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An Efficient Image Dehazing based on Pixel based Dark Channel Prior and Guided Filter

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***Abstract*:- Images of outdoor scenes are usually degraded under bad weather conditions, which results in a hazy image. In this paper, two image priors, called the pixel-based dark channel prior and pixel-based bright channel prior are used to remove haze from a hazy image. Based on the two priors with the haze imaging model, the atmospheric light is estimated via haze density analysis fallowed by finding transmission map. Since the transmission map suffers from halos and block artifacts, we refine it via guided filter. The output of a guided filter is a linear transform of the guidance image. Guidance image can be input image itself or another different image. In our case guidance image is hazy image.**

Keywords:- Dark channel prior, Bright channel prior, Dehazing, Guided filter, Haze density analysis.

1. INTRODUCTION

The quality of photograph in our daily life is undetermined by aerosols suspended in medium, such a dust, mist, fumes, fog or smoke. As the particles and water droplets in the turbid medium increases, the light which is reflected by the object will be scattered and attenuated along the line of sight. In addition to this, the incoming light to the camera will be blended with air light. This as an effect on the image, example contrasts are reduced and the surface color become fait. As a result the image appears to be hazy. Haze removal 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.

Haze removal or dehazing widely used in consumer/computational photography and computer vision, surveillance, aircraft landing applications. However, haze removal is a challenging problem because the haze is dependent on the unknown depth. The problem is under-constrained if the input is only a single hazy image. Hence, several methods have been determined by using multiple images. Polarization based methods [1], [2] remove the haze effect through two or more images taken with different degrees of polarization. In [3], [4], [5], more constraints are obtained from multiple images of the same scene under different weather conditions. Depth-based methods [6], [7] require some depth information from user inputs or known 3D models.

Single image haze removal [8]-[13] has received more importance in the recent times. The success of these approaches usually lies on using stronger priors or assumptions. In [14], it is observed that a haze-free image should have higher contrast compared with its hazy version. Hence, it was proposed to remove haze from a single image by maximizing the local contrast of the restored image. Recently, an effective image prior, called dark channel prior [11] was proposed to remove haze from a single image, where the key observation was that most local patches in outdoor haze-free images contain pixels whose intensity is very low in at least one color channel. Based on this prior with the haze imaging model, the thickness of the haze can be estimated directly and a high-quality haze-free image can be obtained.

In this paper, two novel image priors, called the pixel-based dark channel prior and the pixel-based bright channel prior [15] are used to dehaze a hazy image. The pixel-based dark channel prior is based on the statistics that the most outdoor haze-free images contain some pixels called dark pixel whose intensity is very low in at least one color channel. The pixel-based bright channel prior is based on the statistics that the most outdoor haze-free images contain some pixels called bright pixel whose intensity is very high in at least one color channel.

Based on the two novel image priors with the haze imaging model, the atmospheric light is estimated via haze density analysis followed by finding the transmission map. Since the transmission map suffers from halos and block artifacts. We refine it via guided filter. The guided filter figures the filtering output by considering the contents of a guidance image, which can be the input image itself or another different image. The guided filter can be used as an edge-preserving smoothing operator like the popular bilateral filter [16], but it does not suffer from gradient reversal artifacts.[17-18].

2. PROPOSED METHOD

The model used to describe the hazy image I(x) is given by (1), where x is the pixel index or image co-ordinates.

$$I(x) = J(x)t(x) + A(x)(1 - t(x) \quad (1)$$

where I(x) is the hazy image, J(x) is the scene radiance or haze free image, t(x) is the transmission map, A(x) is the atmospheric light. In the first term J(x)t(x) on the right-hand side is called direct attenuation decreases as the scene depth increases [15], and the second term A(x)(I-t(x)) is called airlight increases as the scene depth increses [15]. The airlight means light scattered or diffused in the air by dust or haze etc., and also it limits the visibility of distant, dark objects.

2.1 Pixel-based dark channel prior

The dark channel prior is based on observation on outdoor haze-free images. Most outdoor haze-free images contain many pixels whose intensity is low in at least one color channel. This property is called as "pixel-based dark channel prior". More specifically, for an image J(x) its pixel based dark channel $J^{dark\text{-}pixel}$ (x) can be derived as

$$J^{dark\_pixel}(x) = \min_{c \in R,G,B} J^C(x) \quad (2)$$

where c denotes one of the three color channels, and where J^c denotes the color channel c of J.

2.2 Pixel-based bright channel prior

On the other hand most outdoor haze-free images contain many pixels whose intensity is very high in at least one color channel This property is called as "pixel-based bright channel prior . More specifically, for an image J(x) its pixel based bright channel $J^{bright\text{-}pixel}$ (x) can be derived as

$$J^{bright\_pixel}(x) = \max_{c \in R,G,B} J^C(x) \quad (3)$$

where c denotes one of the three color channels, and where J^c denotes the color channel c of J.

2.3 Haze density analysis and estimation of atmospheric light

Based on the fact that the haze density is different in different regions of an image, the value of atmospheric light for each pixel should be different. In general, in a haze image, the haze density is higher in the region of deeper depth, while the haze density is lower in the region of shallower depth. To estimate the haze density, first convert the input image I(x) to the color representation I^{HSV} (X) in the HSV(hue, saturation ,value) color space. HSV is a color space which describes color in terms of shades and brightness therefore it is more convenient to describe atmospheric light in HSV color space. From the estimated atmospheric light A(x) with the hazy imaging model, we can estimate the transmission map t(x).

2.4 Estimation of transmission map and its refinement

Based on the estimated atmospheric light, the haze imaging model shown in (1) transmission map can be estimated. Transmission map describes how much of scene radiance reaches the camera from the object without attenuating.

Since the transmission map suffers from halos and block artifacts, we refine it using the guided filter. The guided filter computes the filtering output by considering the content of a guidance image, which can be input hazy image itself or different image. But, in our case hazy image is the guidance image. The output of a guided filter is a linear transform of guidance image.

Currently it is one of the fastest edge-preservation filter. Experiments show that the guided filter is both effective and efficient in a great variety of computer vision and computer graphics.

2.5 Recovery of scene radiance

Once the atmospheric light and the transmission map are estimated the scene radiance J can be recovered by,

$$J(x) = \frac{I(x) - A}{t(x)} + A$$

3. EXPERIMENTAL RESULTS

We apply our dehazing method to input hazy image as shown in Fig.1 The experimental results of the this method is shown in Fig.2 where it can be found that our method can outperform the single image-based dehazing methods.

4. CONCLUSION

In this paper, two novel image priors, called the pixel-based dark channel prior and the pixel-based bright channel prior to dehaze a hazy image. Based on the two priors with the haze imaging model, the atmospheric light is estimated via haze density analysis followed by finding the transmission map. We refine it via guided filter. Based on our experimental results, high-quality haze-free image can be recovered by our dehazing method which can outperform or be comparable with the two state-of the-art methods [11],[14].

5. FETURE WORK

The proposed method and the existing methods will be compared using different qualitative methods.

Fig. 1. Input

Fig. 2. Output

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