ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization Vol. 5, Special Issue 4, March 2016

National Conference on Signal Processing, Instrumentation and Communication Engineering (SPICE' 16)

Organized by

Dept. of ECE, Mar Baselios Institute of Technology & Science (MBITS), Kothamangalam, Kerala-686693, India

Reconstruction of Fog Obscured Image by Local Extrema

Bibila Baby,[1] Jinto Mathew[2]

PG Student [Advanced Communication and Information Systems], Dept. of ECE, MBITS, Nellimattom, Kerala, India [2]

Assistant Professor, Dept. of ECE, MBITS, Nellimattom, Kerala, India [1]

ABSTRACT: Atmospheric particles, such as fog, haze, etc., may significantly reduce the visibility and distort the colors of the images captured. The presence of such particles in the image makes fidelity and the image content can't be recognized which lead to great reduction of dependability for outdoor vision system such as outdoor target recognition, automatic monitor and satellite remote sensing monitoring etc. A foggy image degradation model called atmospheric scattering model is used to model the attenuation of luminance through the atmosphere. Here we propose a simple fog removal method from a single input image which also consider as the effects of skylight and atmospheric veil. This approach makes use of Dark channel prior method, which eliminates the colour cast which is caused by the atmospheric colour and local extrema method for the refinement of atmospheric veil. Using this method with the fog imaging model, we can recover a high quality fog-free image.

KEYWORDS: Defog, Atmospheric scattering model, Dark channel prior, Local extrema.

I. INTRODUCTION

The visibility degradation of images is due to the absorption and scattering of light by atmospheric particles. Fog is mainly the combination of airlight and direct attenuation. It degrades the picture quality. Haze removal is highly desired in road security, consumer and computational photography and other outdoor vision systems. The visibility of the scene can significantly increase by removing fog. The goal of fog removal algorithms is to enhance the image and to recover the detail of original scene from the foggy image. The atmospheric scattering model is usually used to describe the formation of a foggy or hazy image. There are two types of defogging, Multi-image defogging[1] and Single-image defogging[2]. In multi-image defogging, several input images are taken in different atmospheric conditions and processed to remove the haze. This type of defogging produces pleasing results. The main drawback of the multi image defogging is in its acquisition step. In this step, we have to capture a number of input images for processing, so this type of defogging needs huge memory, plenty of time and it is very difficult to carry out. Single image defogging, uses only a single foggy image as input and process this image to generate the defogged image.

In this paper, we propose a defogging method from a single image based on local extrema. Skylight estimation and white balancing is performed using Dark channel prior. In the inference process of the atmospheric veil, the atmospheric veil is first roughly estimated using the minimal component of the color corrected image and the coarser estimate is then refined using a fast edge-preserving smoothing approach. Finally, the scene albedo is recovered by inverting this simplified model. The bad fog image can be put to good use.

II. IMAGE DEGRADATION MODEL

A foggy image degradation model called atmospheric scattering model[3] is used to model the attenuation of luminance through the atmosphere. This model relates the apparent luminance $I(x; y)$ of an object located at distance $d(x; y)$ to the luminance $R(x; y)$ measured close to this object:

$$I(x; y) = R(x; y)\, e^{-\beta\, d(x;y)} + A\,(1- e^{-\beta\, d(x;y)}); \tag{1}$$

where $I(x; y)$ is the intensity of image degraded by fog, $d(x; y)$ is the scene depth ie, distance of the object at pixel $(x;y)$, $R(x; y)$ is the intensity of clear image without fog, A is called skylight and represents the luminance of the sky, β is the scattering coefficient of the atmosphere, $d(x; y)$ is the scene depth ie, distance of the object at pixel $(x; y)$. To get fog free image solve $R(x; y)$. The β is considered to be a constant since the atmospheric scattering model assumes that the atmosphere is homogeneous and does not consider wavelength's influence on atmospheric scattering coefficient. The difficulty is that single image defogging is an ill-posed problem. If we use (1), defogging requires to estimate A, β and

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization Vol. 5, Special Issue 4, March 2016

National Conference on Signal Processing, Instrumentation and Communication Engineering (SPICE' 16)

Organized by

Dept. of ECE, Mar Baselios Institute of Technology & Science (MBITS), Kothamangalam, Kerala-686693, India

d at every pixel, only knowing the input image *I*. Scene depth and atmospheric scattering coefficient requires information such as the vanishing points from the infinite plane which is difficult to estimate accurately, this will cause the bad image visibility restoration. To avoid this problem we introduce the atmospheric veil to avoid solving d and β , which can be expressed by

$$V(x;y) = A(1 - t(x;y)); \quad (2)$$

where *V* is defined as the atmospheric veil, *t* is the transmission map which can be expressed as $t(x;y) = e^{-\beta d(x;y)}$. *V* denotes the effect of ambient light, *t* reflects the ability of light penetration. They both contain the depth information. Estimation of *V* can avoid being directly influenced by other parameters and can be executed quickly and accurately.

III. DEFOGGING METHOD

In this paper, we introduce a novel method for fog removal based on local extrema using a single image. We use dark channel prior methed to remove fog content from the single input image and local extrema method to estimate the atmospheric veil to get better perfect image information. Fig.3.1 shows block diagram for our proposed fog removal. The Dark channel prior[4]-[6] method is used for white balancing and skylight for a single foggy image is done by the help of dark channel.

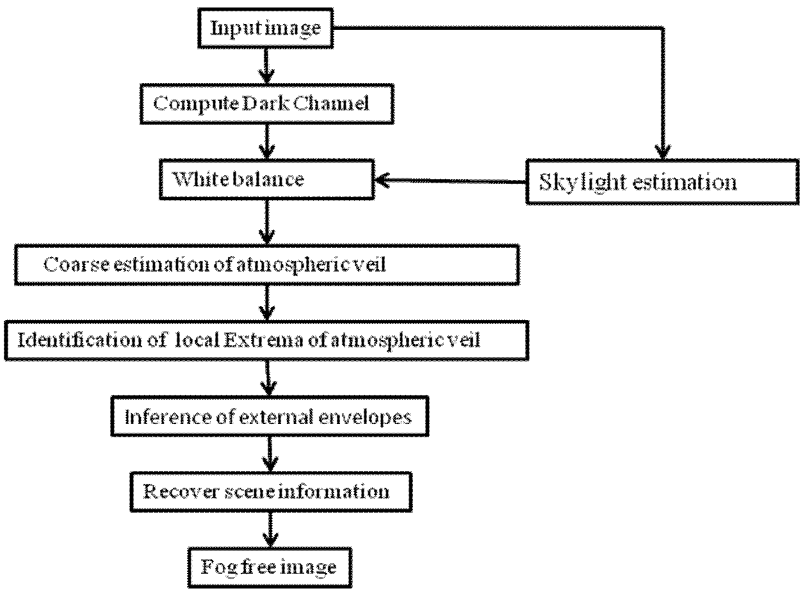

Fig.1: Block diagram for fog removal

Dark channel can estimated from the dark channel prior. It is based on the following observation on fog-free outdoor images: in most of the non-sky patches, at least one color channel has very low intensity at some pixels. In other words, the minimum intensity in such a patch should has a very low value.The dark channel of input image can be defined as

$$I_{dark}(x;y) = \min_{(x;y)\epsilon\psi} \left(\min_{c\epsilon(R;G;B)} I_c(x;y) \right); \quad (3)$$

Where $I_c(x;y)$ is a color channel of $I(x;y)$ and ψ is a local patch. The dark channel values are calculated in each pixel. The pixel containing fog is white in color and which containing object is black in color. Skylight in the captured image A, is typically assumed to be a global constant. We estimate A from the dark channel. In order to solve A, we choose the 0.1% brightest pixels of the dark channel as their preferred region and define these pixels as $I_{0.1\%}$. Then, the average value of $I_{0.1\%}$ in the input foggy image is selected as the initial skylight, i.e, $A_{mean}=mean(I_{0.1\%})$ where A is the ideal skylight estimation result. Then, we can obtain the corrected image I^0 after white balance, which can be inferred as

$$I^0(x;y) = \frac{I(x;y)}{A} \quad (4)$$

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization | Vol. 5, Special Issue 4, March 2016

National Conference on Signal Processing, Instrumentation and Communication Engineering (SPICE' 16)

Organized by

Dept. of ECE, Mar Baselios Institute of Technology & Science (MBITS), Kothamangalam, Kerala-686693, India

In this scheme we also consider the chance of occurring of atmospheric veil. Among selected top 0.1% brightest pixels in the dark channel, the pixels with highest intensity in the input image are selected as the atmospheric light and acquire a rough estimation of the atmospheric veil:

$$V^{'}(x;y) = \min_{(x;y)\epsilon\psi \;\; c\epsilon(R;G;B)} (I^{0}(x;y)); \qquad (5)$$

where V is the coarse estimation matrix of atmospheric veil. Image Restoration is done by Local Extrema[7]. Atmospheric veil depends solely on the depth of the objects. The scene depth is changing smoothly across small neighboring areas except at the edges. Therefore, the refinement of atmospheric veil can be considered a smoothing problem. In this paper, in order to generate an ideal estimation of the atmospheric veil, we apply an edge-preserving smoothing approach based on the local extrema for refinement. Our method based local extrema use edge-aware interpolation to compute envelopes. A smoothed mean layer is obtained by averaging the envelopes. The method can extract fine-scale detail regardless of contrast. Single mean layer is not sufficient to well approximate atmospheric veil, and it is solved by iterative calculation, which is time-consuming.Our method consists of three steps: 1) identification of local extrema of V' ; 2) inference of extremal envelopes; 3) recover the scene information.

To locate the extrema in V' . Pixel p is considered as a maxima if at most k-1 elements in the kxk neighborhood around p are greater than the value at pixel p, otherwise its minima. As for the next step, we will employ the interpolation of the local minima and maxima to compute minimal and maximal extremal envelopes respectively for the inference of extremal envelopes. We can directly recover the scene information using atmospheric scattering model,

$$R(x;y) = \frac{[\, I(x;y) - qV_i(x;y)]\, A}{1 - V_i(x;y)} \qquad (6)$$

where the parameter q ($0 < q < 1$) is simply fixed to 0.95, which is used for regulating the degree of defogging. This means that 95% of the amount of atmospheric veil is removed.In practice, remaining a small amount of mist can make image layer clearer.

IV. RESULT

The simulated results for processing of hazy images in different stages are given below. Figure 4.1 shows the input hazy image. The image is restored using Dark channel method by estimating the atmospheric light and and local extrema method for the refinement of atmospheric veil**.**

Fig.2 Input foggy image and fog free image after defogging method

V. CONCLUSION

In this paper, an approach based on local extrema technique for fog removal in single image capture under bad weather conditions is proposed. It estimates skylight and atmospheric veilsThis method works effectively than other traditional methods for fog and noise removal under different weather conditions. This technique can be modified to get much more clear images.There is still a common problem to be solved. The contrast of the image is not as the original and the

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

An ISO 3297: 2007 Certified Organization *Vol. 5, Special Issue 4, March 2016*

National Conference on Signal Processing, Instrumentation and Communication Engineering (SPICE' 16)

Organized by

Dept. of ECE, Mar Baselios Institute of Technology & Science (MBITS), Kothamangalam, Kerala-686693, India

scattering coefficient β in the atmospheric scattering model cannot be regarded as a constant in inhomogeneous atmosphere conditions

REFERENCES

[1] Y. Y. Schechner, S. G. Narasimhan, and S. K. Nayar, "Instant dehazing of images using polarization", IEEE Computer Society Conference on Computer Vision and Pattern Recognition, pp. 325-332, 2001.
[2] Fattal R. "Single image dehazing". ACM Transactions on Graphics (TOG), 2008, 27(3): 1-9
[3] S. K. Nayar and S. G. Narasimhan, "Vision in bad weather," in Proc. 7th IEEE Int. Conf. Comput. Vis., Jun. 1999, vol. 2, pp. 820–827.
[4] He K M, Sun J, Tang X O. "Single image haze removal using dark channel prior". In: Proceedings of the 2009 IEEE Conference on Computer Vision and Pattern Recognition. Miami, USA: IEEE Press, 2009. 1956¡1963
[5] He K M, Sun J, Tang X O. "Guided image filtering". In: Proceedings of the 2010 European Conference on Computer Vision (ECCV). Berlin, Germany: Springer-Verlag, 2010. 1-14
[6] Tan R T. "Visibility in bad weather from a single image". In: Proceedings of the 2008 IEEE Conference on Computer Vision and Pattern Recognition. Anchorage: IEEE Computer Society, 2008. 1¡8
[7] Subr K, Soler C, Durand F. "Edge-preserving multiscale image decomposition based on local extrema''. ACM Transactions on Graphics, 2009, 28(5): Article No. 147