Study a quality of the Hazy image by using YIQ color space

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Abstract

Determining the quality of the hazy image is difficult problem, thus these images need to analyzing after determined the quality or dehazing. In this paper, we analyzed the hazy(by the dust) images depending on YIQ 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 YIQ 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 lightness (in YIQ) and luminance (in SSIM) component are not effected by the dust whereas the chromatic components are highly effected by the dust.
Keywords: The dust images, Dehazing **,** YIQ color space , Luminance

1.Introduction

Computer vision system can be used for many outdoor applications, such as video surveillance, remote sensing, and intelligent vehicles. Virtually all computer vision tasks or computational photography algorithms assume that the input images are taken in clear weather and robust feature detection are 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 YIQ 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 YIQ has more effective in hazy?". Moreover the components of SSIM in the lightness (Luminance constracture and contrast)has been studied.

2. YIQ Color space

In the development of the NTSC television system used in the United States, a color coordinate system with the coordinates Y, I, and Q is defined for transmission purposes. To transmit a color signal efficiently, the R,G, and B signal is more conveniently coded from a linear transformation. The luminance Signal is coded in the Y-component. The additional portions I and Q contain the entire chromaticity information that is also denoted as chrominance signal in television technology [7]. (I) component containing orange-cyan hue information, and (Q) containing green-magenta hue information. Transform color image from basic RGB color space to YIQ color space by preformed by [8]:

$$M_{RGB\ to\ YIQ} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.270 & -0.322 \\ 0.211 & -0.253 & 0.312 \end{bmatrix} \qquad (1)$$

$$M_{RGB\ to\ YIQ} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.270 & -0.322 \\ 0.211 & -0.253 & 0.312 \end{bmatrix}$$

While the inverse transformation is given by:

$$M_{YIQ\ to\ RGB} = \begin{bmatrix} 1 & 0.956 & 0.621 \\ 1 & -0.272 & -0.647 \\ 1 & -1.060 & 1.703 \end{bmatrix} \quad (2)$$

There are two peculiarities with the YIQ color model, the first is that this system is more sensitive to changes in luminance than to changes in chromaticity; the second is that color gamut is quite small; it can be specified adequately with one rather than two color dimensions. These properties are very convenient for the transfer of TV signals [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]:

$$l(x,y) = \frac{2\mu_X(x,y)\mu_Y(x,y) + C_1}{\mu_X^2(x,y) + \mu_Y^2(x,y) + C_1} \quad (3)$$

$$c(x,y) = \frac{2\sigma_X(x,y)\sigma_Y(x,y) + C_2}{\sigma_X^2(x,y) + \sigma_Y^2(x,y) + C_2} \quad (4)$$

$$s(x,y) = \frac{\sigma_{XY}(x,y) + C_3}{\sigma_X(x,y)\sigma_Y(x,y) + C_3} \quad (5)$$

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]:

$$\mu(x,y) = \sum_{p=-P}^{P} \sum_{q=-Q}^{Q} w(p,q) X(x+p, y+q) \quad (6)$$

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

$$\sigma'_{XY}(x,y) = \sum_{p=-P}^{P} \sum_{q=-Q}^{Q} w(p,q)[X(x+p,y+q) - \mu_X(x,y)] \quad (7)$$

$$[\,Y(x+p, y+q) - \mu_Y(x,y)] \quad (8)$$

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

$$\sum_{p=-P}^{P} \sum_{q=-Q}^{Q} w(p,q) = 1 \quad (9)$$

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 . Given the above measures the structural similarity can be computed as [10]:

$$SSIM(x,y) = [l(x,y)] \cdot [c(x,y)] \cdot [s(x,y)] \quad (10)$$

4. Image degradation model

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

$$I(x) = J(x)t(x) + A(1 - t(x)) \quad (11)$$

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 , $A\left(1 - t(x)\right)$ is air light 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[11].

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. figures(2)and (3) illustrated the images used in this study are greed from low to high of the dust. In the figures (4,a) , (6,a) illustrated the relationship between the max. illuminance and the SSIM for the value component in YIQ 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 whereas the behaviors of structure and luminance are similar the Y component in the figures (4,a) and (6,a), but the SSIM is high in the contrast. the figures (5,a,b) and figures (7,a,b) are illustrated the relationship between the max.illuminance and the NMSE for RGB and each component in YIQ for data images , we can see the NMSE is decreasing with increased the max.illuminance in the all component, and the chromatic components I and Q are more effected by the dust due to the error is high, because increasing the white light in these images.

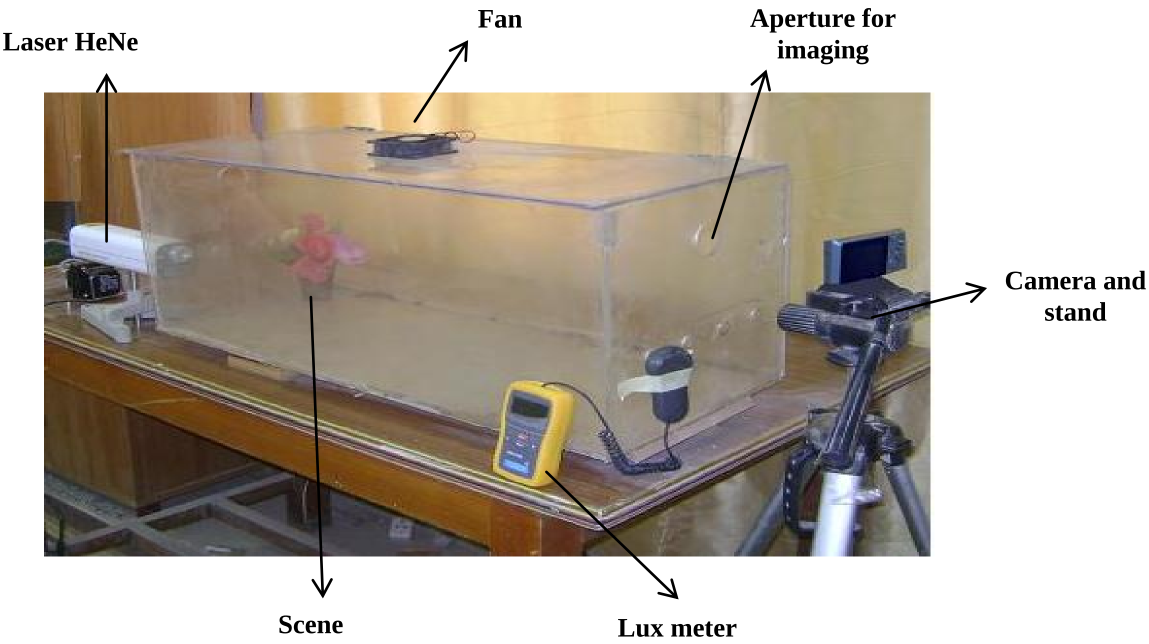

Figure.(1): system with is used to measure the amount of the dust that is made image is hazy.

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a(1**)**

a**(5)**

a(9**)**

a(2**)**

a**(6)**

a(10**)**

a(3**)**

a(7)

a(11**)**

a(4)

a(8)

a(12)

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

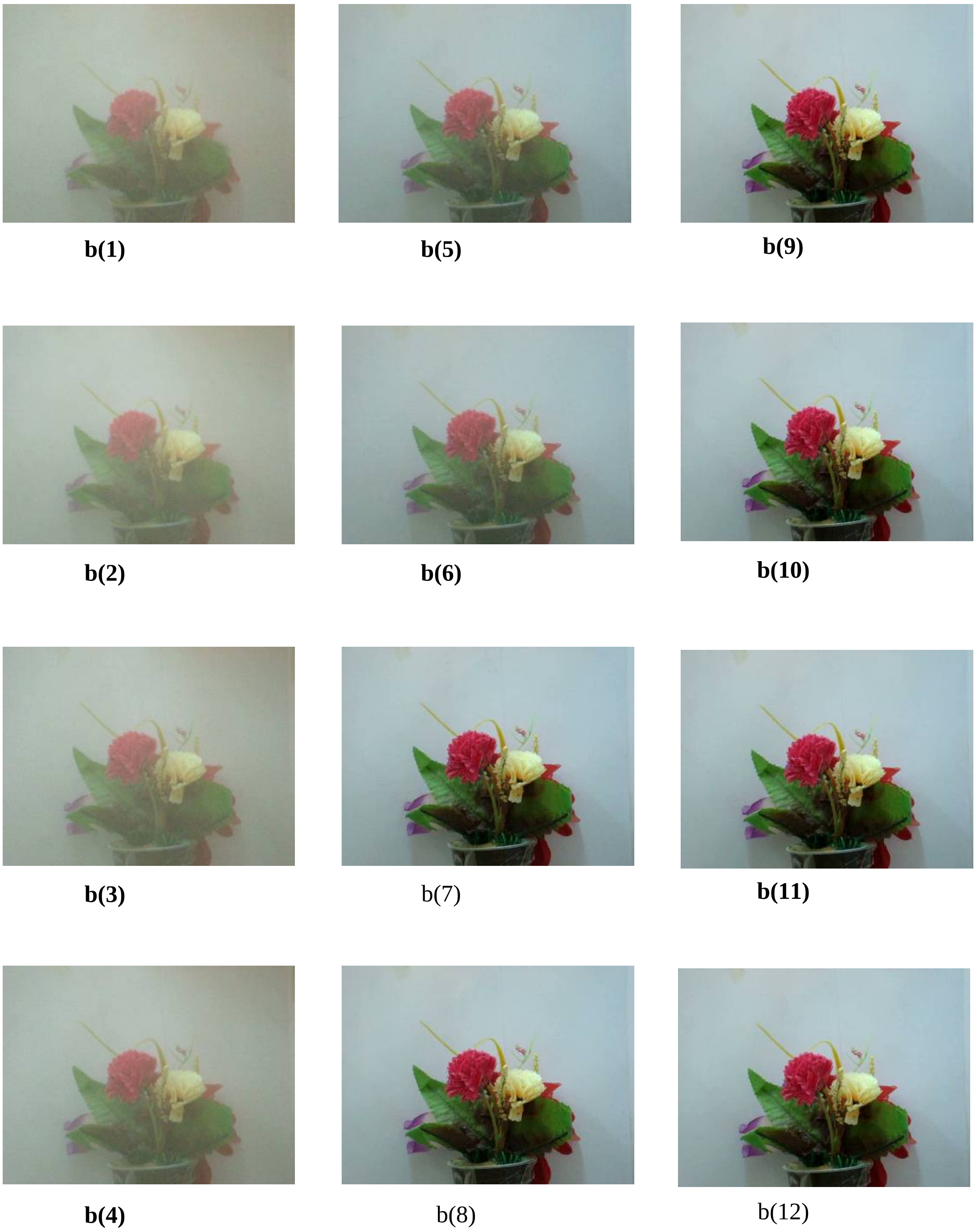
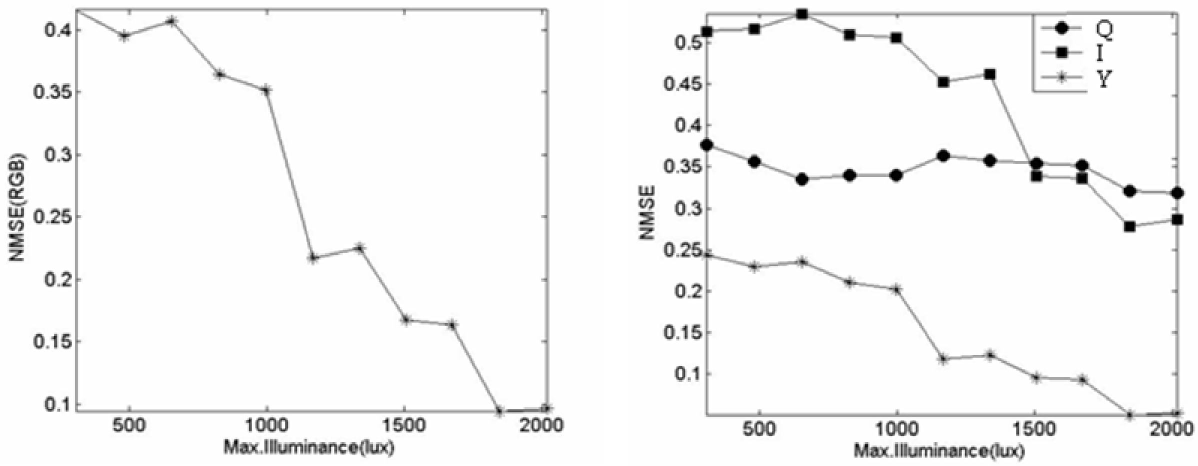
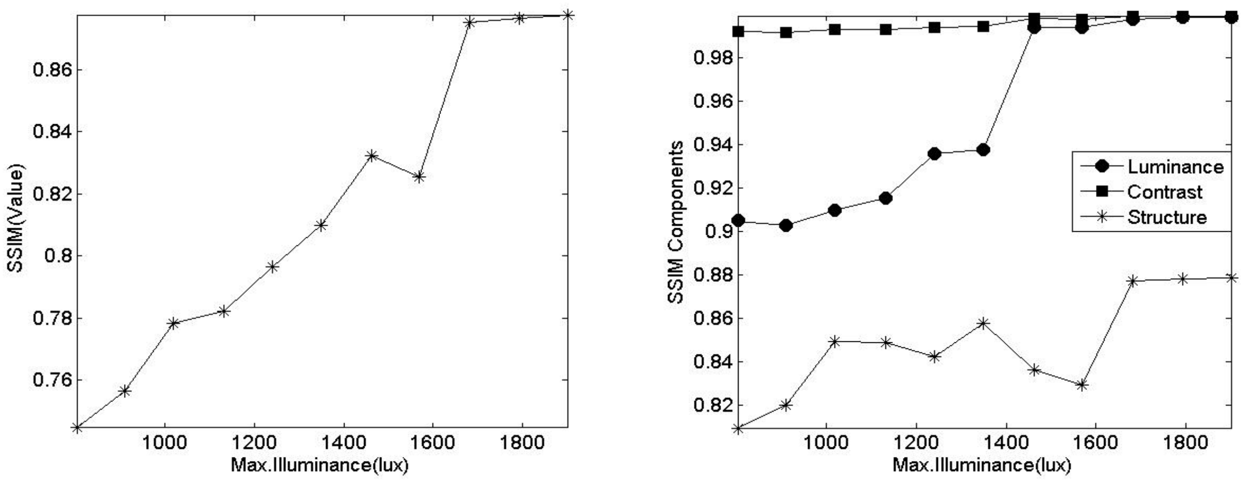


Figure.(3): Second group of the hazy images with different hazy levels (from maximum in b(1) to very low hazy in b(12)).



(a) **(b)**

Figure.(4): The Max.illuminance as a function of SSIM for the value component in YIQ 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 Q ,I and Y, value components, for first group images .

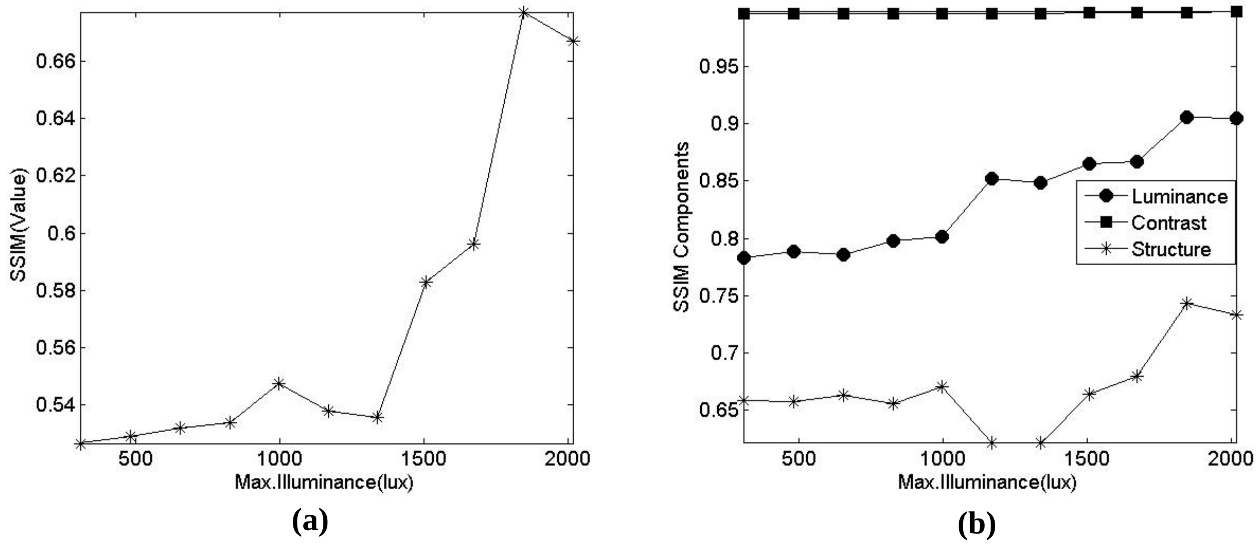


Figure.(6): The Max.illuminance as a function of SSIM for the Value component in YIQ color space (in a) and (in b) the components of SSIM are (Luminance ,Contrast and Structure), for second group images.

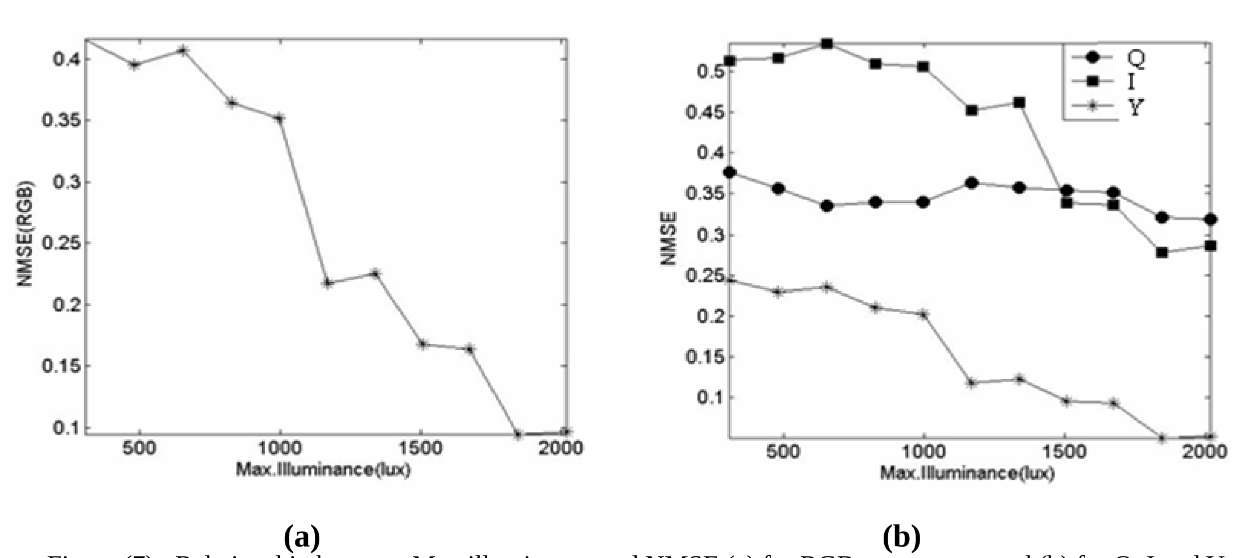


Figure.(7): Relationship between Max.illuminance and NMSE (a) for RGB component and (b) for Q ,I and Y, value components, for second group images .