Chapter 2

Traditional Methods for White Balance

2.1Introduction

The traditional methods for white balance and their corresponding theories will be illustrated in the following sections. Also, the drawbacks and solutions of these methods will be discussed.

2.2 Methods Based on the Gray World Assumption

When talking about white balance methods, we may make some assumptions about color features of an image and take advantage of them [2]. The Gray World Assumption states that given an image with sufficient amount of color variations, the average values of the red, green, and blue components of the image would meet on a gray value. Statistically speaking, this assumption is certainly reasonable. In our real world scenes, the pictures that we took often have very different color variations. Since those variations in color are random and independent, each of the red, green, and blue components of per pixel in the image has an equal probability of being above or below a fixed value in its respective component. If we take a large enough amount of samples, we would expect each average value of the red, green, and blue components of these samples to converge to a fixed value. Therefore, if we take all pixels in an image with similar dynamic ranges for each of its color components into account, the average values of the red, green, and blue components of the image tend to converge to a gray color.

Generally, white balance methods based on the Gray World Assumption can be used to come to good effect. However, white balance methods based on the Gray World Assumption are apt to push the color in an image from one extreme to another when a major portion of an image are occupied by an object of a high chromatic color.

2.3 Retinex Methods

An important contribution to colour constancy is the Retinex work of Land and his colleagues [5-10] and further analyzed and extended by others [11-16]. The original aim of the theory is a computational model of human vision, but it has also been used and extended for machine vision. In theory, most versions of Retinex are robust with respect to slowly spatially varying illumination, although testing on real images has been limited to scenes where the illumination has been controlled to be quite uniform. In Retinex based methods, varying illumination is discounted by assuming that small spatial changes in the responses are due to changes in the illumination whereas large changes are due to surfaces changes. The goal of Retinex is to estimate the lightness of a surface in each channel by comparing the quantum catch at each pixel or photoreceptor to the value of some statistic—originally the maximum— found by looking at a large area around the pixel or photoreceptor. The ratios of these quantities (or their logarithms) are the descriptors of interest, and thus the method implicitly assumes the diagonal model. The details vary in the various versions of Retinex.

2.4 Color by Correlation

Recently, Finlayson et el. introduced Color by Correlation [5] as an improvement on the white balance method. The basic idea of Color by Correlation is to pre-compute a correlation matrix which describes how compatible proposed illuminants are with the occurrence of image chromaticities. Each row in the matrix corresponds to a different training illuminant. The matrix columns correspond to possible chromaticity ranges resulting from a discretization of (r,g) space, ordered in any convenient manner.

Where :

$$r=R/(R+G+B) \quad (2\text{-}1)$$

$$g=G/(R+G+B) \quad (2\text{-}2)$$

Two versions of Color by Correlation are described in [15]. In the first version, the elements of the correlation matrix corresponding to a given illuminant are computed as follows: First, the (r,g) chromaticities of the reflectances in the training set under that illuminant are computed using the camera sensors. Then the convex hull of these chromaticities is found, and all chromaticity bins within the hull are identified as being compatible with the given illuminant. Finally, all entries in the row for the given illuminant corresponding to compatible chromaticities are set to one, and all other elements in that row are set to zero. To estimate the illuminant chromaticity, the correlation matrix is multiplied by a vector whose elements correspond to the ordering of (r,g) used in the correlation matrix. The elements of this vector are set to one if the corresponding chromaticity occurred in the image, and zero otherwise. The i'th element of the resulting vector is then the number of chromaticities which are consistent with the illuminant. Under ideal circumstances, all chromaticities in the image will be consistent with the actual illuminant, and that illuminant will therefore have maximal correlation. As is the case with gamut-mapping methods [16], it is possible to have more than one plausible illuminant, and in their implementation they use the average of all candidates close to the maximum.