Evaluation of Color Constancy Algorithms

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Abstract--This paper presents a review on various color constancy (CC) techniques. The CC is a method that gathers the effect of various light sources on a digital image. The scene recorded by a camera relies on three issues: the physical information of the object, the illumination incident on the scene, and the characteristics of the camera. The objective of CC is to account for the effect of the illuminate. Many existing methods such as Grey-world method, Physics based CC and Edge-based methods were used to measure the CC of objects affected by different light source. All these methods have obvious limitations 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. The overall objective of this paper is to find the gaps in earlier work on CC.

Index terms: *CC, Illuminates, Multiple light source, Gray world*

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1. Introduction

Digital images [1] are collection of pixels. Every color represents the pixel color(or gray level for black or white photos) at a particular point in the image; as a result a pixel is similar to a small dot for particular color. The color of an image calculated at huge number of points, we can generate a digital approximation of the image from which a copy of original is reconstructed. Pixels are tiny like grain particles in a conservative photographic, but ordered in a standard pattern of rows and columns and store information somewhat differently. A digital image is rectangular arrangement of pixels known as bitmap.

COLOR is borrowed as of three mechanisms, i.e., the reflectance of the object, the affectability of cones, and the illuminate spectra. Of these mechanisms, the illuminate spectrum is the least constant. The dissimilar aspects depend on the illumination changes, for example daytime (daylight, noon, and evening) or inside/outside situations. Therefore, the color of an object relies on the illumination under which we seeing it, that is the main difficulty for computer vision. The CC as set [2] solves this difficulty by the human visual system. This asset allows humans to recognize the color of an object separately of the color of the illuminate.CC is the capability to identify colors of objects autonomous of the color of the light source.

Obtaining CC is of significance for various computer vision applications, like image retrieval, image categorization, color object identification and object tracking.CC is an observable fact that describes the human capability to approximate the real color of a view irrespective of the color of illumination of that scene. As an image is creation of the light that falls on the scene and the reflectance properties of the scene, achieving CC is an ill-posed problem and various techniques have been proposed to address it.CC is the ability to perceive a comparatively stable color for an object even under changing illumination. Most computer methods are pixel-based, correcting an image so that its statistics satisfy assumptions such as the average intensity of the scene under neutral light is world scene.

COLOR is derived from three components, i.e., the reflectance of the object, the sensitivity of cones, and the illuminant spectra. Of these components, the illuminant spectrum is the least stable. Illumination changes depending on various aspects, i.e., time of the day (daybreak, midday, and sunset) or indoor/outdoor situations, for example. Thus, the problem for computer vision is that the color of an object relies on the light under which we are looking at it. The human visual system solves this problem due to the so-called CC property. This property allows humans to identify the color of an object independently of the color of the light source.

CC is the ability to recognize colors of objects independent of the color of the light source. Obtaining CC is of importance for many computer vision applications, such as image retrieval, image classification, color object recognition and object tracking.

CC is a phenomenon that describes 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, achieving CC is an ill-posed problem and various techniques have been proposed to address it.CC is the ability to perceive a relatively constant color for an object even under varying illumination. Most computer methods are pixel-based, correcting an image so that its statistics satisfy assumptions such as the average intensity of the scene under neutral light is world scene.

CC is ability to perceive colors of objects, invariant to the color of light source. This ability is generally accredited to the Human Visual System, although exact details remain uncertain. A scene is a set of illuminated objects. In general the illumination has a complex spatial distribution, so that the illuminant falling on one object in the scene may differ from that falling on another. Nonetheless, a useful point of departure is to consider the case where the illumination is uniform across the scene, so that it may be characterized by its spectral power distribution, E(λ).This functions pacifies how much power the illuminant contains at each wavelength. The illuminant reflects off objects to the eye, where it is collected and focused to form the retinal image. It is the image that is explicitly available for determining the composition of the scene.

Nevertheless human color perception does display some degree of constancy. To take a very simple example involving only lightness, consider a page of black print on white paper viewed first under an indoor reading light and then under direct sunlight. The intensity of the light reaching the eye from the white area of the page in indoor illumination is roughly equal to the intensity of the light reaching the eye from the black print in sunlight. (Kaiser and Boynton 1996, p.199) In spite of this rough equality, the page looks white under the indoor illumination and the print looks black under sunlight.

Fig 1.Image under various illuminations (adapted from[4])

2. Techniques used in CC

A. Gray World

Gray-World is well-known CC method based on the assumption which assumes that the average reflectance of surfaces in the world is achromatic. This assumption is held very well: in a real world image, it is usually true that there are a lot of various color variations. The variations in color are random and independent; the average would converge to the mean value, gray, by given an enough amount of samples. Color balancing techniques can apply this assumption by forcing it's images to have a common average gray value for it's R, G, and B components. In the case an image is taken by a digital camera under a particular lighting environment, the effect of the special lighting cast can be removed by enforcing the gray world assumption on the image. As a result of approximation, the color of the image is much closer to the original scene.

$$O_i(x,y) = \frac{C_{i(x,y)}}{L_i} \approx \frac{C_{i(x,y)}}{f_i} = G(x,y)R_i(x,y)$$

Figure 1: (a) Original Image (b) Result Of Gray World

B. White Patch

White Patch method attempts to locate the objects that are truly white, within the scene; by assuming the whites pixels are also the brightest (I = R+G+B).White Patch approach is typical of the CC adaptation, searching for the lightest patch to use as a white reference similar to how the human visual system does. In White Patch highest value in the image is white. White Patch algorithm is best suited for forest category.

WP is a simplified version of the retinex method. This method assumes that the scene has a white patch which reflects the whole wavelength of incident light and the illuminant is uniform across the scene. The illuminant color calculated by WP is estimated as

$$L_i = max_{x,y}\{C_i(x,y)\}$$

Thus, the original color of an object was calculated as

$$O_i(x,y) = \frac{C_{i(x,y)}}{L_i} = G(x,y)R_i(x,y)$$

Figure 2 :(a)Original Image (b) Result Of White Patch

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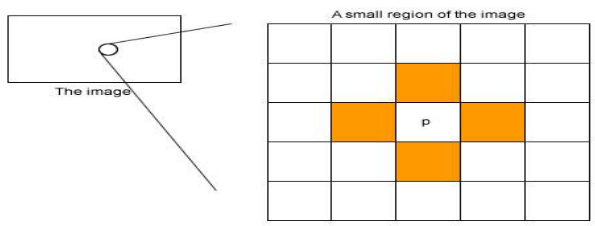
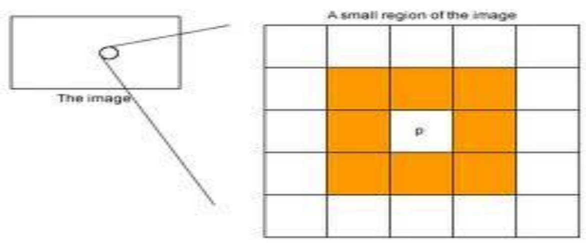
C. Gray Edge 1st order derivative

In gray Edge 1st order derivative 4-neighbouring pixels are considered. The first derivative-based edge detection operator to detect image edges by computing the image gradient values, such as Roberts operator, Sobel operator, Prewitt operator.



(a)



(b)

Figure 3 (a) 4-neighbouring pixels (b) 8-neighbouring pixels

D. Gray Edge 2nd order derivative

The 8-neighbouring pixels are considered. Unlike 4-connected,in 8-connected more information for image correction is available. Gray Edge using 1st order derivative does not proof to be efficient because each pixel considers its 4-neighbouring pixels. So, in this method not all information is available for color correction.

Figure 4 (a) Gray edge 1st order (b) Gray edge 2nd order

E. Gamut Mapping

The gamut mapping algorithm is one of the most promising methods to achieve computational CC. However, so far, gamut mapping techniques are restricted to the use of pixel values to estimate the illuminant. Gamut mapping is extended to incorporate the statistical nature of images. It is analytically shown that the proposed gamut mapping framework is able to include any linear filter output.

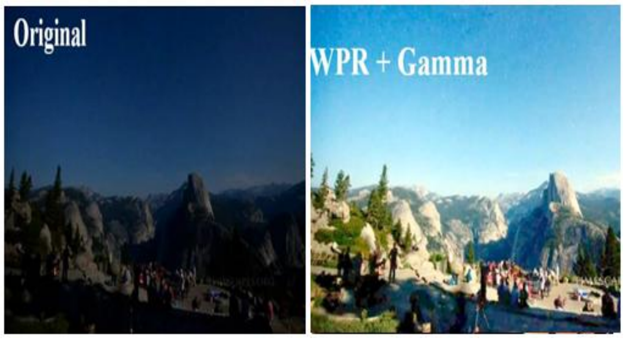


Figure (a) Original Image (b) Result of Gamut Mapping

3. Related work

[1]. F. Chang and S. Pei (2013) define the improved CC approach presented by considering the limitations of well known max-RGB algorithm. Only the unreliable maximum intensities are taken for illuminant estimation. To solve this problem, we process the chromaticity neutralization process, which selects the representative pixels for robust illuminant computing.

[2]. H. Ahn et al (2013) described a novel CC method using the color correction. From a lot of observation, we find tendencies according to saturation weighting function into the existing methods. Experiments are performed on two widely used datasets and the results demonstrate that the proposed method improves the CC with a simple and effective manner.

[3]. M. Wang et al (2013) prescribed the CC technique is introduced and a novel CC remote sensing images enhancement algorithm is proposed. This algorithm can not only restore more details in the dark area of the image, but also self-adaptive to the luminance conditions.

[4]. L. Brown et al (2012) described the limitations of color measurement accuracy and explore how this information can be used to improve the performance of color correction. In particular we show that a strong correlation exists between the error in hue measurements on one hand and saturation and intensity on other hand.

[5]. A. Gijsenij et al (2012) prescribed that the CC generally based on the simplifying assumption that the spectral distribution of a light source is uniform across scenes. However in reality, this assumption is often violated due to the presence of multiple light sources. In this we will address more realistic scenario where the uniform light source assumption is too restrictive.

[6]. A. Chakrabati et al (2012) define an efficient maximum likelihood approach for one part of the CC problem,

removing from an image the color case caused by the spectral distribution of the dominating scene illuminant. The key observation is that by applying spatial band-pass filters to color images one unveils color distribution that are uni-modal, symmetric and well represented by a simple parametric form.

[7]. A. Gijsenij and T. Gevers (2011) prescribed that Existing CC methods are all based on specific assumptions such as the spatial and spectral characteristics of images. However with the large variety of available methods the question is how to select the method that perform best for a specific image. To achieve selection and combining CC algorithm natural image statics are used to identify the most important characteristics of color image.

[8]. S.J. Teng (2010) described CC is an important image processing step in digital camera and machine vision. The proposed CC measure exploits the scanning strategy of RGB channel gain adjustment. In addition, the suppressing mechanism of greyscale pixel maximization (GPM) is used to locate potential illuminants.

[9]. ZhiyuanXu et al (2009) described that the image degraded by fog suffer from poor contrast. In order to remove fog effect, a contrast Limited Adaptive Histogram Equalization (CLAHE)- based method is presented. This method establishes a maximum value to clip the histogram and redistributes the clipped pixels equally to each gray-level.

[10]. Chakrabarti et al. (2012) has introduced an effectual maximal likelihood access for one part of the CC problem: removing from an image the color cast caused by the spectral partition of the domineering scene illuminant. The statistical model for the spatial partition of colors in white balanced images has developed and then applying this model to infer illumination parameters as those being most likely under this model. The key estimation is that by applying spatial band-pass filters to color images one unveils color distributions that are uni-modal, commensurate, and well illustrated by a simple parametric form.

[11]. Javier et al.(2012) has founded color illustration that are constant to illuminant changes is still an open problem in computer vision. Until now, most accesses has based on physical constraints or statistical assumptions borrowed from the scene, because very short attention has been paid to the effects that selected illuminants on the final color image, has represented. Javier et al. has proposed perceptual constraints that are computed on the corrected images. The class hypothesis, which weights the set of possible illuminants according to their capability to plan the corrected image onto specific colors, has defined.

[12]. Gijsenij et al. (2012) has discussed the color correction using edge based techniques to evaluate the illuminant efficiently. However, the several edge types remain in real-world images, like material, shadow, and highlight edges. These various edge types have an isolated effect on the accuracy of the illuminant evaluation.

[13]. Bianco and Schettini (2012) has investigated how illuminant evaluation can be performed exploiting the color enumeration extracted from the faces automatically detected in the image. The technique is based on two clarifications: first, skin colors be likely to form a group in the color space, creating it a signal to estimate the illuminant in the scene; second, many photographic images are portraits or contain people, has proposed. The objectives of computational color correction to evaluate the actual color in an acquired view disregard its light source. Until now, this is an ill-posed problem, as its results lacks uniqueness and stability, various solutions available, each based on various assumptions. If suppositions are not according to the algorithm’s estimation of the actual illuminant can be very inadequate.

[14]. Eduardo Monari (2012) has discussed the re-identification of person most difficult task, and still an unanswered problem for various applications in video surveillance. The accesses apply colors as major attributes for object explanation, which are in fact vital indication for re-identification. However, the colors captured by camera undergo from unidentified and varying global and local light situation in the view.

[15]. Negrete and Yanez (2012) has discussed that image enhancement issues addressed by analyzing the outcome of both famous CC techniques in grouping with gamma correction. CC has ability to recognize the correct colors, independently of the illuminant present in the image. Human vision has a natural capability to correct the color effects of light source. However, the mechanism that is involved in this capability is not yet fully understood.

4. Conclusion and future work

The CC is a method that gathers the effect of various light sources on a digital image. The image recorded by a camera relies on three factors: the physical content of the scene, the illumination incident on the scene, and the characteristics of the camera. The objective of the computational CC 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 CC of digital images affected by light source. All these methods have obvious limitations 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. The noise and the uneven illuminate issue has been neglected by the most of the researchers. In near future a new algorithm will be proposed which will modify the gray world hypothesis to enhance the results further.

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