Survey on Haze Removal Algorithm for image

[1]Ruhi Kolhe, [2]Prof. P. R. Badadapure

[1]Student, [2]Professor, [1,2]Imperial college of Engg. & Research Wagholi, Pune, Maharashtra, India.

[1]*ruhi174@gmail.com*

Abstract - In this paper, the image dehazing algorithms have been discussed. The Haze makes the image processing and computer vision systems failure because haze diminishes the visibility of the scene. Hence the details in the image have been lost. The main factors of the formation of the haze are the attenuation of the atmospheric light and the air light. The factor attenuation reduces the image contrast while whiteness in the image is occur due to air light. These problems can be solved by the proper implementation of the dehazing algorithms. These algorithms remove the hazing effect from the image and recover the original image.

***Keywords* — Attenuation, CLAHE, Dark channel prior, De-hazing, HDR imaging, polarization, visibility restoration.**

I. INTRODUCTION

In outdoor imaging, captured images are easily affected by particles in the atmosphere and that causes scattering of light. The image degradation occurs due to object camera motion, camera misfocus, atmospheric violents etc. such degraded images are visually poor. Image is usually degraded due to the scattering of light caused by small particles (e.g. fog, haze, smoke etc.) present during bad weather conditions. Haze is the phenomenon where the environmental contents like dust, fog, smoke alters the clarity of the sky. . It includes a classification of horizontal obscuration into categories of fog, ice fog, steam fog, mist, haze, smoke, volcanic ash, dust, sand and snow. Due to haze the color of the sky becomes brownish or bluish gray in color.

Therefore haze removal is of utmost importance for processing of such degraded images to be used in various research areas. Various haze removal techniques have been proposed so far that have been proved to be highly efficient and useful. Dehazing techniques mostly focus on image enhancement and image visibility restoration.

Haze removal is the crucial task because the fog depth is depends on the distance between camera and object. This problem can be solved by requires the estimation of air light map or depth map. Effective haze or fog removal of image can improve the stability and robustness of the visual system and it is useful in consumer/computational photography as well as computer vision applications.

II. LITERATURE SURVEY

This section covers study of various haze removal techniques proposed so far. Various methods have been discussed below.

A. Atmospheric Light Estimation

Atmospheric light is one of the parameter which helps to remove the hazing effect from the image. Most of the existing method uses thresholding techniques to atmospheric light estimation. But sometime light from the vehicle makes brighter pixel. Hence hard thresholding makes the estimation wrong.

Huimin, et al. [2015] has proposed a single optimized image dehazing method that estimates atmospheric light efficiently and removes haze through the estimation of a semi-globally adaptive filter. The processed images have good exposure in the dark environment. The textures and edges of the processed images are also enhanced significantly. This method contains following steps:

1. Robust Estimation of Ambient Light.

2. Scene Transmission Estimation.
3. Refinement based on a Semi-Globally Adaptive Filter.

(a)

(b)

(c)

Fig.1. Atmospheric Light estimation (a) Input foggy image (b) Estimated scene transmission (c) Refined by Semi-Globally Adaptive Filter

B. Visibility Restoration technique

A novel approach of image dehazing based on the visibility restoration is proposed by Livingston, et al. [2016]. The proposed technique along with atmospheric light estimation involves additional three important modules: a Depth Estimation (DE) module, a Color Analysis (CA) module and a Visibility Restoration (VR) module. Initially, the proposed DE module designs an effective refined transmission procedure which takes advantage of the median filter to preserve edge information and thereby avoid generation of block artifacts in the restored image. The intensity of the transmission map is adjusted by the process of transmission enhancement. After these two procedures are accomplished by the DE module, effective depth information can be obtained. Next, in order to recover true color, the color characteristics and color information of the input hazy image are respectively analyzed and acquired in the proposed CA module. In last step the VR module recovers the haze free image using correlated information.

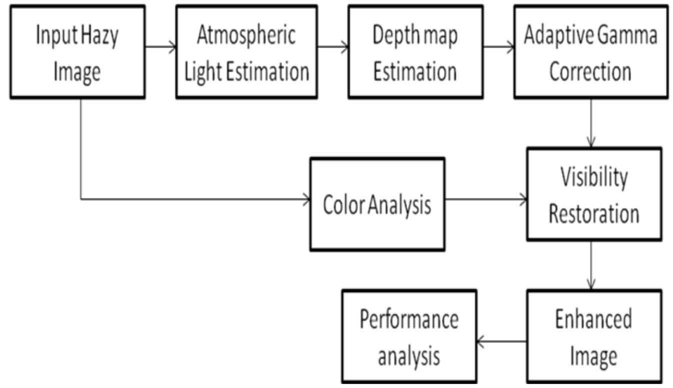


Fig.2. Block diagram of proposed visibility restoration technique

C. Color Attenuation Prior

The technique of image dehazing based on the color attenuation prior is presented by Zhu, et al. [2015]. In this method color attenuation helps to develop a linear model for scene depth of the hazy image. The applying supervised learning to the linear model, the hazy image depth map can be separate out from the original cleared image. With the help of this method the haze from the image can be easily removed.

This method is processed through following steps:

1. Atmospheric Scattering Model.
2. Color Attenuation Prior.
3. Scene Depth Restoration.
4. Scene Radiance Recovery.

The outputs of the color attenuation prior approach are as shown below in Fig. 3.

Fig. 3 Color attenuation prior results (a) Hazy image (b) Processed image

D. Polarization

Schechner, et al. [2005] presented a novel approach that can overcome degradation effects in underwater vision. It analyzes the physical effects of visibility degradation. The primary effect of the degradation is cause due to the partial polarization of the light. Hence this problem can be solved by the inverting the image formation process by recovering good visibility in images of scene. The algorithm does not require any calibration of the environmental parameters and exploits natural lighting. Also it is based on a couple of images taken through a polarizer at different orientation. In addition to this, the algorithm analyzes the noise sensitivity of the recovery. This algorithm achieved the good improvement in scene contrast and color corrections.

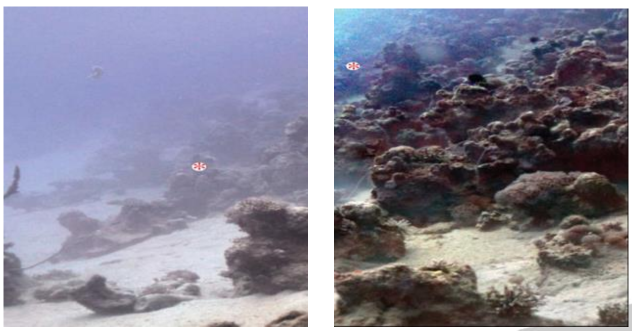


Fig. 4 Polarization results: Comparison between the raw image and the recovered image

E. Multi-Sensor Fusion

The images from different environmental conditions are studied by Narasimhan, et al. [2003] and Cozman et al. [1997]. Narasimhan present the physic based approached in which the model is created by considering the scenes in the bad weather conditions. The change in the intensities of the image in different weather condition helps to create the model. Then, a fast algorithm to restore scene contrast is presented.

In contrast to previous techniques, in this method the algorithm does not required any prior information about a prior scene structure, distributions of scene reflectance's, or detailed knowledge about the particular weather condition. This all methods are applicable to the wide range of environmental conditions.

Further, the methods can be applied to gray scale, RGB color, multispectral and even IR images. This technique also extend to restore contrast of scenes with moving objects, captured using a video camera.

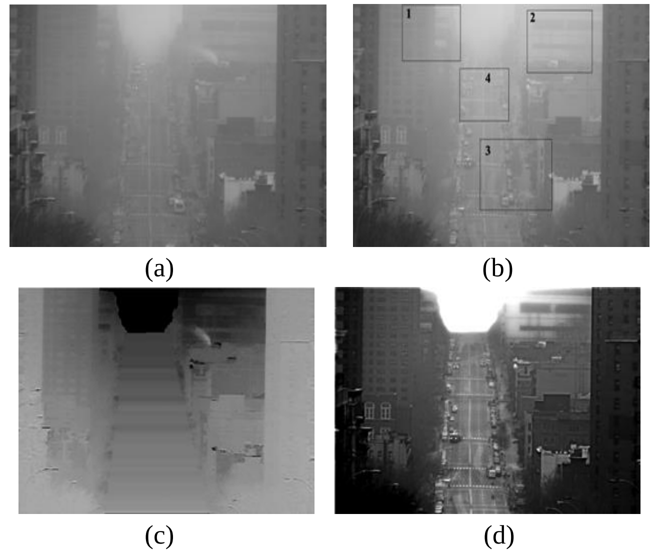
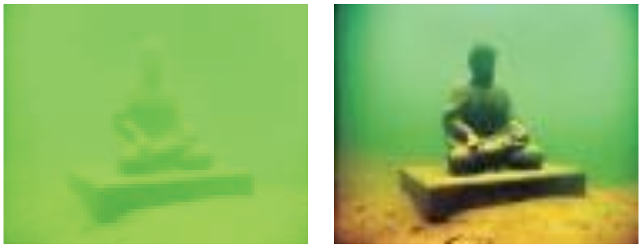


Fig. 5. Multi sensor fusion method results (a) Scene imaged at 5:00 P.M. (b) Scene imaged at 5:30 P.M. (c) Depth map computed from images (a) and (b). (d) Contrast restored using image.

F. HDR Imaging

Ancuti, et al. [2012] describes the method to enhance underwater videos and images. Built on the fusion principles, the strategy derives the inputs and the weight measures only from the degraded version of the image. In order to overcome the limitations of the underwater images such as color correction and contrast enhancement of the original underwater images but the clarity of the image is poor due to the distance between the object and camera because the light is scattered and absorbed by the particles. This algorithm neither required any prior knowledge about the environment nor hardware. The output images are less noisy, better exposedness in the dark area, improved contrast and preserve the edges. The fusion of the Laplacian pyramids based method is applied over the hazy image that consider the pyramid contrast, contrast, saliency, and exposure features between a white-balanced image and a color-corrected image. Then, they utilized the exposure fusion algorithm to obtain the final result. However, several experiments report color shifts as a result of exposure processing.



(a) (b)

Fig. 6. HDR imaging on underwater image (a) Input image (b) Obtained result

G. Dark Channel Prior

He et. al. [14] presents the effective dark channel prior to remove the haze from the single input hazy image. The dark channel prior is referred to as the statistic of outdoor haze free image. The haze free image contains some pixels whose intensity value is very low. With this feature we can construct a model and can directly remove the haze from the image. Since the dark channel prior is a kind of statistics, it may not work for some particular images. The dark prior is failed if the intensity of the scene object and atmospheric light is similar. The dark channel of the scene radiance has bright values near such objects. As a result, our method will underestimate the transmission of these objects and overestimate the haze layer.

Fig.7. Dark channel prior output (a) Hazy image (b) De-hazed image

H. CLAHE

Zhiyuan, et al. [2009] proposed a method called Contrast limited adaptive histogram equalization (CLAHE) that is used for contrast enhancement of images. This method doesn't require any weather information before the process of fogged image.

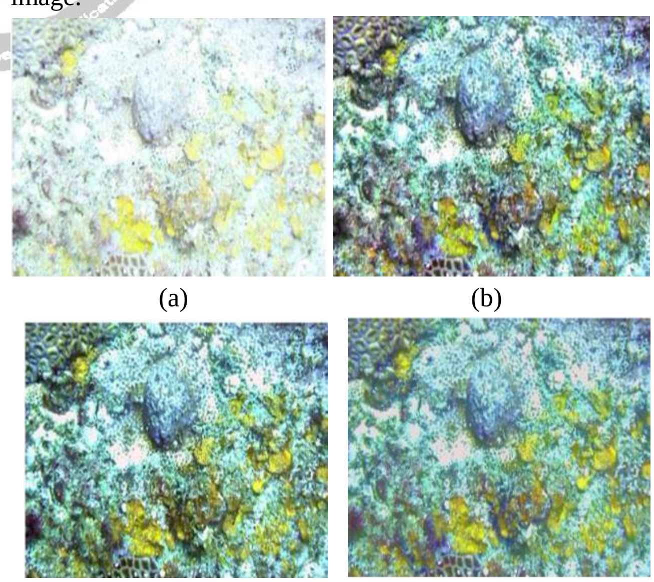
a) Convert input image from RGB format to HSV color space. This image conversion is required as human sense colors in same way as colors are represented in HSV format.

b) CLAHE is used to process the value component without affecting hue and saturation of image. The method uses histogram equalization to a contextual region. Each pixel in the original image is placed in the middle region of the contextual region. The histogram of the original image is cropped and it is redistributed over the whole image. The new histogram is different from the original histogram, because pixel intensity is limited to a user-defined maximum. In last step, the input image processed in HSV format is converted back in RGB format.

Fig 2.9 (a) input image (b) output image

I. Mix-CLAHE

Hitam, et al. [2013] [5] proposed a method which can be used to improve underwater image details, it is based on CLAHE. The visibility of the underground image is improved by this method. It produces the maximum PSNR and the minimum MSE values. Thus, this method is able to classify the coral reefs. The aim of this method is to enhance the image contrast and at the same time preserve the natural look of underwater image.



(a) (b)

(c) (d)

Fig. 7. Mix-CLAHE method (a) original underwater image (b) CLAHE-RGB image (c) CLAHE-HSV image output and (d) CLAHE-Mix result.

J. Trilateral Filtering

Cheng et. al. [7] proposed an image smoothing approach which preserves the edges by means of non linear combinations of nearest neighbor's pixels. In this filter replaces each pixel by weighted averages of its neighbor's pixel. The weight allotted to each neighbor pixel decreases with both the distance in the image plane and the distance on the intensity axis. This filter helps us to get result faster as compare to other. While using trilateral filter we use pre-processing and post processing steps for better results. Histogram stretching is used as post-processing and histogram equalization as a pre processing.

III. CONCLUSION

The survey of the different image dehazing algorithm has been discussed in this paper. From the study of the different method it is found that the most of the issues were neglected such as noise reduction in the fog removal algorithm is missing. The problem of uneven and over illumination is not observed by the researchers.

Hence, It is more important to develop or modify the existing system in such a manner that method could remove the above defined problem and achieve a good PSNR.

REFERENCES

[1] Y. Schechner, N. Karpel, "*Recovery of underwater visibility and structure by polarization analysis*", IEEE Journal of Oceanic Engineering, 30(3), pp.570-587, 2005

[2] J. Liang, L. Ren, H. Ju, E. Qu, Y. Wang, "*Visibility enhancement of haze images based on a universal polarimetric imaging method*, Journal of Applied Physics, 116(17), pp.1731071- 731077, 2014.

[3] F. Cozman, E. Krotkov, "*Depth from scattering*", in Proc. of IEEE Conference on Computer Vision and Pattern Recognition, pp.801-806, 1997.

[4] C. Ancuti, C. O. Ancuti, T. Haber, P. Bekaert, "*Enhancing underwater images and videos by fusion*", in Proc. of IEEE Conference on Computer Vision and Pattern Recognition, pp. 81–88, 2012.

[5] Hitam, M. S., W. N. J. H. W. Yussof, E. A. Awalludin and Z. Bachok, "*Mixture contrast limited adaptive histogram equalization for underwater image enhancement*", IEEE International Conference on Computer Applications Technology (ICCAT), pp. 1-5, 2013.

[6] Zhiyuan Xu. "*Fog Removal from Video Sequences Using Contrast Limited Adaptive Histogram Equalization*", International Conference on Computational Intelligence and Software Engineering, 2009.

[7] Cheng, F-C., C-H. Lin, and J-L. Lin (2012): *Constant time O (1) image fog removal using lowest level channel* Electronics Letters 48.22, 1404-1406.

[8] Y. Y. Schechner, S. G. Narasimhan, and S. K. Nayar, "*Instant dehazing of images using polarization*," in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR), 2001, pp. I-325–I 332.

[9] Y. Y. Schechner, S. G. Narasimhan, and S. K. Nayar, "*Polarization-based vision through haze*," Appl. Opt., vol. 42, no. 3, pp. 511–525, 2003.

[10] S. G. Narasimhan and S. K. Nayar, "*Chromatic framework for vision in bad weather*," in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR), Jun. 2000, pp. 598–605.

[11] S. K. Nayar and S. G. Narasimhan, "*Vision in bad weather*," in Proc. IEEE Int. Conf. Comput. Vis. (ICCV), vol. 2. Sep. 1999, pp. 820–827.

[12] S. G. Narasimhan and S. K. Nayar, "*Contrast restoration of weather degraded images*," IEEE Trans. Pattern Anal. Mach. Intell., vol. 25, no. 6, pp. 713–724, Jun. 2003.

[13] S. G. Narasimhan and S. K. Nayar, "*Interactive (de) weathering of an image using physical models*," in Proc. IEEE Workshop Color Photometric Methods Comput. Vis., vol. 6. France, 2003, p. 1.

[14] K. He, J. Sun, and X. Tang, "*Single image haze removal using dark channel prior*," IEEE Trans. Pattern Anal. Mach. Intell., vol. 33, no. 12, pp. 2341–2353, Dec. 2011.

[15] Q. Zhu, S. Yang, P. A. Heng, and X. Li, "*An adaptive and effective single image dehazing algorithm based on dark channel prior,*" in Proc. IEEE Conf. Robot. Biomimetics (ROBIO), Dec. 2013, pp. 1796–1800.

