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Review on Single Image Dehazing Methods

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Abstract: Haze is formed due to attenuation and air light processes which degrades the visibility of outdoor images. Haze removal from images provides applications in navigation, remote sensing, satellite image identification, object detection and many vision applications. Single image dehazing methods are based on statistical assumption and essence of the scene. This paper reviewed various single image haze removal algorithms used for dehazing operation in image processing applications.

Keywords: Dehazing, Image enhancement, Image Restoration, Single image

I. INTRODUCTION

Haze is naturally an atmospheric effect. Haze is formed due to airlight and attenuation process. Air light increases the whiteness and attenuation effect reduces the contrast and deteriorates in color of the image. Haze tends to produce a distinguishing gray hue and is influenced to effect visibility. Dehazing is the process of removing haze from images. The visibility of outdoor images is often poor due to the atmospheric phenomena (haze, fog, sandstorms) in image processing applications. When the distance between the object and the camera is increased, the clarity of the image obtained is reduced and visibility of the image is reduced when having poor illumination. Dehazing is required in consumer/computational photography and computer vision applications.

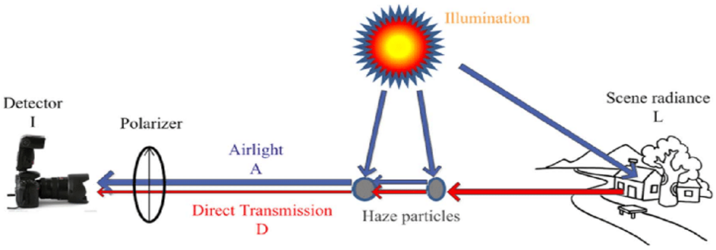

Fig.1 : The schematic of the imaging model in haze [1]

In computer vision, the model widely used to describe the formation of a hazy image is [2]:

$$\mathbf{I}(x) = \mathbf{J}(x)\, t(x) + \mathbf{A}\,(1- t(x))$$

where **I** is the observed intensity, **J** is the scene radiance, **A** is the global atmospheric light, and t is the medium transmission describing the portion of the light that is not scattered and reaches the camera.
Dehazing needs depth path and transmission map estimation.

II. IMAGE DEHAZING TECHNIQUES

A. Dark Channel Prior

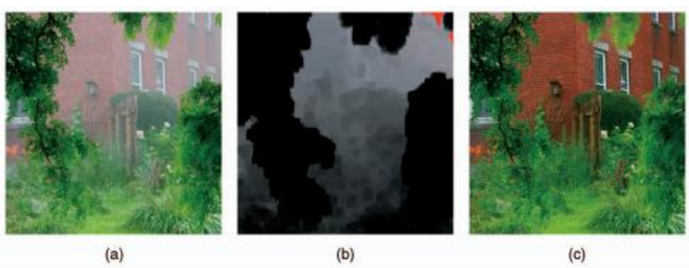

Fig.2: (a) Input image (b) Dark channel (c) DCP-haze free (Reproduced Xu et al.[3])

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In He et al. [3], Dark Channel Prior (DCP) method was applied to eliminate haze from images where some pixels, called dark pixels, have less intensity in any one color channel and used to calculate the transmission map. This approach is physically valid and gives a better dehazing result. When the scene objects are similar to the air light then it is invalid. In the hazy image, the intensity of these dark pixels in that channel is mainly contributed by the airlight. Therefore, these less intensity pixels directly provides accurate estimation of the haze transmission. With this method, single image haze removal becomes simpler and more effective. Its drawback is fails to remove haze in the sky region and method may fail to recover the true scene radiance of the distant objects and they remain bluish. Also Halo effects were produced in the resultant image [3].

B. Improved Dark Channel

The paper [4] examines the physical process of imaging in unclear weather. This algorithm based on a bilateral filtering combined with dark colors prior. Xu et al. uses the atmospheric scattering model [6] to derive an estimated transmission map by using dark channel prior [3]. Then combines with grayscale to extract refined transmission map by using the fast bilateral filter [7], where the filter replaces each pixel by a weighted average of its neighbours.

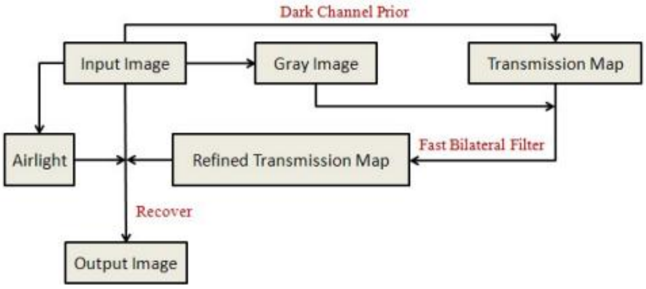

Fig.3: The flow chart of improved dark channel [4]

The paper [4] shown comparison of DCP and improved DCP result, as in the following fig 4:

(a) (b) (c)

Fig.4: (a) Input Image (b) DCP based dehaze image (c) Improved DCP dehaze image (Xu et al. [4])

C. Colour Attenuation Prior

In Q.Zhu et al. [5] is a based on the alteration between the brightness and the saturation of the hazy image pixels. By creating a linear model of the scene depth information of the haze image, using supervised learning method, keeps transmission map and restores visibility.

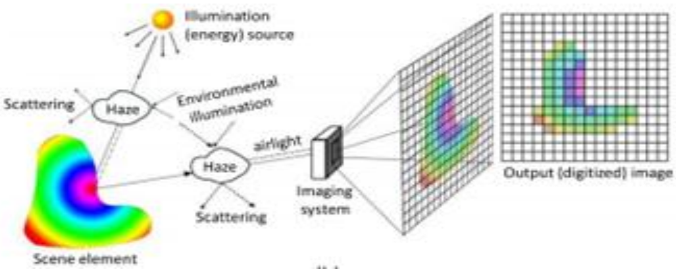

Fig.4: The process of imaging in hazy weather [5]

With the improved depth information it is possible to remove the haze from the single hazy image. It has high efficiency and good dehazing ratio. Easily estimate the transmission and restore the scene radiance.

Fig.5: (a) Hazy image (b) De-Hazed image [5]

D. Contrast Enhancement using Dark Channel Prior

This dehazing method is based on dark channel prior and contrast enhancement methodologies. The dark channel prior method removes haze and restores colors of objects in an image and the contrast method recovers the local contrast of objects. This method combines the advantages of these two approaches for keeping the color while dehazing. For this, an optimization function is used to balance between the contrast and colors distortion, where the contrast measure tracks the image statistics and the hue component is used to constrain the color changes [8].

E. Atmospheric Scattering Model

In this method [9] fine details are removed from the minimum channel of RGB by a low-pass filter to use it as an estimation of the transmission map. Then, refined that estimated transmission map by using the HIS color space saturation channel and local contrast.

Fig.6: (a) Input image (b) Haze free output [9]

III. APPLICATIONS OF HAZE REMOVAL METHODS

Haze removal methodology plays a crucial role in many image processing areas such as aircrafts, underwater image processing ,remote sensing, intelligent transportation systems, , Object detection, railway systems, aerial imagery, computational vision applications, video analysis and recognition, military surveillance system, etc.

IV. CONCLUSION

This paper presents single image haze removal methods which are used in several important applications. Due to the calculation of scene depth map, dehazing of a single image is a tedious and also it requires certain prior knowledge. Also to conserve the edges, illumination of the images and to maintain color characteristics dehazing of the images is important.

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