Review on Haze Removal Methods

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Abstract- Image dehazing is one of the most important research area in image processing and pattern analysis. Haze is naturally an atmospheric effect. And it is the combination of air light and attenuation process. Air light increases the whiteness of the image and attenuation effect reduces the contrast. Haze removal algorithms are important in many vision applications. This paper reviewed various haze removal algorithms used for the purpose of dehazing operation in image processing applications.

Index Terms- Haze removal, image enhancement, visibility restoration, DCP, ICA polarizer.

I. INTRODUCTION

The main aim of image processing is to understand, recognize, and interpret the data from the image pattern. In some cases image may be corrupted by moistureless particles such as dust, smoke, snow, haze, and fog. These poor weather conditions reduce the clarity of the images. When increasing the distance between object and the camera, clarity of the image automatically reduces.

Haze and fog are an atmospheric effect, but they are different: fog is thick and opaque effect while haze is thin and translucent effect.

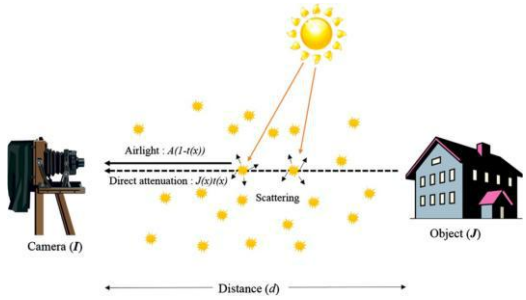

Figure.1: Formation of Haze

Haze is formed due to airlight and attenuation process as shown in Figure.1. Airlight increases the whiteness and attenuation decreases the contrast in an image Haze removal method divided into to two classifications: image enhancement and image restoration. The main objective of image enhancement is to process a given image so that the result is more suitable than the original image. Image restoration is the process of taking a corrupted or dehazed image and evaluating the clean original image. The image corruption is caused by many reasons such as motion blurs, noise, camera miss-focus image, etc.

Some of the dehazing methods are reviewed here. Fast image dehazing using improved dark channel prior [4] uses the contrast limited adaptive histogram equalization. Here original image is divided into sub image and histogram of sub image calculated and clipped. Single image haze removal using edge detection [5] calculating atmospheric light and transmission for dehazing the images. Here sobel edge detection is used in the preprocessing step. Single image fog removal using bilateral filter [3] smoothes the image without affecting edges. This filter replaces every pixel by weighted average of its neighboring pixel. Similarly many methods are used to enhance the visibility of hazy images.

II. RESTORATION TECHNIQUE

Haze removal method can be classified into multiple image dehazing method and single image dehazing method as shown in Figure.2.

Multiple image dehazing methods:

This method uses two or more images of the same scene. It avoids unknown and attains known methods.

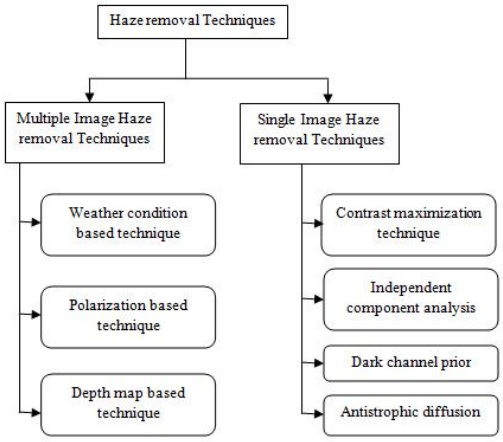

Figure 2: Restoration technique

Weather condition based method

In this method [1, 2] uses variations of two or more images of same scene. These images possess different characteristics of the contributing medium and also enhance the visibility. This method unable to handle the dynamic scene and cannot give the better result suddenly as shown in Figure.3.

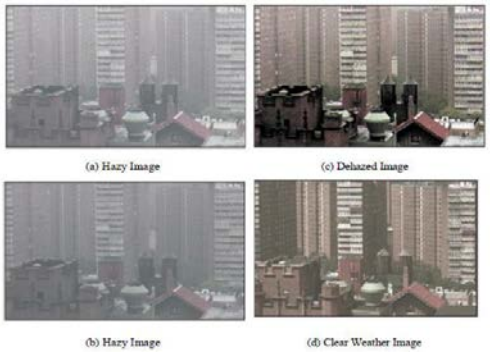

Figure. 3: Weather condition based dehazed image

Polarization based method

In this method [6] uses two or more images of the same scene with different polarization filter, which are acquired by rotating a polarizing filter attached by the camera. This method cannot be applied to dynamic scenes for which the changes are more rapid than the filter rotation. This method may fail in very dense haze as shown in Figure.4.

Figure. 4: Dehazing using polarizer

Depth map based method

In this method [7] uses the 3D geometrical model and texture of the scene. This 3D model aligns hazy image and provides scene depth and accurate result as shown in Figure.5. This method is not automatic.

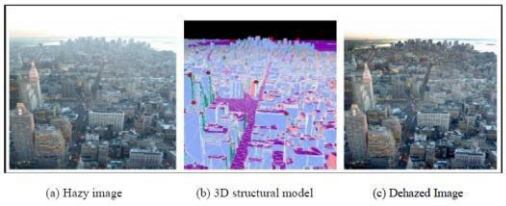

Figure. 5: Depth map based method

Single image dehazing methods:

This method uses the single input image and this method depends upon statistical assumption and essence of the scene.

Contrast maximization method

This method enhances the contrast and does not physically enhance depth or brightness as shown in Figure.6. The results of this method have large saturation values.

Figure. 6: Contrast maximization method

Independent component analysis

In this method [9] divide two additional components from a single image as shown in Figure.7. It is based on the assumption that surface shading is statistically uncorrelated in local patch. This method provide better result but the disadvantage is cannot remove dense fog or haze clearly.

Figure. 7: Independent component analysis

Dark channel prior

Dark channel prior [16] is one the effective method to dehaze the hazy image as shown in Figure.8. Dark channel means minimum of lowest intensity value. In this method[13, 14, 15 17], first we have to calculate the atmospheric light and transmission for removing the haze in an image. Here top .1% of dark channel of the input image is considered as the atmospheric light. And also 3x3 window size is used here. Main disadvantage is cannot remove halo artifact efficiently.

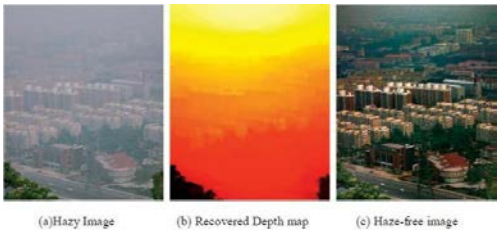

Figure.8: Dark channel prior method

Improved single image dehazing using dark channel prior

This method [18] is similar to dark channel prior method, difference is for calculating atmospheric light window size is increased to 31. This method provides better result than DCP.

Improved haze removal algorithm using DCP (based on Guided filter)

When the large grey region of the image is similar to the atmospheric light, DCP cannot work. In this situation guided filter [19] is used for getting better result. It provided more accurate and better result.

Improved single image haze removal algorithm based on DCP and Histogram specification.

In this method [3] first DCP is proposed then rebuilding the histogram of the image by change the contrast and intensity of the resultant image. The main advantages are image contrast reduction, thick haze removal. Disadvantage is it increases the thickness of haze, when haze in the image is not removed clearly.

A novel defogging technique for dehazing images

This method [12] also finds the atmospheric light and transmission for getting dehazed image. This method overcome the disadvantage of DCP method and provides better result. Main advantages are less time complexity, Remove halo artifact, high edge preservation.

Table 1. Comparison of different DCP method

Parameter	DCP	IDCP	Guided Filter	Histogram Specification	Novel Defogging method
Time	Very high	High	Low	Low	Very low
Halo Effect	Very high	Medium	Low	High	Very low
Edge Preservation	Very low	Low	medium	High	Very high

Weighted haze removal method

This weighted method [10] is an efficient method to remove haze from hazy image. Here weighted atmospheric light and transmission of an image is calculated. Normal atmospheric light and transmission calculation causes long execution time. Weighted atmospheric light calculation balance the illumination of images and weighted transmission calculation mitigate the artifact.

Novel single image-based dehazing

This method [7] produce two image prior called pixel based dark and bright channel prior as shown in Figure.9. Based on this image prior estimate the atmospheric light and transmission. This method uses bilateral filter, which is efficient and with lower complexity. So as to produce high quality haze free image with low computational cost.

Figure. 9: Novel image based dehazing

Anisotropic diffusion

This method [11] removes the haze without removing edge, line and other image pats. This method smooth the airlight map and it produce better haze free images.

III. CONCLUSION

Haze removal algorithms are used to improve the visual quality of an image, which is affected by light scattering through haze particles. This paper studies various dehazing methods used in the field of image processing techniques. While compared with other novel single image dehazing produce the better results.

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