



Fog Removal Based On Local Extrema

Depthy S Nair

Student, Department Of ECE, EASA College Of Engineering And Technology, Coimbatore, India

Abstract: Atmospheric conditions induced by suspended particles, such as fog and haze, severely alter the scene appearance. In this paper, we propose a novel defogging method based on the local extrema, aiming at improving the image visibility under foggy or hazy weather conditions. The proposed method utilizes an atmospheric scattering model to realize the fog removal. It applies the local extrema method to figure out three pyramid levels to estimate atmospheric veil, and manipulates the tone and contrast of details at different scales through a multi-scale tone manipulation algorithm. The results on the experiments of comparison with traditional methods demonstrate that the proposed method can achieve more accurate restoration for the color and details, resulting in a great improvement in image visibility.

Keywords: Defog, local extrema, atmospheric scattering model, haze removal.

I. INTRODUCTION

Poor visibility becomes a major problem for most outdoor vision applications. Bad weather, such as fog and haze, can significantly degrade the visibility of a scene. The low visibility inevitably handicaps visual recognition and comprehension. The goal of defogging methods is to remove the effects of fog and recover details and colors of the scene from a foggy image.

Most traditional image enhancement methods, such as histogram equalization, Retinex, the wavelet transform, usually cannot obtain an ideal defogging result. These methods mainly focus on enhancing low brightness and low contrast features in digital images, and they are simple, efficient, and can be applied to most real-time scenes. However, they do not consider the reason why the image is degraded by fog and cannot compensate effectively. Therefore, these methods are limited to performing the defogging task and even may introduce halo artifacts or distort the color.

II. BACKGROUND

The attenuation of luminance through the atmosphere was studied by Nayar and Narasimhan, who derived a foggy image degradation model called an atmospheric scattering model. 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:

$$I(x; y) = R(x; y) e^{-\tau d(x; y)} + A \int_0^{\infty} e^{-\tau t} dt; \quad (1)$$

where $d(x; y)$ is the distance of the object at pixel $(x; y)$, A is called skylight and represents the luminance of the sky, τ is the scattering coefficient of the atmosphere, $I(x; y)$ is the intensity of the image degraded by fog, $R(x; y)$ is the intensity of the clear image without fog. The removal of the fog is actually to solve $R(x; y)$. The atmospheric scattering model assumes that the atmosphere is homogeneous and does not consider wavelength's influence on atmospheric scattering

coefficient, so τ is considered to be a constant. The difficulty is that single image defogging is an ill-posed problem. Indeed, from (1), defogging requires estimating A , τ , and d at every pixel, only knowing the input image I .

In the atmospheric scattering model, the calculation of scene depth and atmospheric scattering coefficient generally requires additional information such as the vanishing points from the infinite plane. The location confirmation of vanishing points relies on the subjective judgment or is realized through the image processing algorithm (e.g., Hough transform, Curvelet transform). In many cases, vanishing points are difficult to be accurately estimated, which may cause the bad image visibility restoration. As a consequence, we introduce the atmospheric veil to avoid solving d and τ , which can be expressed by

$$V(x; y) = A \int_0^{\infty} t(x; y) dt; \quad (2)$$

where V is defined as the atmospheric veil, t is the transmission map which can be expressed as $t(x; y) = e^{-\tau d(x; y)}$. V denotes the effect of ambient light [1], t reflects the ability of light penetration. They both contain the depth information. Estimating the transmission map and atmospheric veil are two main kinds of defogging methods based on the physical model. The estimation of t needs to rely on the solution of skylight and a constant parameter setting [6], however, estimation of V can avoid being directly influenced by other parameters and can be executed quickly and accurately. Through the subsequent parameter adjustment, estimating the atmospheric veil method can achieve a good image restoration result.

III. DEFOGGING METHOD

In this paper, we introduce a novel defogging technique based on the local extrema method to remove fog or haze from a single image. Our method can be decomposed into



three steps: estimating the skylight and correcting color through white balance; estimating the atmospheric veil based on local extrema method and recovering the image visibility by inverting atmospheric scattering model; Controlling the visibility by multi-scale tone manipulation algorithm

visually pleasing restored results. The time consumption of is mainly associated with the estimation of transmission map or atmospheric veil. Both of their calculations can reach $O(N)$. From top to bottom, the dimensions of images provided in Fig. 3 are 315x315, 460x380, 600x400 and 600x450, and the four groups of experimental images are expressed as Fig. 3(a)-(d)

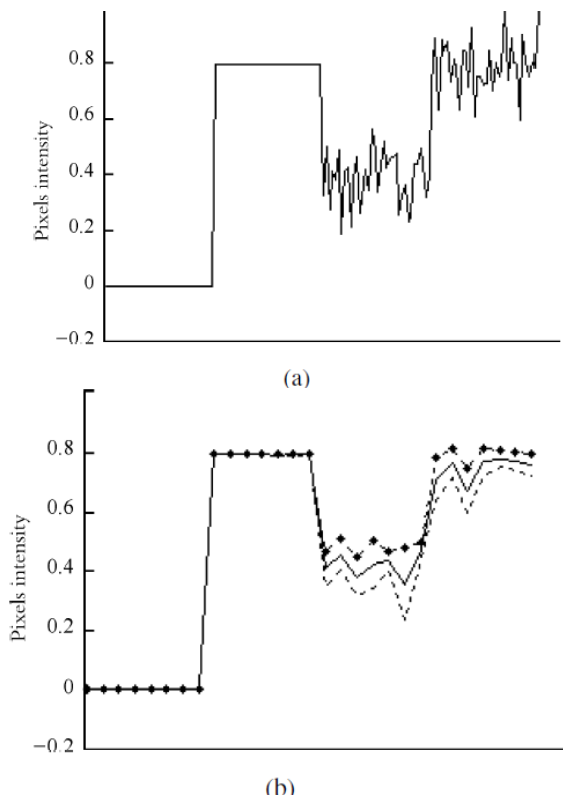


Fig. 1. Image smoothing effect in three scales. (a) The input image signal (b) The smoothed results by the minimal envelope (dash line), maximal envelope (dot-dash line) and the mean layer (continuous curve) computed by these two envelopes.

IV. COMPARISON EXPERIMENTS

In order to verify the effectiveness of the defogging method, we will evaluate the proposed method on the real scene and the virtual scene. The experiments will be conducted on the matlab platform and mainly deal with low resolution images for better detail comparison. Firstly, in the aspect of restoring real world foggy images, our method will compare with two classical methods: Tarel's no black-pixel constraint (NBPC) and He's method based on guided filter. Tarel et al. introduced a complete inference of atmospheric veil in . He et al first proposed dark channel prior to initialize transmission estimation in . However, the matting Laplacian regularization might lead to an overall reduction of contrast at the distant regions and had high time and space complexity. Reference was their improved method free from these problems. Both methods are known for their robustness and can produce

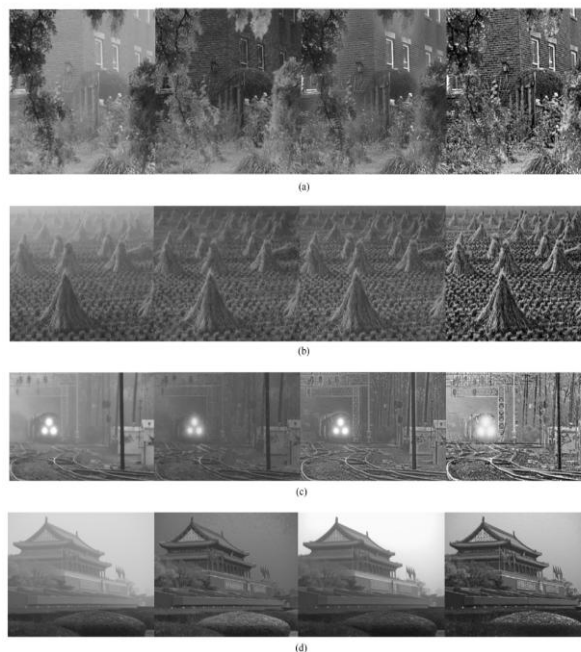
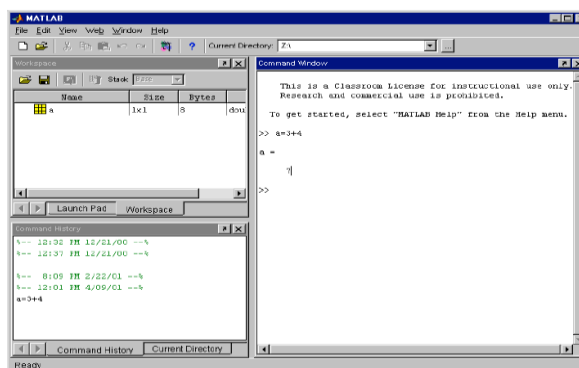


Fig. 3. Fog removal results of real world image. From left to right: the input foggy images, Tarel's results, He's results, and our results

V. USING MATLAB

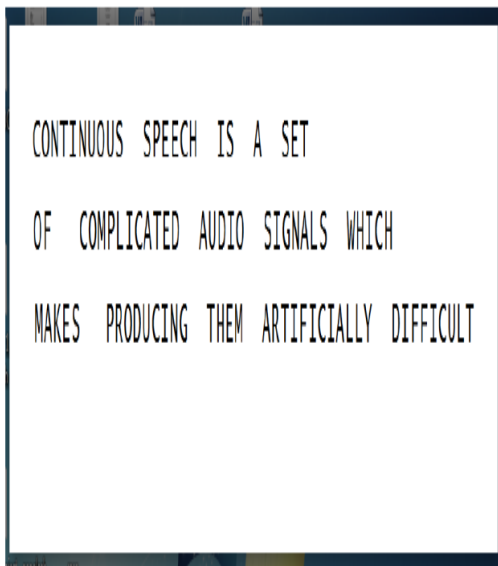
The fog removal conversion is achieved through the Matlab software. To prove the robustness of our method, the new operator has been tested on a large dataset of different natural hazy images. Haze due to dust, smoke and other dry particles reduces visibility for distant regions by causing a distinctive gray hue in the captured images..

A. Command Window





B. INPUT IMAGE



V1.SIMULATION AND RESULT

The Text To Speech conversion is achieved through the Matlab software. However, our technique has been successfully tested as well for a slightly different case: foggy scenes. For our problem, fog has a similar impact as haze, but technically it appears as a dense cloud of water droplets close to the ground when night conditions are clear but cold, and the heat released by the ground is absorbed during the day. We assume that the input hazy/foggy images are color images and the images may contain achromatic objects

ACKNOWLEDGMENT

My foremost thanks go to my research supervisor Asst. **Prof. Mr Mukunthan S**, who had showered us with ideas and guidance through the whole time till last second. This work would not have been possible without her help and inspiration.

We would like to thank our Head of Department Professor **Dr. Sudhakar S** and Project coordinator **Ms Shabana J**, for her vital encouragement and support. Last but not least, we would like to express our appreciation to our beloved parents for the unconditional love and support that let us through the toughest days in our life.

REFERENCES

- [1] Nayar S K, Narasimhan S G. Vision in bad weather. In: Proceedings of the 7th International Conference on Computer Vision 1999. Kcrkyra: IEEE Computer Vision, 1999. 820;827
- [2] Narasimhan S G, Nayar S K. Contrast restoration of weather degraded images. IEEE Transactions on Pattern Analysis and Machine Intelligence,

- 2003, 25(6): 713;724
- [3] Shwartz S, Namer E, Schechner Y Y. Blind haze separation. In: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. New York, USA: IEEE Press, 2006. 1984;1991
- [4] 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
- [5] Fattal R. Single image dehazing. ACM Transactions on Graphics (TOG), 2008, 27(3): 1;9
- [6] 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
- [7] 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
- [8] Tarel J P, Hauti N. Fast visibility restoration from a single color or gray level image. In: Proceedings of the 12th International Conference on Computer Vision. Kyoto, Japan: IEEE, 2009. 20;28
- [9] Yu J, Li D P, Liao Q M. Physics-based fast single image fog removal. Acta Automatica Sinica, 2011, 37(2): 143;149
- [10] Nishino K, Kratz L, Lombardi S. Bayesian defogging. International Journal of Computer Vision, 2012, 98(3): 263;278

BIOGRAPHY



Deepthy S Nair, pursuing final year MTech degree in Electronics and Communication Engineering from Anna University, Tamilnadu, India. Completed BTech in Electronics and communication Engineering from MG University, Kerala