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A Fast Advanced Algorithm for Haze Removal by using Color Attenuation Prior

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Abstract:
The problem of haze removal has a long and well-travelled history. Dehazing from a single input hazy image is very challenging. This is because we have a little knowledge about the image. Since concentration of the haze in a hazy image is different from place to place it will become very hard to detect haze in image. The proposed work is a fast single image haze removal technique and it is work by using color attenuation prior. This method remove haze progressively. A linear model is created and the depth map is produced by using that model. From depth map estimate the transmission diagram and restore the scene radiance. Thus haze can be removed efficiently. Experimental results show that color attenuation prior model will work more efficiently than state-of-art haze removal algorithms.

Keywords: *Dehazing, depth map, transmission diagram, scene radiance*

1. Introduction

The problem of haze removal from a hazy image is encouraged in many engineering and science applications, including aerial imagery, remote sensing, image classification, video analysis and recognition, image/video retrieval. Haze recognition is difficult task because the concentration of haze can be varied from place to place in a hazy image, thus haze removal is a challenging task. In traditional techniques dehazing effect is limited because very little information is available from a single image. Dehazing effect can be improved if dehazing is performed with multiple images. The proposed work is a color attenuation prior for dehazing of single image.

The quality of images is usually degraded in the atmosphere by particles, water droplets etc… in a haze free condition little energy is lost when the light from image reaches to the imaging system. But in a hazy condition the situation will be different, more energy will be lost because of atmospheric scattering and airlight. Distance of scene points from the camera is a fact that affects amount of scattering. Since haze removal task is depends on the unknown depth information dehazing is a very challenging problem.

The existing methods of haze removal can be grouped into two categories, multiple haze removal and single haze removal. In multiple haze removal task multiple instances of the same scene is available. So the haze removal task is easy when it compared to single haze removal techniques. In single haze removal only single hazed image is available and the task is to remove the haze from that image. This is very challenging task because little information about hat image is available. This method gets more and more researcher's interest. The success of these methods lies in using a stronger prior or assumption.

2. Advanced Algorithm for Haze Removal

The proposed method works progressively and it is based on color attenuation prior. Large number of experiments are conducted on hazed image and reaches a conclusion that in a hazy image brightness and saturation of a pixel vary sharply along with the change of haze concentration. In the presence of haze, saturation decreases and brightness increases. So the difference between saturation and brightness increases. When the concentration of haze increases then the difference will also increase.

$d(x) \; \alpha \; c(x) \; \alpha \; v(x) - s(x)$

Where d is the scene depth, c is the concentration of haze, v is the brightness of the scene and s is the saturation. From these results a linear model is constructed and parameters in that model is learned by using statistical model. The linear model used in this work is: -

$d(x) = \theta_0 + \theta_1 v(x) + \theta_2 s(x) + \varepsilon(x)$

Training is done on a sample consist of a hazy image and depth map. After the training we get the values of constants. So by using the above model scene depth is calculated. From depth map cumulative probability, transmission map and scene radiance is calculated. Using all this information it is possible to remove haze from hazy image. The output from the program is then send for second iteration. The same operations are repeated. So this work will make clearer image progressively.

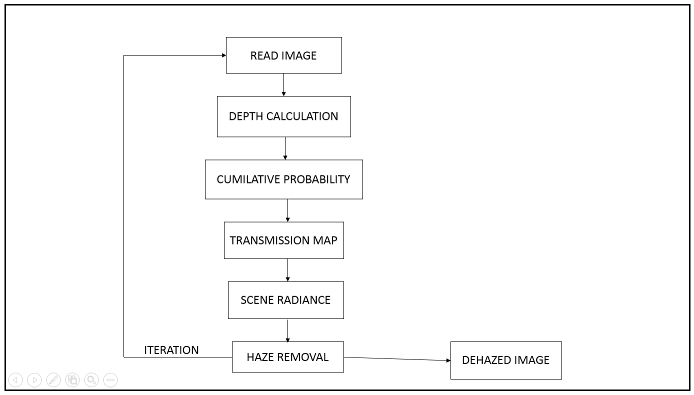

Figure 1

3. Related Works

Haze removal methods can be grouped into two categories that are multiple haze removal and single haze removal. Here we are discussing some single haze removing methods. This method only requires a single input image. The paper surveyed most relevant five papers in this area.

3.1. A Fast Single Image Haze Removal Algorithm Using Color Attenuation Prior

This paper [i] propose a simple but powerful color attenuation prior for haze removal from a single input hazy image. It works by creating a linear model and learning the parameters of the model using a supervised learning method. The model is created based on the difference between the brightness and the saturation of the pixels within the haze image. Depth map of hazy image is created by using the linear model. Scene radiance of the haze image is created from depth map.

This is the basic form of the proposed method. The proposed method can give more accurate results than this method.

3.2. Visibility in Bad Weather from a Single Image

Haze diminishes the contrast. Removing the haze enhance the contrast of the image. This paper proposes a contrast maximization method [ii]. Contrast maximization is a method that enhances the contrast under the constraint. Given an input image I the algorithm estimate the atmospheric light. This can be done by finding a small spot that has the highest intensity in image I. In the next step compute the light chromaticity. However, to be more accurate, estimate it using an existing color constancy method.

This method has number of disadvantages. The resultant image has larger saturation values because this method does not physically improve the brightness or depth but somewhat just enhances the visibility. Moreover, the result contains halo effects at depth discontinuities.

3.3. Single Image Dehazing

This paper [iii] present a new method for estimating the optical transmission in hazy scenes given a single input image. Based on this estimation, the scattered light is eliminated to increase scene visibility and recover haze-free scene contrasts. Independent component analysis is the method used in this work. Independent component analysis is a statistical method to separate two additive components from a signal.

This approach is physically valid and can produce good results, but may be unreliable because it does not work well for dense haze.

3.4. Single Image Haze Removal Using Dark Channel Prior

This work proposes [iv] a simple but effective image prior – dark channel prior to remove haze from a single input image. It is based on the observation – most local patches in haze-free outdoor images contain some pixels which have very low intensities in at least one color channel. In the haze image, the intensity of these dark in that channel is mainly contributed by the airlight. So by using this pixel it can directly provide accurate estimation of the haze’s transmission.

The dark channel prior may be invalid when the scene object is inherently similar to the airlight over a large local region and no shadow is cast on the object.

3.5. An Improved Single Image Haze Removal Algorithm Based on Dark Channel Prior and Histogram Specification

This work [v] combines dark channel prior (DCP) and histogram specification. The intensity histogram, which is usually the only information for a grayscale image, indicates the probability of every gray value of the pixel. It can conveniently obtain the contrast and intensity information of one image by analyzing the histogram.

Histogram specification, whose core idea is to rebuild the histogram of image. It is very convenient to change gray value of image by altering histogram, due to the property of the histogram which has little relation with the scene shape.

The weakness of the histogram specification is that, it will occur gray scale degeneracy on image, which can lead too serious anamorphose.

4. Discussion

The first paper [i] can give accurate result in a very short time. But the proposed method is an advanced version of this method. It works progressively and give more accurate results in approximately 3 seconds. The second paper [ii] does not physically improve the brightness or depth but somewhat just enhance the visibility. Moreover, the output poses discontinuities. The third paper [iii] can give a good result. This approach is physically valid and can produce good results, but may be unreliable because it does not work well for dense haze. The fourth paper [iv] based on dark channel prior. This approach is physically valid and work well in dense haze. When the scene objects are similar to the air light then it is invalid. The fifth paper [v] is an advanced version of fourth paper. It combines dark channel prior and histogram specification. The disadvantage of this method is that when merging is done then the contrast will become lower, background area on the haze removal image will become dark, tendency of left-shifting. The proposed method is based on stronger color attenuation prior. It works progressively, and return dehazed image more accurately in a short time.

5. Conclusion

In this paper, we have presented a survey of different haze removal method in single image haze removal. Additionally, we tried to give a brief idea about the existing different methods for haze removal. From the survey we found that almost all existing haze removing methods have its own disadvantages.

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