DESIGN AND IMPLEMENTATION OF A MODEL FOR HAZE REMOVAL USING IMAGE VISIBILITY RESTORATION TECHNIQUE

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Abstract - *Images plays an important role in the real world, images are used for describing the changes in the environment. Images are captured in open environment due to the bad weather or atmosphere images are not a clear. Images acquired in bad weather, such as the fog and haze, are extremely degraded by scattering of an atmosphere, and decreases contrast. The bad weather not only lead to variant of the visual outcome of image, but also to the difficulty of the post processing of the image. Images captured during adverse weather conditions frequently feature degraded visibility and undesirable color cast effects. The presence of suspended particles like haze, fog and mist in the atmosphere deteriorates quality of captured images. In this paper, we have proposed a dark channel prior and contrast limited adaptive histogram equalization technique, it is based on adaptive histogram equalization. The dark channel prior technique is helpful to clear the hazy images. Removing haze effects on image is a challenging and meaningful task for image processing and computer vision applications. In this work we remove haze from hazy image, and improve the quality of an image and then at last we obtain restored enhance haze-free image with clear visibility. The proposed technique is designed and implemented in MATLAB.*

Keywords: **Single image dehazing, Dark channel prior, Visibility restoration**

1. INTRODUCTION

Haze is a state of poor air quality characterised by opalescent appearance of the atmosphere. Haze was historically used to mean a particularly thin fog. Sources for haze particles include farming traffic, industry, and wildfires. Seen from afar (e.g. approaching airplane) and depending upon the direction of view with respect to the sun, haze may appear brownish or bluish, while mist tends to be bluish-grey. Whereas haze often is thought of as a phenomenon of dry air, mist formation is a phenomenon of humid air. However, haze particles may act as condensation nuclei for the subsequent formation of mist droplets; Such forms of haze are known as "wet haze." The presence of haze in bad weather will result in poor visibility and lost the contrast in images, as a result, a lot of bad impacts will arise on computer vision applications, such as outdoor surveillance, object recognition and tracking, unmanned vehicle systems etc.

Haze is produced by the presence of suspended little particles in the atmosphere, called aerosols, which are able to absorb and scatter the light beams. Aerosols can range from small water droplets to dust or pollution, depending on their size. The processing of hazy images focuses solely on compensating either light scattering or color change distortion. Haze brings trouble to many computer vision/graphics applications as it diminishes the visibility of the scene. Haze is formed due to the two fundamental phenomena.

Here, it describes the formation of a haze image as follows:

$$I(x) = J(X)t(x) + A(1 - t(x)) \qquad (1.1)$$

Where I is the observed haze image,
J is the scene radiance,
A is the global atmospheric light, and
t is the transmission medium. It describes the portion of the light that is not scattered and reaches the camera. The goal of haze removal is to recover J, A, and t from I.

Haze removal techniques are widely used in many applications such as outdoor surveillance, object detection, consumer electronics, etc. Images of outdoor scenes are usually degraded by atmospheric haze, a phenomenon due to the particles in the air that absorb and scatter light. Haze often occurs when dust and smoke particles accumulate in relatively dry air. Here we propose a dark channel prior method to remove haze from a single input hazy image and contrast limited adaptive histogram equalization technique; it is based on adaptive histogram equalization. The dark channel prior is a kind of statistics of the haze-free outdoor images. The haze is dependent on the unknown depth information.

2. LITERATURE REVIEW

In order to improve visibility in hazy images, some de-hazing approaches have been proposed to enhance the visibility of degraded images.

Removing the haze effects on images is a challenging and meaningful task for image processing and computer vision applications. In this, they propose a multiscale fusion method to remove the haze from a single image. They present a novel single image dehazing method based on atmospheric scattering model [1]. Images play an important role in the real world, images are used for describing the changes in the environment and also use of traffic analysis. Images are captured in open environment due to the bad weather or atmosphere images are not a clear. Images acquired in the bad weather, such as the fog and haze, are extremely degraded by scatting of the atmosphere and decrease the contrast and create the object features challenging to recognize. The bad weather not only lead to variant of the visual outcome of the image, but also to the difficulty of the post processing of the image, as well as the inconvenience of entirely types of the tools which rely on the optical imaging, such as satellite remote sensing method, aerial photo method, outdoor monitoring method and object identification method [2].

Image captured in outdoor scene are highly despoiled due to poor lighting situation or due to turbid medium in poor weather, such as haze, water droplets, dust particles or due to submergence in water. So due to these particles the irradiance coming from the object is scattered or absorbed between the digital camera and the captured object. It produces an effect called haze, which trim down the overall contrast in images and led to color shift, affecting the visibility of image [3]. The objective of fog removal algorithm is to estimate the airlight map for the given image and then perform the necessary operations on the image in order to overcome the fog in the image and enhance the quality of the image. The dark channel prior method of fog removal is more suitable and time-saving in real-time systems. In this work, an efficient approach for fog removal of foggy images based on the combination of dark channel prior and genetic algorithm is presented [5].

Images captured in foggy weather conditions often suffer from poor visibility, which will create a lot of impacts on the outdoor computer vision systems, such as video surveillance, intelligent transportation assistance system, and remote sensing space cameras and so on. In this work, they propose a new transmission estimated method to improve the visibility of single input image as well as the image details [7]. Proposed a new method for estimating the optical transmission in hazy scene. Based on this estimation, the scattered light is eliminated to increase scene visibility and recover haze-free scene contrasts. In this they formulate a refined image formation model that accounts for surface shading in addition to the transmission function. This allows them to resolve ambiguities in the data by searching for a solution in which the resulting shading and transmission functions are locally statistically uncorrelated [8].

3. ARCHITECTURE OF PROPOSED SYSTEM

In this paper we have proposed an approach for removing of haze from single image captured during different environmental conditions like fog, haze etc. The proposed method will improve the quality of images and produce results superior to those of other state-of-the-art methods. Here figure 3.1 describes proposed system of project.

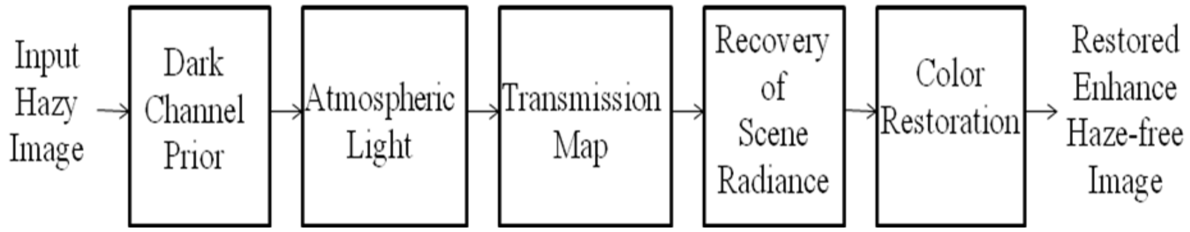

Figure 3.1: Architecture of Proposed System

In this work we remove haze from hazy image, and improve the quality of an image and then at last we obtain a restored enhance haze-free image with clear visibility. The experimental results demonstrate that the proposed technique produces a satisfactory restored image. In this, we have introduced a single image de-hazing approach, which is dark channel prior and contrast limited adaptive histogram equalization for enhancement and restoration. In this work correct assumptions need to be made in order to obtain good results.

Here we are going to introduced proposed system:

Input Hazy Image: This is a first step of proposed technique; in this step we will take any haze image from database. In this scheme we are going to upload hazy image then goes towards the further processing.

Estimate Dark Channel Prior: We propose a dark channel prior, for single image haze removal. Dark channel prior method can produce a natural haze free image. The dark channel prior is based on the following observation: in most of the non-sky patches, at least one color channel has very low intensity at some pixels. In other words, the minimum intensity in such a patch should have a very low value.

The low intensities in the dark channel are mainly due to three factors:

- Shadows. e.g., the shadows of cars, the shadows of leaves,
- Colorful objects or surfaces. e.g., any object (for example, green grass/tree/plant, blue water surface; b),
- Dark objects or surfaces. e.g., dark tree trunk and stone,

As the outdoor images are generally full of shadows and colorful, the dark channels of images will be dark. Because of fog, a hazy image is brighter than its image without haze. Since haze usually occurs in outdoor landscape and cityscape scenes.

Estimate Atmospheric Light: Generally, an atmospheric light *A* is always considered as the brightest intensity in the entire image because a large amount of haze makes the object scene brighter than itself. However, this will be not reliable when a white object is present in the scene. The basic idea of this method is that atmospheric light should be estimated from the region with brighter intensity and less texture. It searches the region with the largest score obtained by the difference of its mean and standard deviation iteratively. The atmospheric light is estimated as the value that has the least distance to the pure white. The atmospheric light was estimated from hazy image by using dark channel prior with a fixed patch size.

Estimate Transmission Map: In transmission Map, the transmission map implies the amount of light transmitted through haze from the object point to the camera. For an object at a far distance from the camera, the transmission value will be lesser; while for a closer object, the transmission value will be closer to one. In transmission map value of omega is assumed to be 0.95. The estimated transmission map from an input hazy image is roughly good, but it contains some block effects since the transmission is not always constant in a patch.

Recovery of Scene Radiance: With the atmospheric light and transmission map, we can recover the scene radiance from input image. According to (1.1) the direct attenuation term J(x)t(x) can be very close to zero when the transmission t(x) is close to zero. The directly recovered scene radiance J is prone to noise. Therefore, we restrict the transmission t(x) to a lower bound to, which means that a small certain amount of haze are preserved in very dense haze regions. A typical value of t_0 is 0.1. It usually needs to be increased when an image contains substantial sky regions, otherwise the sky region may wind up having artifacts. In recovery of scene radiance we will get dehaze image, after that color restoration will be performed.

Restored Enhance Haze-free Image: To get restored enhance haze-free image, following method will be used Enhance Local Contrast implements the method Contrast Limited Adaptive Histogram Equalization (CLAHE) for enhancing the local contrast of an image and restore the visibility of original image. CLAHE is an adaptive contrast enhancement method, it is based on adaptive histogram equalization (AHE). At the last stage we will get image as restored enhance haze-free image with clear visibility.

4. RESULT AND DISCUSSION

In this work we have obtained restored enhance haze-free image with clear visibility using image processing approach in MATLAB 2013a. The work has been tested on some hazy images. Haze due to dust, smoke and other dry particles reduce the visibility in the captured image.
Here figure 4.1 shows the results of proposed image haze removal system.


Figure (a)


Figure (b)


Figure (c)


Figure (d)


Figure (e)

Figure 4.1: Results of proposed image haze removal system. (a): Original image (b): Dark channel image (c): Transmission map image (d): Dehazed image (e): Restored enhance haze-free image

In figure 4.1 proposed image haze removal system, here we upload any one image form database, then it shows the results of original image, and its dark channel and transmission map image. In that it also shows dehazed and restored enhance haze-free image.

Following table will show the values of the RMSE, PSNR, and CORRELATION:

Performance Parameters		
RMSE	PSNR	Correlation
13.1406	36.9447	0.7244

Table 4.2: Performance Parameters of proposed image haze removal system.

5. CONCLUSION AND FUTURE SCOPE

Haze due to dust, smoke and other dry particle reduces the visibility in the captured images. The hazy image is suffers from low contrast and resolution due to poor visibility conditions. One of the central problems in image processing in open air is the presence of cloud, haze, fog or smoke which fades the colors and reduces the contrast of the observed things. Haze removal is a challenging problem because the haze is dependent on the unknown depth information. In this work, we have proposed a prior technique, called dark channel prior, for single image haze removal and contrast limited adaptive histogram equalization for enhancement and restoration. And By doing this, restored enhance haze-free image with clear visibility can be generated. More advanced models can be used to describe complicated phenomena, such as the sun's influence on the sky region, and the bluish hue near the horizon. We intend to investigate haze removal based on these models in the future. In future we extend our image haze removal method to video. And in future we will improve the proposed technique to achieve better utility and performance.

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