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Measuring a Quality of the Hazy Image by Using Lab-Color Space

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ABSTRACT

A Measuring the quality of the hazy image is difficult problem, thus these images need to analyzeafter determined the quality or dehazing. In this paper, we analyzed the hazy images by using Lab-color space. First we designed the system captured images which graded for high to very low hazy (by adding the dust) by using HeNe laser, in these images we calculated the Normalize Mean Square error (NMSE) for each components in Lab and RGB color space, and the basic components in the Structure Similarity Index (SSIM) are (contrast, structure and luminance) moreover the mean for all has been calculated. We can see the b-component (in Lab) effected by the dust compare with the L and a components and in SSIM the contrast has more distorted by the dust.

Keywords:hazyimage, quality, Lab-color space.

1.INTRODUCTION

Computer vision system can be used for many outdoor applications, such as video surveillance, remote sensing, andintelligent vehicles. Virtually all computer vision tasks orcomputational photography algorithms assume that the inputimages are taken in clear weather and robust feature detectionare achieved in high quality image [1].The irradiance received by the camera from the scene point is attenuated along the line of sight. Furthermore, the incoming light is blended with the air light [2]. Hazy image analysis it is important case in the dehazing image and image quality assessment. For example many search [1 ,3 ,4], included dehazing but not used objective quality assessments .where The image quality metrics can be broadly classified into two categories, subjective and objective. A large numbers of objective image quality metrics have been developed during the last decade. Objective metrics can be divided [5,6] in three categories: Full Reference, Reduced Reference and No Reference. In this paper, the hazy color images have been analyzed depending on two objectives quality are the SSIM and NMSR. The each component of Lab- color space are employed in SSIM and NMSR and we compared between them, the important of this procedure is determine the quality of hazy image and the manner of it enhanced.in this search we attempt to answer the question "what is the component in Lab has more effective in hazy?". Moreover the components of SSIM in the lightness (Luminance ,constracture and contrast)has been studied.

2.LAB-COLOR SPACE

The Lab color coordinate system is developed to give a simple measure of color in agreement with the Munsell color system. The CIELAB space has been designed to be a perceptually uniform space. A system is perceptually uniform if a small perturbation to a component value is approximately equally perceptible across the range of that value [7]. In CIELab, the L-axis is known as the lightness and extends from 0 (black) to 100 (white). The other two coordinates a and b represent redness-greenness and yellowness-blueness, respectively and samples for which a=b=0 are achromatic. Therefore, the L-axis represents the achromatic scale of grays from black to white. The three coordinates L, a and B are computed from the tristimulus values X, Y, and Z as follows [8]:

$$L = \begin{cases} 116(\frac{Y}{Y_n})^{\frac{1}{3}} - 16 & if \ \frac{Y}{Y_n} > 0.008856 \\ 116(\frac{Y}{Y_n})^{\frac{1}{3}} & if \ \frac{Y}{Y_n} \le 0.008856 \end{cases} \quad (1)$$

$$a = 500(f\left(\frac{X}{X_n}\right) - f\left(\frac{Y}{Y_n}\right))(2)$$

$$b = 200(f\left(\frac{Y}{Y_n}\right) - f\left(\frac{Z}{Z_n}\right))(3)$$

Where Xn, Yn, and Zn describe a specified white object color stimulus and the function f is defined as[8]:

$$f(x) = \begin{cases} X^{\frac{1}{3}} & if\ X > 0.008856 \\ 7.787X + \frac{16}{116} & if\ X \le 0.008856 \end{cases} \quad (4)$$

The b- coordinate represents the yellowness–blueness. The coordinates a and b have a range of approximately [−100, 100] [9].

3.IMAGE QUALITY ASSESSMENT

The SSIM metric is based on the evaluation of three different measures, the luminance, contrast, and structure comparison measures are computed as[10]:

$$l(x,y) = \frac{2\mu_X(x,y)\mu_Y(x,y)+C_1}{\mu_X^2(x,y)+\mu_Y^2(x,y)+C_1} \quad (5)$$

$$c(x,y) = \frac{2\sigma_X(x,y)\sigma_Y(x,y)+C_2}{\sigma_X^2(x,y)+\sigma_Y^2(x,y)+C_2} \quad (6)$$

$$s(x,y) = \frac{\sigma_{XY}(x,y)+C_3}{\sigma_X(x,y)\sigma_Y(x,y)+C_3} \quad (7)$$

Where X and Y correspond to two different images that we would like to match, i.e. two different blocks in two separate images, μ_x, σ_x^2, and σ_{xy} the mean of X, the variance of X, and the covariance of X and Y respectively where[10]:

$$\mu(x,y) = \sum_{p=-P}^{P}\sum_{q=-Q}^{Q} w(p,q)X(x+p,y+q) \quad (8)$$

$$\sigma^2(x,y) = \sum_{p=-P}^{P}\sum_{q=-Q}^{Q} w(p,q)[X(x+p,y+q)-\mu_X(x,y)]^2 \quad (9)$$

$$\sigma_{XY}(x,y) = \sum_{p=-P}^{P}\sum_{q=-Q}^{Q} w(p,q)[X(x+p,y+q)-\mu_X(x,y)] [Y(x+p,y+q)-\mu_Y(x,y)] \quad (10)$$

Where $w(p,q)$ is a Gaussian weighing function such that:

$$\sum_{p=-P}^{P}\sum_{q=-Q}^{Q} w(p,q) = 1$$

And C_1, C_2, and C_3 are constants given by $C_1 = (K_1 L)^2$, $C_2 = (K_2 L)^2$, and $C_3 = C_2/2$. L is the dynamic range for the sample data, i.e. $L = 255$ for 8 bit content and $K_1 << 1$ and $K_2 << 1$ are two scalar constants In this study we used K_1=0.01 and K_2=0.03 [20]. Given the above measures the structural similarity can be computed as [10]:

$$SSIM(x,y) = [l(x,y)]\cdot[c(x,y)]\cdot[s(x,y)] \quad (11)$$

4.IMAGE DEGRADATION MODEL

In image processing, the model widely used to describe the formation of a haze image is given by [3 ,11]:

$$I(x) = J(x)t(x) + A(1-t(x)) \quad (12)$$

A is the global atmospheric light, and t is medium transmission $J(x)$ is the original surface radiance vector at the intersection point of the scene with the real-world ray .$J(x)t(x)$is direct attenuation term [11], representing the scene radiation decay effect in the medium , $A(1-t(x))$ is airlight term [2,11], describing the light scattering from atmosphere particles inducing color distortion. Direct attenuation describes the scene radiance and its decay in the medium, while air light results from previously scattered light and leads to the shift of the scene color. Real-world ray corresponding to the pixel $x \equiv (x,y)$ and equation (12) is defined on the three RGB color components.

5. EXPERIMENT RESULTS

In this search a system has been designed to measure the amount of the haze (particle of dust), that is distorted the image. Figure (1) illustrated the measurement system which is made up of firm glass box, Fan, laser HeNe, Camera stand, camera and Lux meter .The Fan is used to stirs the dust that is putting in the box, in the same time the lux meter measured the laser intensity. When a specific amount of the dust is added in the box the fun will be stir the dust, after small time the dust is gets still at the bottom of the box. The images are taken from this time (during the dust is stirs to it gets on the bottom), we can consider all images are the hazy image but the last image is approximately optimal images.in this system if the dust is increased the laser intensity is decreased. The two group images a and b are illustrated in the figure 2and 3.

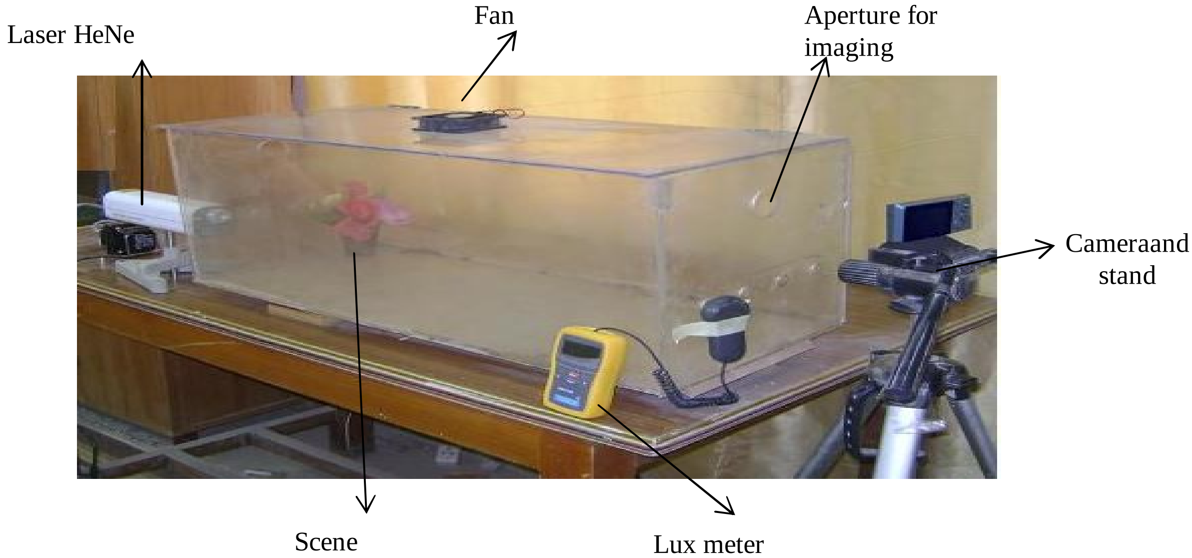
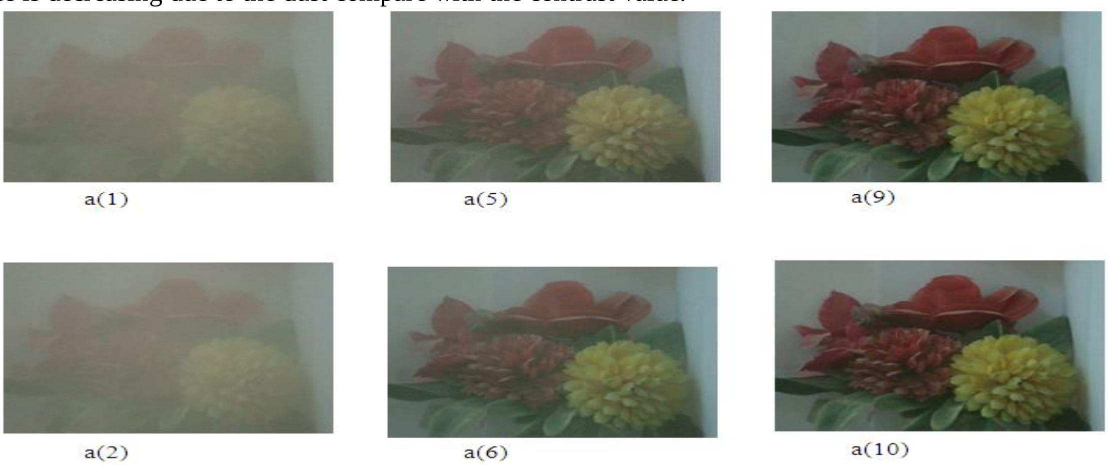


Figure 1: system which is used to estimate the amount of the dust that is made hazy image.

In the figures (4,a) , (6,a) illustrated the relationship between the max.illuminance and the SSIM for the value component in Lab-color space for data images, from these figure we can see the max.illuminance increasing with increased the SSIM due to decrease the dust. And the relationship between the max.illuminance and SSIM components was illustrate In the figures (4,b),(6,b) we can noted the contrast component is approximately remaining constant , and is not effected by increasing the dust, whereas the structure value became lower by increasing the dust and the luminance is slightly effect by distortion.And figures (5,a,b) and (7,a,b) are illustrated the relationship between the max.illuminance and the NMSE for RGB and each component in Lab for data images , we can see the NMSE is decreasing with increased the max.illuminance in the b-chromatic are more effected by the dust and the(L and a)components are not effect by increasing the dust.

6.CONCLUSION

In this search, we study the quality of the hazy images by using Lab- color space, from the result we can see the chromatic component (b- component) is very affected by the distortion and the lightness component L ,and the (chromatic component a) are low affected. And in reference SSIM quality for value the structure follows the luminance is decreasing due to the dust compare with the contrast value.



a(1) a(5) a(9)

a(2) a(6) a(10)

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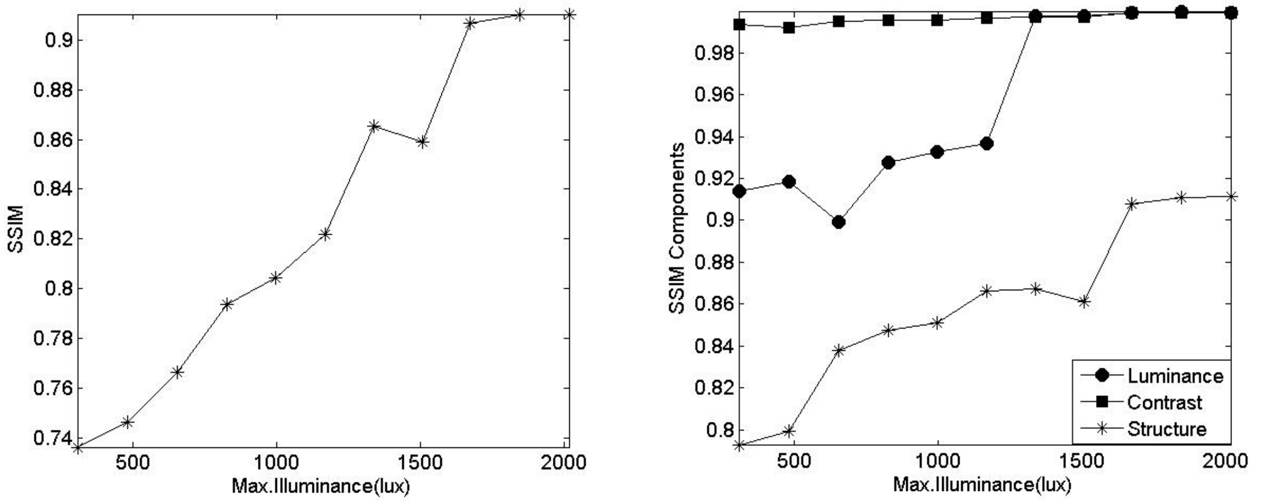
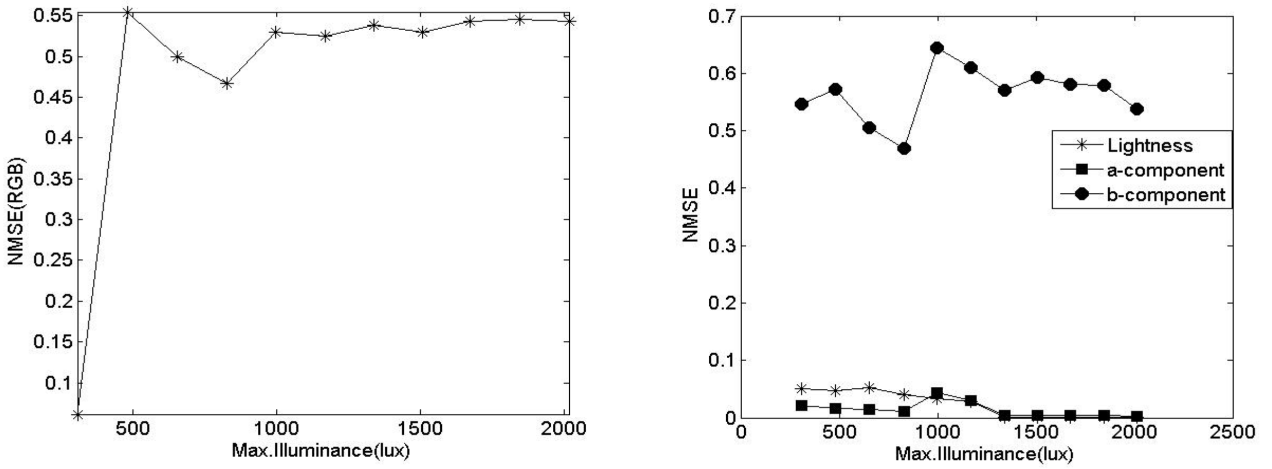
Figure 2: First group of the hazy images with different hazy levels (from maximum in a(1) to very low hazy in a(12)).



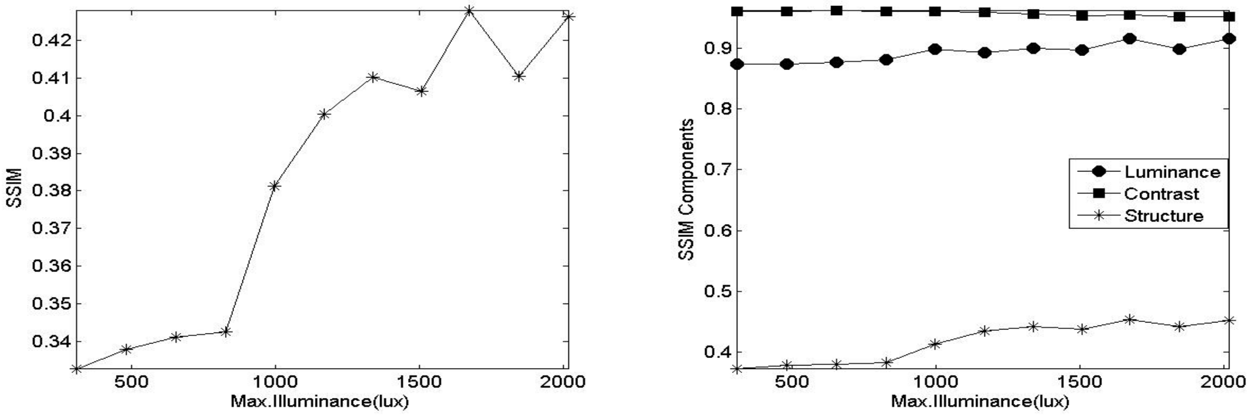
(a) (b)

Figure 4: The Max. illuminance as a function of SSIM for the Value component in Lab color space (in a) and (in b) the components of SSIM are (Luminance ,Contrast and Structure), for first group images



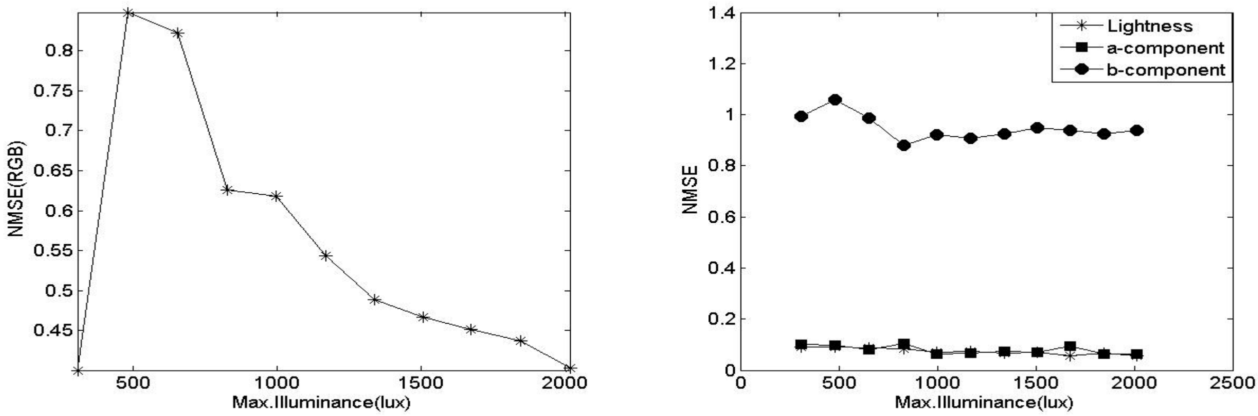
(a) (b)

Figure 5: Relationship between Max. illuminance and NMSE (a) for RGB component and (b) for lightness ,a-component and b- components, for first group images.



(a) (b)

Figure 6: Relationship between Max. illuminance and NMSE (a) for RGB component and (b) for lightness ,a-component and b- components, for second group images.



(a) (b)

Figure 7: The Max. illuminance as a function of SSIM for the Value component in Lab color space (in a) and (in b) the components of SSIM are (Luminance ,Contrast and Structure), for second group images.

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