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An Algorithm for Haze removal from images

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Abstract:

Image dehazing plays an important role in image processing. Many researchers have suggested many techniques like histogram equalization and gamma transformation in order to reach the target. But these techniques have many limitations like different degree of polarization, different kind of weather conditions or depth information of pixel in image. The proposed work has tried to develop a more effective and improve image quality assessment method that can evaluate the quality of the proposed dehazing algorithms. The overall objective of this paper is to explore the short comings of the earlier presented techniques used in the revolutionary era of image processing applications. As compared to previous work it provides better results.

Introduction

In this topic various articles have been suggested for haze removal from images. Existing literature also addresses the issue of noise that has relied on multiple images either for de-noising prior to dehazing or in the dehazing processes itself. It is difficult to find a sequence of images or multiple images at the same time. So, single image based approaches are one of the most successful with the consideration of the "dark channel prior". Haze removal (or dehazing) is highly desired in both consumer/computational photography and computer vision applications. First, removing haze can significantly increase the visibility of the scene and correct the color shift caused by the air light. In general, the haze-free image is more visually pleasing. Second, most computer vision algorithms, from low-level image analysis to high-level object recognition, usually assume that the input image (after radiometric calibration) is the scene radiance. The performance of vision algorithms (e.g., feature detection, filtering, and photometric analysis) will inevitably suffer from the biased, low contrast scene radiance. Last, the haze removal can produce depth information and benefit many vision algorithms and advanced image editing. Haze or fog can be a useful depth clue for scene understanding. The bad haze image can be put to good use. However, haze removal is a challenging problem because the haze is dependent on the unknown depth information. The problem is under-constrained if the input is only a single haze image. Therefore, many methods have been proposed by using multiple images or additional information. Polarization based methods remove the haze effect through two or more images taken with different degrees of polarization. More constraints are obtained from multiple images of the same scene under different weather conditions. Depth based methods require the rough depth information either from the user inputs or from known 3D models. Recently, single image haze removal has made significant progresses. The success of these methods lies in using a stronger prior or assumption. Tan observes that the haze-free image must have higher contrast compared with the input haze image and he removes the haze by maximizing the local contrast of the restored image.

$$Y(x) = I(x) + n(x) = R(x).\ t(x) + a\ (1 - t(x)) + n(x)$$

Here, Y is the observed image, and noise contribution is n which is assumed to be independent and identically distributed (I.I.D.) throughout the image, with zero mean and variance. Assuming that the atmospheric light and transmission map are perfectly known, if the scene radiance is recovered by a naive inversion and the noise contribution is amplified by 1/t(x).

Most of the outdoor vision based applications such as outdoor video-surveillance as well as monitoring and analysis of traffic systems. For these applications, improving the dehazing technique is highly desired for real-time based systems. On the one hand, removal of haze from image can increase the visibility in order to restore the real color of the scenery objects. On the other hand, developing or recovering the haze-free image one can benefit for vision algorithms (for instance, image annotation, image segmentation and so on). For these reasons, in the area of image processing and computer vision, image dehazing has important and realistic significance.

Till now, many methods have been proposed to remove haze from the outdoor images. Previously, many researchers have suggested many techniques like histogram equalization and gamma transformation in order to achieve the target. But these techniques have many limitations like different degree of polarization, different kind of weather conditions or depth information of pixel in image .These methods can hardly be used for real-time applications because of these limitations.

Fig. 1: (a) Input image (Hazed image) and (b) Resulting image (Dehazed image)

One of the main problems is that these methods are not as much convenient to obtain additional information for removal of the haze from image. In this context, the main attention should be given to develop a dehazing algorithm for single image. Here, we have presented a simple example for real hazy image and Dehazed image as shown in Figure 1. In some case, de-noising prior to dehazing is also required and the proposed approach can be suitable enough to suppress the noise automatically in dehazed image. However, the proposed method is more appropriate to preserve maximum information. Problem Statement One of the key problems observed by us in image dehazing is that it is very challenging to recognize the white scenery objects whose pixel value is inherently similar to atmospheric light's value. According to literature survey and various methods proposed by various researchers, the state of-the-art algorithms are suitable to acquire impressive dehazing effect in most cases. However, these algorithms have the common limitation that may be the big obstacle to progress in the area. In this chapter, we propose the following issues which are the significant challenges of single image dehazing. In literature, there is requirement of a more robust method for image dehazing in inhomogeneous atmosphere. Here, this work has tried to develop a more effective and reliable image quality assessment method that can evaluate the quality of the proposed dehazing algorithms.

It is to be noted here, the main contribution of the proposed work has been listing as:

1. To develop a method that could reduce the hazed part of image.
2. To improve the detection quality of hazed image by minimizing haze part.
3. To focus on dehazing caused of environmental sources like haze, fog, dust, mist etc. The image is de-blurred while a user is capturing an image from his/her digital camera and due to above mentioned external sources available in the environment.

The removal of haze can produce depth information that is a benefit for many vision algorithms and advanced image editing based applications. The haze removal is a challenging and problematic issue because the haze is dependent on unknown depth information of the pixel in an image. Generally, images captured in outdoor scenes often degrade due to haze problem, resulting in contrast reduction or color fading. For many reasons, it is required to remove these effects. Unfortunately, removal of haze is difficult due the inherent ambiguity between the haze and the underlying scene. The haze removal is used mainly for enhancing image quality in image analysis. The haze is simply a set of atmospheric effect which reduces contrast the in an image.

Therefore, the proposed method is also more suitable when it comes to an offline system.

Proposed algorithm

Brief description of working algorithm. The complete haze removal procedure is summarized in above algorithm. In the beginning, the proposed work read a single hazed image from the dataset. After reading the image we have converted it into a simple 1-dimentional vector for less computation. Since the dark channel basically relies on sample minima because dark channels are sensitive to the outliers. The artifacts arise during computation of the dark channel. As mentioned in (algorithm 1.1), the dark channel calculation focused on minima of pixel intensity that simply selects minimum value of intensity for each pixel in the local patch. In literature, lots of methods are available that robustly estimate the dark channel from dehazed image. With the help of extension of dark channel, we have computed the transmission map that also assumes the presence of noise. This is more sophisticated approach that has taken by applying stochastic approximation to locate the local minima which is followed by the point estimate. The point estimate is needed (for example, to estimate the atmospheric light), this method simply de-noise the entire image by removing noise automatically with the assumption as a pre-processing step. Now, simply compute the transmission map from dark channels, by selecting minima of normalized dark channels. Finally recover the scene radiance from most haze-opaque based minima and subtracting from 1 as shown in algorithm 1. In computer vision and computer graphics, the model widely used to describe the formation of a haze image is as follows:

$$I(x) = R(x).\, t(x) + L(1 - t(x))$$

Where I, R and L are the observed intensity, scene radiance and global atmospheric light respectively. Whereas t is the medium transmission which describes the portion of un scattered light that reaches the camera. The goal is to recover R, L and t from I. The first term on the right hand side of the equation (2) is i.e. R(x).t(x) is called direct attenuation which is used to describe scene radiance and its decay in medium. And the second term L(1-t(x)) is called air-light which is the result of previously scattered light and contributes to shift in scene color.

Dark Channel Prior

Dark channel prior (Wang, Yan et al, 2010) is used for the estimation of atmospheric light in the dehazed image to get the more real result. This method is mostly used for non-sky patches; in one color channel have very low intensity at few pixels. The low intensity in the dark channel is predominant because of three components:

1. Items or surfaces
2. Shadows(shadows of car, buildings etc)
3. Dark items or surfaces(dark tree trunk, stone)

As the outdoor images are usually full of shadows the dark channels of images will be really dark. Due to fog (air light), a foggy image is brighter than its image without fog. So we can say dark channel of foggy image will have higher intensity in region with higher fog. So, visually the intensity of dark channel is a rough estimation of the thickness of fog. In dark channel prior we use pre and post processing steps for getting good results. In post processing steps we use soft matting or trilateral filtering etc. Let J(x) is input image, I(x) is hazy image, t(x) is the transmission of the medium.

Dark channel prior 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, 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. 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 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 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.

Figure.2: Dark channel prior method

Improved single image dehazing using dark channel prior .This method 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.

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. Applying the prior into the haze imaging model, single image haze removal becomes simpler the haze removal is used mainly for enhancing image quality of an image in image analysis. The haze is simply a set of atmospheric effect which reduces contrast the in an image. In literature, main problems observed in image dehazing are to recognize the white scenery objects whose pixel value is inherently similar to atmospheric light's value. So, there is requirement of a more robust method for image dehazing in homogeneous atmosphere.

Future Scope

This work proposed a simple, efficient and powerful method haze removal in image. This work proposed a robust method that is capable enough to improve the detection quality of hazed image by minimizing atmospheric haze effect. The local min operator used because its complexity is linear to image size and make proposed method faster. The proposed method also reduced dehazing effect in image caused of environmental sources like haze, fog, dust, mist etc. In the experimental results and more effective. The main motive of proposed work is to find better quality, so we focus on the quality of image. There is minimum difference between time based analyses between both methods. In the further extension of this work, we will apply this work in video data that can be applicable for real-time based computer vision applications like traffic vehicles to reduce the haze part for driver surveillance system, army, police patrolling, air surveillance, other indoor-outdoor surveillance system.

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