Research On Haze Elimination Based On The Image Visibility Restoration Method

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Abstract-Haze proves to be problematic especially when photographing vibrant and open landscapes like deserts as it lessens the quality of the photograph. According to (Tedla et al., 2004) the images that are captured in the desert areas continuously have degraded visibility, not to mention undesirable color effects. These photos are affected by the extreme sunny weather of the desert, which makes them undergo reduced visibility. The poor visibility in return results to a lot of influences on the outside computer vision systems. According to (Kerins, 2014) One of the main problems for processing images in desert areas is the presence of extreme sunlight, which contributes to image hazing and staining. The damage caused by these images by the sunlight is cumulative and irreversible, a factor that makes it necessary for the careful monitoring and limiting of the intensity of sunlight exposure.

1. INTRODUCTION

According to (Yu et al., 2013), Haze is an atmospheric condition which causes clarity and transparency of the air are reduced due to the presence of dust, smoke, mist, fog, rain or snow in the air. These media or particles in the air cause attenuation and air-light which are some of the significant factors that cause the light transmission loss due to it traveling through specific media causing it to scattering or get diffused.

In terrestrial imaging, the haze causatives presence in the atmosphere results in contrast loss in a subject owing to light scattering by haze elements as they scatter the light before it reaches the camera. The shorter blue wavelengths being more scattered, and red/infrared wavelengths which are longer are scattered less (Kopeika et al., 1998).

Some of the information obtained from the outside computer vision systems like traffic surveillance systems, remote sensing systems or even object recognition systems is usually hazy because of the particles in the atmosphere as the systems cannot meet all weather and all-time capabilities. To be able to obtain good quality images, and many image processing techniques have been developed to enhance image quality to achieve maximum image information (Chauhan et al., 2005)

This paper will focus on image haze elimination based on the image visibility restoration method to obtain high quality, haze-free images.

2. LITERATURE REVIEW

Many haze processing methods have been used to enhance image quality. (Wang, 2010), proposed an algorithm founded on the atmospheric scattering. A dark channel prior was applied to approximate the hazy light but it did not depend on the depth of the information. The disadvantage of this algorithm is that one color channel will have a low intensity of contrast due to shadows, colorful or dark objects producing distorted color images due to the dark channel prior.(Yu, 2011) Also proposed a de-hazing algorithm founded on a scattering ideal but used a white balancing technique before the scattering model to restore visibility of the images. The method then utilizes a weighted least square (WLS) approach to smoothen the image edges. An inverse scene albedo recovery process is then used to de-haze the image entirely without the need of prior information.(Xiangdong Zhang, 2012) Proposed a new algorithm to improve the image contrast and de-noising method for the photos. This technique was beneficial for images captured in low light circumstances where many image properties are unclear or even unseen. The proposed algorithm improved the image contrast to brightening the hazy landscapes. (Zhu, et al., 2013) Proposed an improvement algorithm that would ensure effective single image de-hazing by refining the different kinds of amorphous on blurry images after application of the dark channel prior. This algorithm made the images seem more realistic after de-hazing. (Shih-Chia Huang, 2014) Noticed that during fog, Captured images acquired low visibility and undesirable contrast properties hence proposed visibility restoration approach using the Laplacian-method to de-haze the images and to improve the color cast.

3. PROPOSED IMAGE VISIBILITY RESTORATION METHOD

This proposed image de-hazing method will restore blurry images captured in the desert in extremely sunny conditions or even in sandstorms.

The proposed visibility restoration method will entail the following processes:

	PROCEDURE
1.	INPUT HAZY IMAGE
2.	**DEPTH MAP ESTIMATION**
3.	**ADAPTIVE GAMMA CORRECTION(CA)**
4.	**VISIBILITY RESTORATION(VR)**
5.	ENHANCED IMAGE

Figure 1.Proposed Method

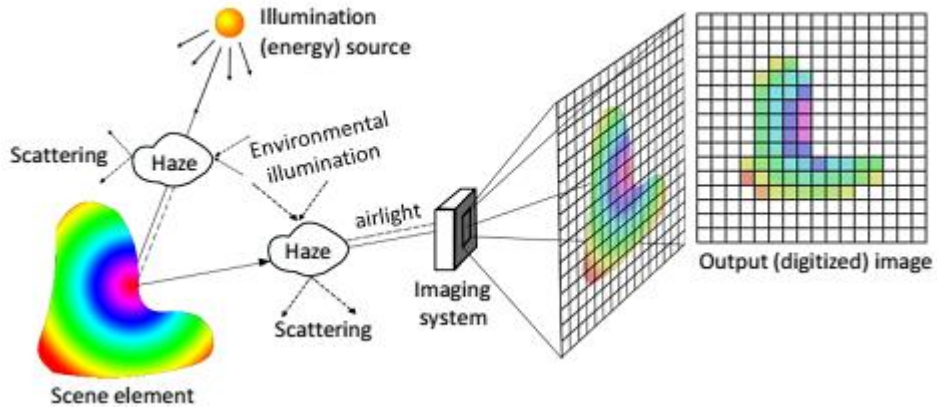


Figure 2.Hazy image production

I (x) = J (x) t (x) + A (1-t(x))

Here, the following applies: I(x) =concentration of blurred image, J(x) =section radiance, A= global atmospheric light(x) = transmission medium representativeof light received by camera, J(x) t(x) = attenuation, A (1-t(x)) =air light.

4. DEPTH MAP ESTIMATION

This depth map estimation sets up an image transmission process that utilizes a median filter to reserve the info of the photo edges, avoiding production of the block objects in the reestablished image (Ullah et al., 2013). It is primarily centered on the Dark Channel Prior technique (Li et al, 2015), but the use of an enhanced and refined transmission process helps to overcome the generation of halo effects.

According to (Huang et al., 2014), the refined transmission technique utilizes a median filter to reserveinfo along the edges which could have been lost if the Dark Prior Estimation Process was relied on as it depends upon the use of the minimum screen. This preservation of edge information avoids the generation of halo effect as the median filter performs non-linear filtering to suppress the noise as it preserves the data.

$$D(x) = \omega(\min_{-min_{y\in\Omega(x)}(W(y))} median_{y\in\Omega(x)}(W(y)), W(x))$$

Detailed edge information = D(x), w is set to 0.95(minimum value of color channels), mediany2(x) =median filter, miny2(x) =minimum filter, W(x) and W(y) = independent pixels.The min procedure is carried out on the three RGB frequenciesindividually to produce a roughly good transmission map since it still has certain block properties as the spread is not permanently consistent.In improved transmission, an adaptive gamma modificationprocess is utilized to intensify the transmission map as the Dark Channel Prior method causes loss of intensity in one if not all colors in the RGB channel in sandstorm/desert images (Yan et al., 2014).

5. COLOR ANALYSIS

This color analysis enhances the image transmission process to achieve optimal de-hazing of the images so that sufficient depth of information can be obtained(Huang et al, 2015). The input image is then analyzed to get accurate color information and characteristics. In sandstorms and other adverse weather conditions, imaging can be disappointing as severe color distortion occurs due to attenuation and air-light effects. The Color Analysis comes in by using the Gray World Assumption technique which according to (Tarel et al., 2009) is used to determine the qualities of each color channel.

6. VISIBILITY RESTORATION

By the in-depth information in addition to color correlation info in the prior steps, this Virtual Restoration (VR) module conceals the particles in the real world weather conditions to achieve high-quality haze free images (Narasimhan, 2003).

$$J^C(x) = \frac{X^C(x) - A^C - d^C}{\max(t_e(x), t_0)} + (A^C - d^C), for\ C \in (r, g, b)$$

Where*:*

J(x) = section radiance, I(x) =concentration of blurred image, A= atmospheric light, d=color variance, t(x) = improved transmission map, t0=0.1.

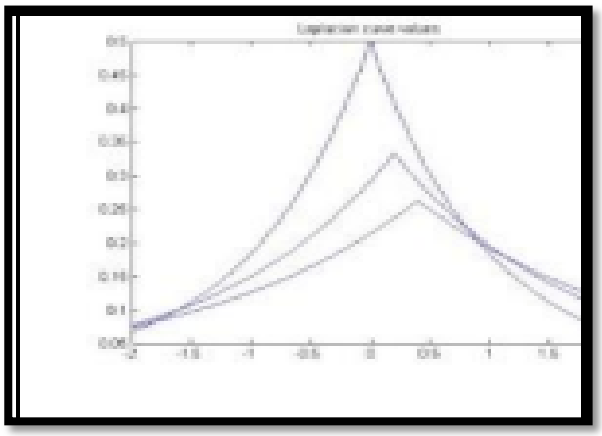
7. EXPERIMENTAL RESULTS

The images that are produced using the proposed image restoration process prove to have better performance regarding color distortion compared to the images presented using the Laplacian-based approach or the CLAHE method. See the images below:

(a) Input image

(b)Enhanced image using CLAHE method

(c) Laplacian distribution curve



(d) De-hazed and Gamma corrected image using proposed image restoration method.

Table1: Comparison

	CLAHE	LAPLACHIAN	PROPOSED
Rate of new visible edges	0.09	0.04	0.024
Percentage of pixels that become completely black or white after restoration	0.013	0.001	0.00
Gradients at visible edges	1.62	1.56	1.87

8. DISCUSSION

When the *J(x) t(x)* (attenuation) isadjacent to zero, the *t(x)* very close to zero, this means that the image radiance recovered is noisy. So the transmission is bound to zero so that if any haze is preserved, it is very minimal and only in the very dense haze regions.

After the haze removal, the images seem slightly dim due to the low brightness which cannot compare to the atmospheric light. The scene exposure has to be improved for better radiance of the final high-quality haze-free image using the following equation:

$$J(x) = \frac{I(x) - A}{\max(t(x), t_0)} + A$$

After the transmission map has been used, original scene radiance can be achieved in the hazy images according to the haze formation equation.

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

9. CONCLUSION

Haze in desert regions can be caused by the presence of dust particles in the air or even due to the extreme sunny conditions causing a grey hue in the images produced hence resulting in low contrast and resolution due to poor visibility. The proposed visibility restoration method can, in the three steps of depth map estimation, color analysis, and visibility resolution, restore the contrast of the dark/blurry image hence producing a high-quality haze-free image with clear visibility properties. This means that information obtained from various outdoor visual systems around the world can be enhanced, increasing their constancy and strength using the proposed haze removal algorithm by restoring their visibility. By using haze elimination algorithms, we can boost the constancy and power of the graphicstructure.

10. FUTURE SCOPE OF THE RESEARCH

De-hazing is a crucial part of image and information retrieval from visual systems technology. This is due to presence of turbid medium like particles or droplets in the atmosphere that cause scattering of light. Images captured in all weather conditions, whether sunny or foggy have a high chances of being less visible. According to (Zhu et al, 2015) many traditional methods have been developed to eliminate haze in images but have not been accurate as the haze thickness proves problematic.

An image visibility restoration algorithm is important to be able to achieve clear, high quality images so that extraction of information from outdoor visual systems can be easier because these systems cannot perform normally in hazy conditions. The application of this algorithm ensures more efficiency and speed in repairing the transmission maps and analyzing colorsassuring achievement of satisfactory visibility of information from hazed images. This speed and efficiency will aid greatly tothe constancy and power of the graphic structure of images obtained from computer vision systems like the aerial imagery and remote sensing.

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