direct indications to the visual cortex that in turn processes those impressions into a individual discernment of the color. Color correction or constancy is a procedure that permits the brain to distinguish acquainted thing as being a reliable color nevertheless of the amount of light imitating from the object at a specified moment. The proposed algorithm will have great impact on the real time vision applications. The proposed algorithm will become useful in smart phones, smart cameras and projectors. Subsequent is the algorithm that has been used to improve the color constancy.

Step 1: First of all color input image will be passed to the system then we will find the size of image using the equation

$[M, N, \sim] = size(I)$..... (1)

Where M represents row, N represents column, ~ represents any channel i.e. red, green or blue and I represents image.

Step 2: Now we will remove saturation color points i.e. the colors which are heavily affected by the light source by using following equations

(a) First of all we measure all three channels by using the following equation

$T_{R=} \sum\sum(I_R)$..... (2)

$T_{G=} \sum\sum(I_G)$..... (3)

$T_{B=} \sum\sum(I_B)$..... (4)

Where T_R, T_G, T_B represents total red, green and blue color and I_R, I_G, I_B represent red, green and blue image.

(b) After calculating R,G,B Channel we will calculate the mean of all 3 channels by using the following equation

$gm = \sum(r_m g_m b_m)/3$...... (5)

Where gm represent global mean and $R_M G_M B_M$ represent mean of all individual channel.

(c) Now color aggregation will be applied to remove the saturation points by using the following equation

$a_r = gm/r_m$ .... (6)

$a_g = gm/r_g$.... (7)

$a_b = gm/r_b$.... (8)

Where A_R, A_G, A_B represents aggregate function for red, green and blue channel.

(d) Now after removing the saturation points we will obtain new images by using the following equation

$ni(red) = a_r * I_R$..... (9)

$ni(green) = a_g * I_g$..... (10)

$ni(blue) = a_b * I_b$..... (11)

Where ni represents new image.

Step 3: Now we will remove the effect of light using edge based 2nd order derivation color constancy algorithm by using the following equation

(a) First of all we will estimate the illuminace value to represent the gray edge hypothesis by using the following equation

$ew = \sqrt{wr * 2 + wg * 2 + wb * 2}$.... (12)

Where ew represents effect of light and wr, wg, wb represents effect of red, green and blue color

Step 4: Now after estimating the light source, color normalization will come in action to balance the effect of the poor light.

(a) First of all we will calculate the effect of red, green and blue channel by using the following equations

$wr = wr/ew$ ..... (13)

$wg = wg/ew$..... (14)

$wb = wb/ew$..... (15)

Where wr, wg, wb represent effect of red, green and blue color and ew represents effect of light.

(b) Now we will normalize red, green and blue channels individually.

$OI_R = (\frac{OI_R}{wr * \sqrt{3}})$ .... (16)

$OI_G = (\frac{OI_G}{wg * \sqrt{3}})$.... (17)

$OI_B = (\frac{OI_B}{wb * \sqrt{3}})$.... (18)

Step 5: Now we will apply adaptive histogram equalization on L*a*b color space to get the final color constant image by using the following equation

Step 6: End.

6. Experimental set-up

In order to implement the proposed algorithm, design and implementation has been done in MATLAB using image processing toolbox. Table 1 is showing the various images which are used in this research work. Images are given along with their formats. All the images has different kind of the light i.e. more or less in some images.

Table 1. Experimental images

S.No	NAME	FORMAT
1	Image1	JPEG
2	Image2	JPEG
3	Image3	JPEG
4	Image4	JPEG
5	Image5	JPEG
6	Image6	JPEG
7	Image7	JPEG
8	Image8	JPEG
9	Image9	JPEG
10	Image10	JPEG
11	Image11	JPEG
12	Image12	JPEG
13	Image13	JPEG

7. Experimental results

For the purpose of the confirmation we have taken 13 dissimilar images and passed to the edge based using first order, edge based using second order, and proposed algorithm. Following section contains a result of one of the 13 selected images to show the improvisation of the proposed algorithm over the other techniques.Figure 2 has shown the input image for new purpose. The image has show low intensity and the effect of red color on the image is much. The whole objective is to improve the brightness of the image and to fix the effect of the color of the light source.

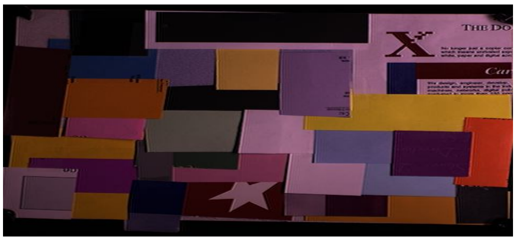

Figure 2. Input image

Figure 3 has shown the result image produced by the Edge based using first order. The image has shown more brightness and some more effect of the red color. However the difficulty of this technique is establish to be some artefacts which make poor quality of the image.

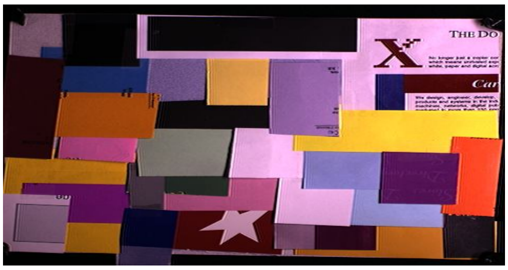

Figure 3. Edge based using first order

Figure 4 has shown the production image occupied by the Edge based using second order. The image has more brightness. However the problem of this technique is found to be is the effect of the green channel has not been minimized as expected.

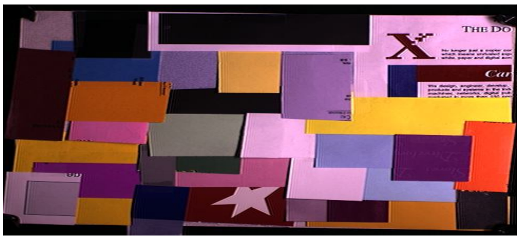

Figure 4. Edge based using second order

Figure 5 has shown the output image taken by the proposed color constancy algorithm. The image has contained the balanced brightness and the impact of the red channel is also reduced. Comparing with other method the proposed has shown quite significant result with respect to all cases. The effect of the individual channel has also been normalized as well as the effect of the brightness is also normalized.

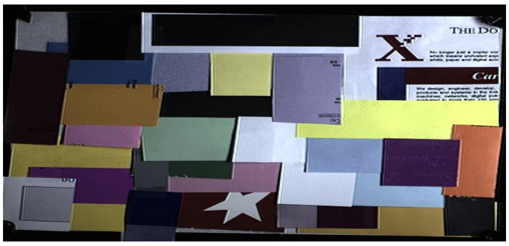

Figure 5. Final proposed image

8. Performance analysis

This segment contains the calculation among active and projected techniques. Some familiar image presentation parameters for digital images have been selected to verify that the performance of the projected algorithm is moderately better than the obtainable methods.

Table 2 has shown the quantized examination of the mean square error. As mean square error requires to be abridged therefore the proposed algorithm is presenting the better output than the existing methods as mean square error is fewer in each case.

Table 2. Mean Square Error

Image Name	Edge based using first order	Edge based using second order	Proposed
Image1	0.0339	0.0297	0.0035
Image2	0.0348	0.0326	0.0239
Image3	0.0215	0.0205	0.0086
Image4	0.0549	0.0523	0.0084

Image5	0.0558	0.0518	0.0203
Image6	0.0387	0.0361	0.0073
Image7	0.0482	0.0460	0.0163
Image8	0.0589	0.0549	0.0192
Image9	0.0099	0.0087	0.0074
Image10	0.0210	0.0205	0.0090
Image11	0.0389	0.0362	0.0169
Image12	0.0338	0.0320	0.0085
Image13	0.0954	0.1006	0.0302

Table 3 is viewing the relative examination of the Peak Signal to Noise Ratio (PSNR). As PSNR require to be maximized; so the major objective is to increase the PSNR as much as probable. Table 3 has evidently shown that the PSNR is greatest in the case of the projected algorithm therefore projected algorithm is providing improved output than the existing methods.

Table 3. Peak Signal –to- Noise Ratio

Image Name	Edge based using first order	Edge based using second order	Proposed
Image1	62.8244	63.3984	72.7368
Image2	62.7101	63.0046	64.3394
Image3	64.8019	65.0119	68.8101
Image4	60.7382	60.9492	68.8757
Image5	60.6606	60.9838	65.0649
Image6	62.2483	62.5523	69.4869
Image7	61.3018	61.4988	66.0114
Image8	60.4300	60.7323	65.2866
Image9	68.1573	68.7316	69.4097
Image10	64.2340	62.5383	68.5957
Image11	62.2340	62.5383	65.8488
Image12	62.8475	63.0760	68.8593
Image13	58.3349	58.5703	63.3299

Figure 6 has shown the quantized examination of the mean square error. As mean square error requires to be abridged therefore the proposed algorithm is presenting the better output than the existing methods as mean square error is fewer in each case.

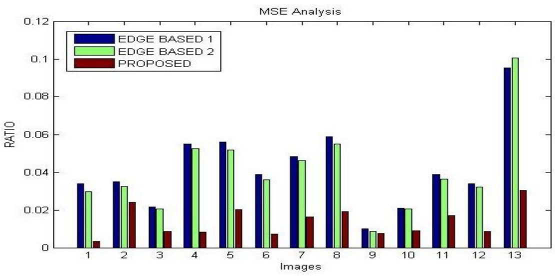

Figure 6. Mean Square Error

Figure 7 is viewing the relative examination of the Peak Signal to Noise Ratio (PSNR). As PSNR require to be maximized; so the major objective is to increase the PSNR as much as probable. Table 3 has evidently shown that the PSNR is greatest in the case of the projected algorithm therefore projected algorithm is providing improved output than the existing methods.

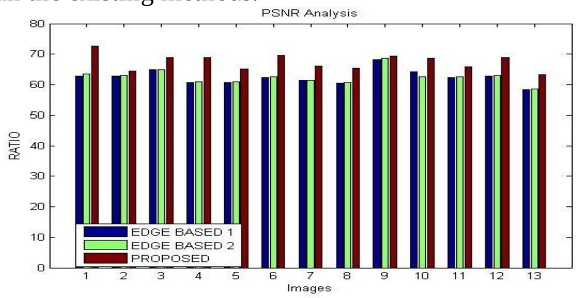

Figure 7. Peak Signal –to- Noise Ratio

9. CONCLUSION AND FUTURE WORK

Color constancy is the ability to conclude colors of substance independent of the color of the illumination source. These Edge-based color constancy procedures create utilize of image derivatives to approximate the light source. On the other hand, dissimilar edge types are in real-world images, such as material, shade, and emphasize edges. These various edge types may have a individual authority on the performance of the illuminate evaluation. This examine work has proposed a new color constancy algorithm which has integrated gray world color constancy with the adaptive histogram stretching on L*a*b color space. The proposed algorithm is planned and implemented in MATLAB using image processing toolbox. The evaluation among the proposed and gray edge based color constancy has shown that the proposed algorithm outperforms over the available algorithms. In near future we will modify the proposed algorithm further modifying the edge based hypothesis with fuzzy set theory.

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