A Review on Different Image De-hazing Methods

Sweta Shaw, Rajarshi Gupta and Somshubhra Roy

Abstract This paper is written to present a review on the different haze removal techniques. Image de-hazing is the most important field of research in image processing and analysis. The process of de-hazing is important to make human understanding easier in low visibility. Haze is a state of poor air quality characterized by a pale scent appearance of atmosphere and reduces visibility. It is caused by high concentration of air pollutants suspended in the atmosphere that scatter and absorb sunlight. Because of this, the picture gets whitened and its contrast is reduced. The de-hazing techniques are very much in use in the field of numerous applications in the field of computer vision such as video surveillance and detection of object. The thorough purpose of this paper is to delve different procedures of efficaciously expel haze from any image and checks the drawbacks of the existing methods.

Keywords De-hazing · Depth map-based · Polarization-based · Dark channel prior

1 Introduction

The main aim of image processing is to visualize, sharpen, restore, retrieval, and recognize an image. Haze, fog, smog, etc. vitiate the image condition of outside scene. Haze present in an image is an abrasive issue as it quells the contrast and changes the color. Many applications do not work reliably because of it. The presence of haze also cutbacks the clearness of underwater pictures. As a result, removal of these bad weather situations is critical and unavoidable area of computer graphics.

Many issues have been created by the haze present in atmosphere in the field of terrestrial photography, as here for image distant subjects, the diffusion of enormous quantity of heavy atmosphere is necessary. Because of the consequences of scatter-

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ing of light by the haze particles, the contrast and hence the visibility get reduced. The prodigy of image de-hazing debauches picture quality, which adversely affects many applications which uses image processing. The scattering is basically due to attenuation and air light. Haze attenuates the light reflected from the objects which is then mixed with extra light present in atmosphere. The main motive of this technique is to boost the reflected light from the mixed light. An image's resolution and strength can be boosted by usage of the de-hazing technique. This can be achieved by using many image de-hazing techniques such as DCP, ICA, and depth map-based method.

2 Image De-hazing Methods

Following are the two major classifications of methods of image de-hazing.

2.1 Multiple Image De-hazing Method

In this de-hazing method, more than one image of the same scene is taken. There are many variables in an image. This method obtains the variables which are known and averts the variables which are unknown. The following methods fall under this category.

Method Based on Various Weather Conditions
Here many pictures are collected at different weather conditions. As the primitive idea, the differences of various pictures of the same object are taken. All the pictures have different prospects of devoted medium. It has some advantages as well as disadvantages. This method can surely improve the visibility, but one need to wait until the properties or rather the weather changes. So, it is time-consuming (Fig. 1).

Polarization-Based Method
Here, multiple pictures are taken at different polarization filters. In this method, the underlying principle is to take many pictures of similar view at various polarization degrees. To achieve this, the polarizing filter that is affixed with the camera is rotated. But this method is not so accurate for dynamic scenes (Fig. 2).

Depth Map-Based Method
In this procedure, the information of the depth is used for de-hazing. Here, a single image is used and it has been assumed that three-dimensional geometrical prototype of this view is imparted by any existing database and also assumed that the texture of the scene is given. This model is then aligned with hazy image to provide the depth of the scene. This method gives truthful results. But the disadvantage of this method is that it needs user interaction and cannot be applied automatically. This method needs many resources which are sometimes very difficult to obtain (Fig. 3).

Fig. 1 Hazy and De-hazed images

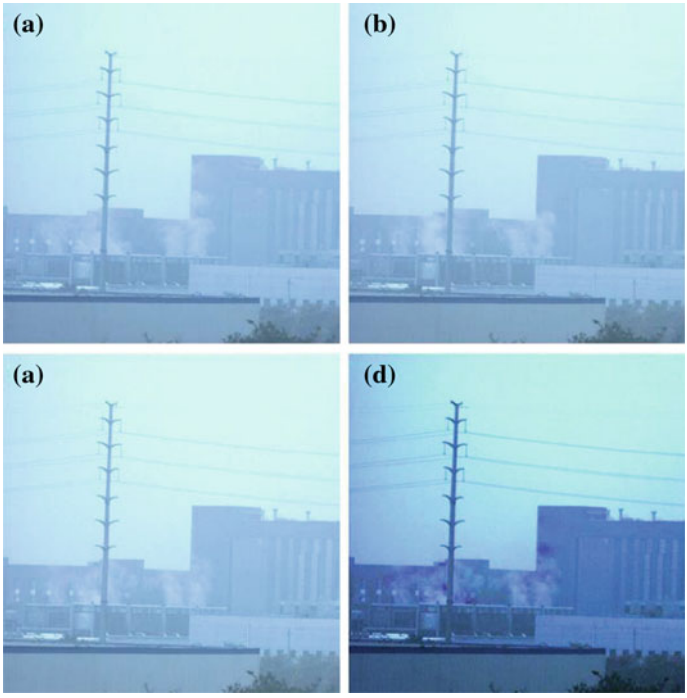

Fig. 2 **a** Image taken at polarization degree 0, **b** image taken at polarization degree 45, **c** image taken at polarization degree 90, and **d** the de-hazed image

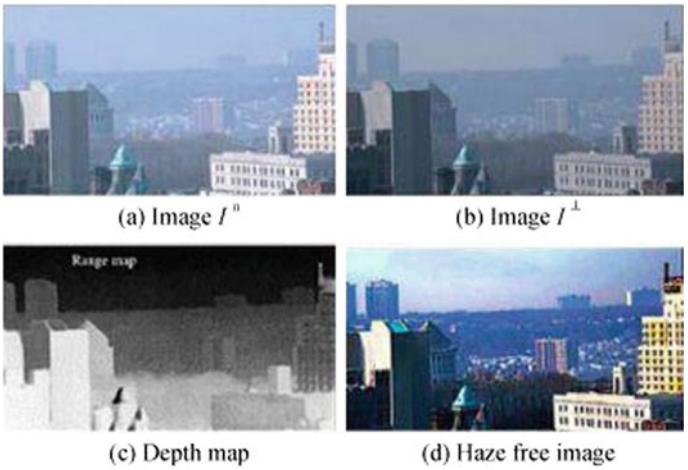

Fig. 3 De-hazing using depth-based method

Fig. 4 Images at different contrasts, de-hazed image

2.2 Single Image De-hazing Method

Unlike the multiple image de-hazing method, in this procedure, only one picture is taken. In this procedure, all the required information of the scene is taken from a single image, taken as the input. Researchers are more interested toward this method than the other one. The following methods fall under this category.

Method of Contrast Maximization
Haze abates the contrast. So, removing haze means embellishing the contrast. In this method, the contrast is enhanced, but there are many constraints. In this method, the brightness and depth are actually not improved. Only the visibility is enhanced by enhancing the contrast. Because of this, the saturation in the output image is very large, which is a great disadvantage of this method (Fig. 4).

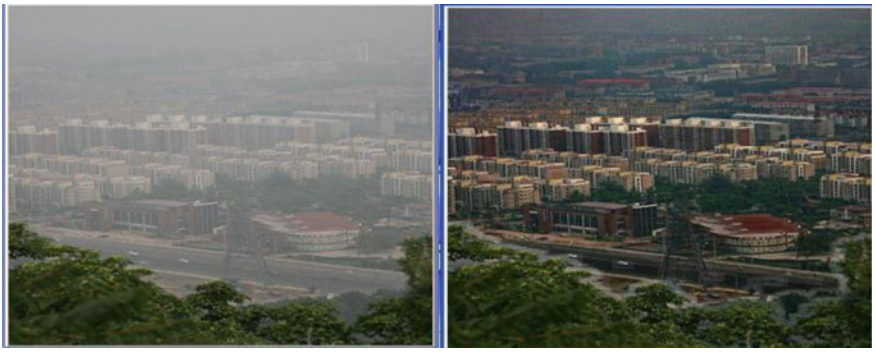

Fig. 5 Hazy and de-hazed images

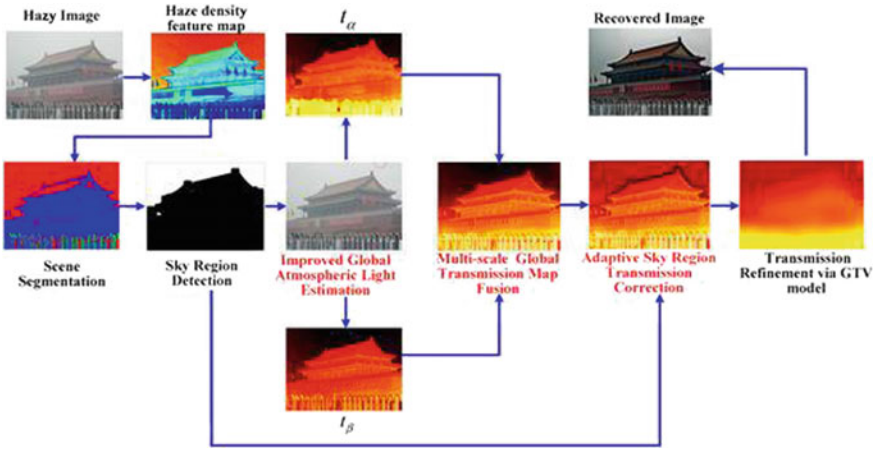

Fig. 6 De-hazing using DCP

Independent Component Analysis

This is a statistical procedure where two additional elements of the input image are divided. Here it is assumed that the transmission and shading of surface are statistically orthogonal in local patch. This procedure gives good result in sparse haze as it produces good result but in dense haze, it does not work properly (Fig. 5).

Dark Channel Prior Method

This is one of the most effective methods of image de-hazing. If we take all the lowest intensity value, then the minimum of it is the dark channel. In this method, the atmospheric light and transmission are calculated first of all for the purpose of de-hazing an image. Although this method gives successful output in both sparse and dense haze, it does not give good result when the scene image is same to the air light, as here the atmospheric light cannot be calculated accurately (Fig. 6).

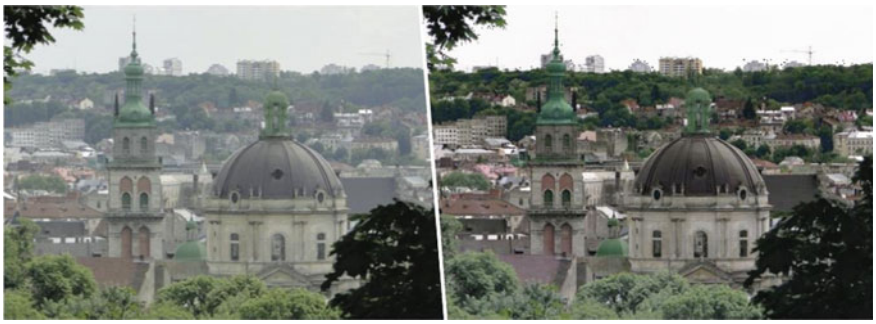

Fig. 7 Hazy and de-hazed images

Antistrophic Diffusion
In this method, the haze is removed without removing the important parts of the image such as edges and lines so that image understanding is not disturbed. In this method the antistrophic diffusion for refining air light map from DCP. The benefit of this method is that it is very flexible and works well in dense haze (Fig. 7).

3 Literature Survey

Tarel et al. [13] have given an algorithm for single image de-hazing, which depends on filtering approach. In this method, there are few linear operations that require many frameworks for alteration. The advantage of this algorithm is its speed which allows application of visibility restoration in real-time application of de-hazing of image.

He et al. [16] gave a very uncomplicated but adequate method (DCP) to de-haze an input image. It is a kind of stats of outside non-hazy pictures. Here, the estimation of haze transmission is achieved. This method doesn't effectively when air-light & surface object are same.

Xu et al. (2012) gave an enhanced DCP. The DCP was improved by rehabilitating the tedious soft matting part with the quick bilateral filter. It improved the previous dark channel prior algorithm by having fast execution speed and greater efficiency.

Ullah et al. [19] gave another improved DCP. In the new version of dark channel prior, both achromatic and chromatic features of input picture are considered. Here, the contrast and color vibrancy of restored images are further improved. Here, the least of saturation and intensity is considered instead of RGB components.

Arora et al. (2014) have proposed a new integrated dark channel prior (IDCP) method by combining dark channel prior (DCP), contrast limited adaptive histogram equalization (CLAHE), and gama correction methods. *M*ain motive of this algorithm is to boost the certainty of intelligent transportation system (ITS).

Ansia et al. (2014) *gave* a method to cynosure on contrast-based single image de-hazing. A white balancing is used to obliterate the color. The estimation of saliency map is done for the determination of the discernible region of the image. Then morphological operator is used to abolish the specularities. Then intensified CLAHE approach is used to augment the color contrast. This method produces better result for homogenous haze images.

JunMaro et al. (2014) developed a function for reckoning the haze degree for automatic detection of foggy image with different haze degree value. This method is advantageous in unusual weather conditions for computer vision-based applications such as video surveillance.

4 Gaps in Literature

A haze-free image possesses evident contrasts compared to a hazy image. There are many vision applications for which image de-hazing is important. After studying different methods/algorithms, it has been revealed that the researchers have overlooked many aspects. Using the literature survey, many research gaps are achieved which are listed below.

- The methods which are mentioned above neglect the noise removal.
- The methods also neglect the issue of irregular illumination which degrades the algorithm.
- No efforts have been taken to integrate the methods of DCP and CLAHE.
- Researchers have not made enough approach toward underwater images.
- No measure is taken toward remote sensing images.

5 Conclusion

Image de-hazing has been a prior research field in image processing. It has been a very important research as it is used to make the visibility possible in bad weather. There are many methods and algorithms proposed till now. The main two categories of these methods are single image de-hazing and multiple image de-hazing. Out of which, single image de-hazing is found to be more accurate and efficient than multiple image de-hazing as this method is less time-consuming and requires less resources. But none of these methods is suitable for all the circumstances. Some method lacks in one circumstance while the other lacks in any other circumstance. Hence, the methods which are already present need to be modified in such a way that they overcome all the problems simultaneously.

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