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SINGLE IMAGE DEHAZING USING SKY ADAPTIVE FUSION

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Abstract: *Hazy days often appears in our daily life, which reduces the visibility of images captured from various cameras. High quality dehazing algorithms are in great demand. Most of the common approaches are based on the dark channel prior (DCP). However, DCP is not valid in the sky region and make the estimated transmission close to zero, which lead to color distortions and noise appear in the sky region. To deal with the above problem, this paper proposes a bright channel prior (BCP) to for computing the transmission map in the sky region. After that, the transmission maps obtained using DCP and BCP are fused effectively using the proposed gradient-based fusion scheme. The haze-free images are finally recovered using the fused transmission map and input hazy image. Experimental results demonstrate that the proposed method outperforms the DCP method especially on preserving the color consistence of sky regions.*

Keywords: *-component image dehazing bright channel prior; dark channel prior; gradient*

I. INTRODUCTION

There are various kinds of turbid media in the atmosphere (e.g. dust, water droplets). Scene reflect light which is absorbed and scattered before it reaches the camera. The weather transmission decline severely, causing the reflected light attenuate. Haze images contrast become lower and color faded, so that these images lose their authenticity. algorithm base on dark channel prior, and refined the transmission by soft matting. The image restoration effect is more natural. However, this method can produce halo and color distortion in

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haze-free images, when process the sky region. Tan et al. observed that haze images had higher contrast than haze-free images, and proposed a algorithms to maximize the local contrast of images, but the result of hazefree image was leading to color distortion and oversaturation. Zhu et al. observed the relationship between brightness and color saturation in haze images, and proposed a method of haze removal based on color decay prior, but it is easy to cause inadequate degree of haze removal in local areas. Kim et al. improve image contrast by minimizing loss function, but there are some problems such as loss of detail information after dehazing. Fattal et al. proposed an image dehazing method based on color line prior, but this method can not be applied to dense fog. Inspired by the above, we find that there are many deficiencies in dehazeing algorithms when they process the sky region. In this paper, we proposed the bright channel prior (BCP). It can be known that gradient of the sky region is generally smaller than the nonsky region. Using this feature, the weight of the image can be calculated and the transmission of the image can be corrected, thus effectively improving the sky noise of the image.

Images captured by the camera, are often affected by haze due to several atmospheric conditions such as fog, smoke, multiple light sources, the scattering of light, etc. Presence of haze in an image obscures the clarity and hence needs to be restored. The flux of light per unit area received by the camera from the scene is attenuated along the line of sight. This redirection of light lessens the immediate scene transmission and replaces with a layer of scattered light known as air light. Such scattering of light due to rigid particles floating in the air reduces the visibility of the scene. To enhance the quality of images is essential in various applications of computer vision, for instance, object recognition, scene analysis and traffic observation. Notwithstanding, outdoor images inevitably encounter the ill effects of awful climate conditions that straightforwardly cause the

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degradation of the image quality. The typical effects that result from the haze, fog, mist and smoke incredibly decay the visibility of the image. Haze/mist can massively reduce the color contrast, as appeared in Fig. 1(a). Fig. 1(b) shows the eventual outcome of image dehazing on Fig. 1(a).

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Fig. 1. Haze removal for a single image. (a) Input haze image. (b) Dehazing result

II. LITERATURE SURVEY

Traditional strategies for haze removal primarily depend on additional depth information or various multiple observations of a similar scene. The conventional methods exploited multiple images to overcome the problem. For example, the method of Narasimhan and Nayar [1] requires multiple pictures of a similar scene taken under various climate conditions. The method of

Shwartz et al. [2] requires images with the various level of polarization. However, images taken in various climatic conditions may be unavailable in reality. Recently researches are attempting for single image dehazing,

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where reference images for the given hazy images are not required.

Under the assumption that haze-free images contain a considerably higher contrast compared to hazy images,

Tan [3] proposed a dehazing approach that maximizes local contrast primarily based on a Markov random field model. Fattal proposed another dehazing technique based on unbiased component analysis under the assumption that surface shading and medium transmission are locally uncorrelated [4].

He et al. [5] proposed a straightforward and effective dehazing technique that depends on the dark channel prior (DCP). The DCP-based approaches produce good result, but cannot handle locales where shading segment does not shift fundamentally contrasted with noise.

Another approach was introduced by Fattal in [6], where the color line was introduced for dehazing. The color line based methods approximate transmission map based on the shift of the direction of atmospheric light from the origin. However, both the approaches fail to retain the original color of the objects in the hazy image

Unlike Ancuti et al. [7], where the concept of estimating the airlight in local image patches was introduced, the proposed method applies the approximation of airlight in local patches of YCbCr representation of images, to preserve the original texture of the image. Moreover, unlike the state-of-the-art methods, we apply NN regularization on the DCP image, to smoothen the DCP. We interject and regularize the fractional evaluations of pixel intensity values into an entire transmission map, and outline an Adaptive Naive Bayes Classification approach to deal with pixels with a significant depth (such as sky region). At the sky regions of the hazy image, the amount of haze becomes uneven due to the atmospheric scattering. The uneven haze leads to estimate an uneven color at the flat sky region. In adaptive filtering scheme, the patch size is automatically increased at the flat regions of the image in order to get information from more pixels in the

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neighborhood, which results in estimation of flat intensity values at the flat sky regions. Contrary to the conventional field models which comprise of normal coupling between adjacent pixels, we settle the transmission in isolated locales by fluctuating the number of pixels. Specifically, the proposed adaptive filter uses smaller patches at textured regions of the image, whereas, we take the likelihood of more number of pixels in a bigger patch, to get the suitable pixel intensity value

Recently, some deep learning-based methods [8] have been proposed, producing much better results compared to the handcrafted features like DCP and color-line. However, in case of images where sky background is present, the deep learning-based methods fail to dehaze properly. The amount of haze at high depth area (where distance of the object from the camera is very high, such as sky area) is naturally higher compared to the low depth area of the image. Number of images with a significantly large sky region is very less in the datasets we use. Moreover, the number of patches in the images including sky regions is even less. Hence, being data-greedy techniques, deep learning based techniques fail to learn the amount of haze at high depth regions, due to the lack of adequate patches including high depth regions

Hazy days often appears in our daily life, which reduces the visibility of images captured from various cameras. High quality dehazing algorithms are in great demand. Most of the common approaches are based on the dark channel prior (DCP). However, DCP is not valid in the sky region and make the estimated transmission close to zero, which lead to color distortions and noise appear in the sky region. Scene reflect light which is absorbed and scattered before it reaches the camera. The weather transmission decline severely, causing the reflected light attenuate.

III. PROPOSED SYSTEM

Enhancing haze removal algorithms have been proposed by researchers . There are also many dehazing

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methods based on different weather in the same scene, and some directly input information. In this section, we will introduce our background of our experiment which is detailed description of the dark channel prior. We will give the shortcomings of this algorithm in dealing with the sky region, and propose a new algorithm to solve them.

Inspired by the above, we find that there are many deficiencies in dehazeing algorithms when they process the sky region. In this paper, we proposed the bright channel prior (BCP). It can be known that gradient of the sky region is generally smaller than the non-sky region. Using this feature, the weight of the image can be calculated and the transmission of the image can be corrected, thus effectively improving the sky noise of the image.

METHODOLOGY

The following haze imaging model often used in the field of image processing which have been proposed in Refs [14- 16]: t(x))− A(1+ J(x)t(x) =I(x)

I(x) is the haze image observed, J(x) is the dehazing image to be estimated; A is the atmospheric light intensity of the whole image; t(x) is the transmission of medium, in which the transmission can be expressed as (2).

$$t(x) = e^{-\beta d(x)} \qquad (2)$$

In (2), d(x) is the depth value of the pixel x and β is the scattering coefficient are represented. Model (1) shows that if A and t can be estimated in advance, a dehazing image can be obtained. Dark channel prior (DCP) was proposed by He et al. [9] is the common method for haze removal. For any image J, the following formula of dark channel J dark is given.

$$J^{dark}(x) = \min_{y \in \Omega(x)} \left(\min_{c \in \{r,g,b\}} (J^c(y)) \right)$$

where Ω(x) represents the local centered area on the pixel (usually a square matrix size 7×7 or 15×15); J c is color channels of the image. If J is an outdoor haze-free image, the value of the dark channel Jdark outside the sky is very small and tends to be close zero.

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Assuming A c is the value of atmospheric light of the whole image, the transmission t(x) of the local region Ω(x) remains unchanged, and the formula can be changed to (4).

$$\frac{I^c(x)}{A^c} = t(x)\frac{J^c(x)}{A^c} + 1 - t(x)$$

Two minimization operations are performed on both sides of equation (4). By substituting (4) into (1), and J dark→0, we can get (6)

$$\min_{y\in\Omega(x)}(\min_{c\in\{r,g,b\}}(I^c(y)) = \min_{y\in\Omega(x)}(\min_{c\in\{r,g,b\}}(J^c(y)) + 1 - t(x) \quad (5)$$

$$t(x) = 1 - \min_{y\in\Omega(x)}(\min_{c\in\{r,g,b\}}(\frac{I^c(y)}{A^c}) \quad (6)$$

IV. RESULTS

To run project double click on run.bat file to get below screen

Fig.2 In above screen click on 'Upload Hazy Image' button and upload haze image

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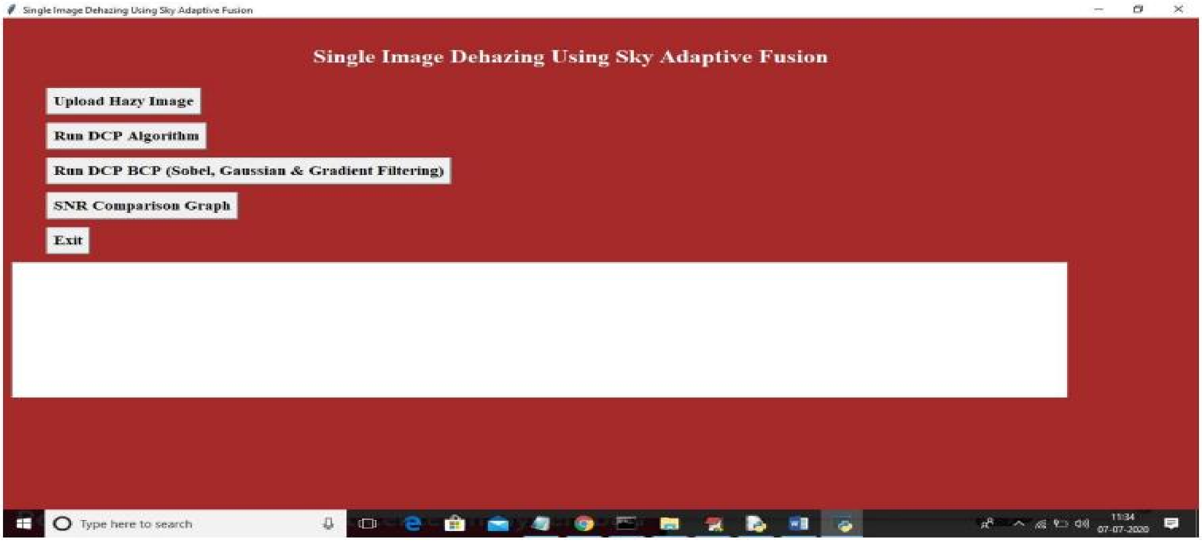

Fig.3 In above screen uploading '1.png' image which is taken from base paper and then click on 'Open' button to load image

Fig.4 In above screen image loaded to application and then click on 'Run DCP Algorithm' button to apply DCP algorithm on input image

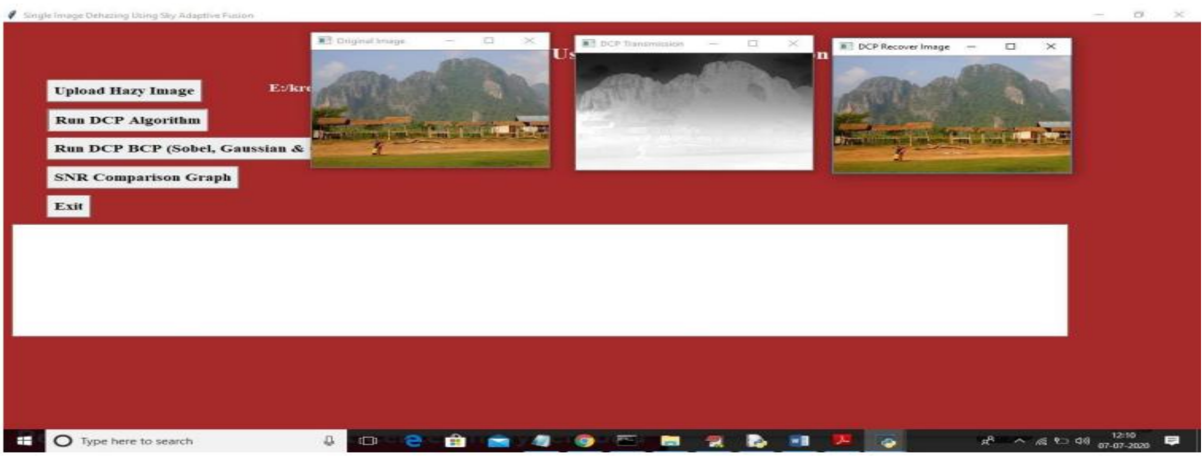

Fig.5 In above screen after applying DCP algorithm we will get original image and then DCP transmission image and then DCP recover image after removing haze. Now close all images 46 and then click on 'Run DCP BCP (Sobel, Gaussian & Gradient Filtering)' button to apply BCP algorithm

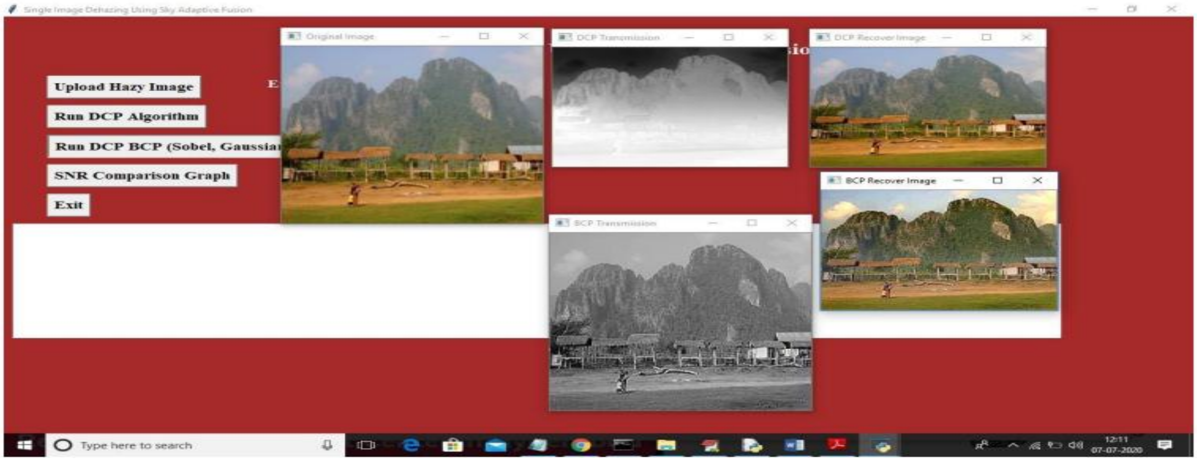

Fig.6 In above screen first image is original image and second is the DCP transmission image which is completely white and third is the DCP recover image and fourth is the BCP transmission image which is little clear compare to DCP transmission image and fifth is the propose BCP recover image which has clear sky region with clouds compare to DCP recover image. Now to check image quality click on Image Quality comparison Graph to get below graph

Fig.7 In above screen we can see image quality of each algorithm and quality of DCP is very low compare to BCP and LDR. Extension LDR having better image pixel quality compare to BCP. Below is comparison graph

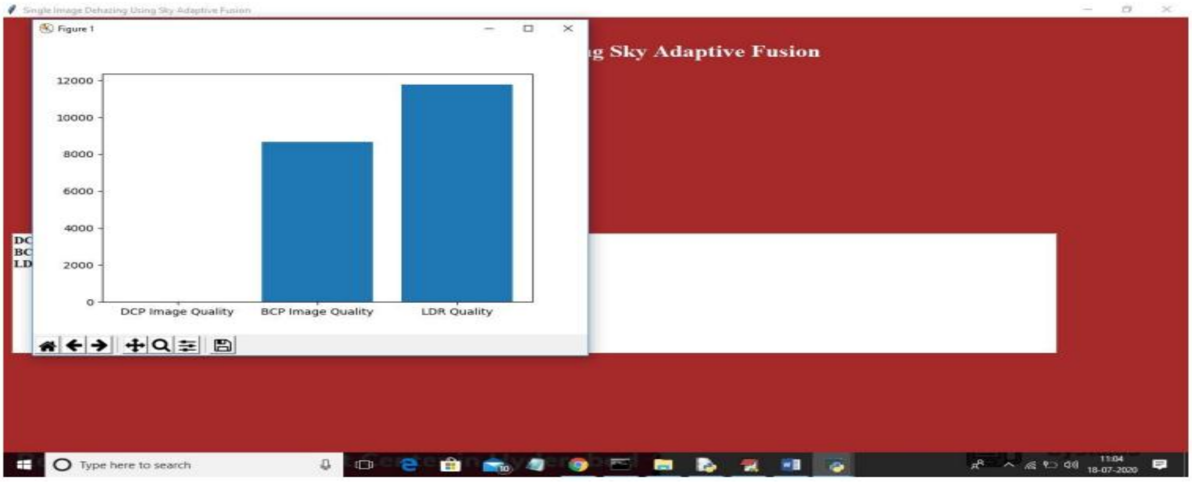

Fig.8 In above graph x-axis represents technique name and y-axis represents image pixel quality. Note: Extension LDR super resolution require tensorflow installation so install by using below command pip install tensorflow==1.14.0.

V. CONCLUSION

In this project, we have proposed a sky adaptive fusion method for image dehazing. Two individual transmission maps are computed using DCP and BCP separately, which are then fusion effectively guided by a gradient-based weighting map. In this way, the sky region and non-sky region can be processed adaptively with distinct priors. Experimental results show that our method outperforms the DCP method on restoring the visibility and colors of sky regions.In this section, we give our results and comparison with DCP. Four groups of contrast diagrams are provided. We can obviously feel the comparison of sky region that DCP manage is serious distortion whereas the bright channel, which we propose in this project, effectively eliminate the haze, meanwhile, maintaining the authenticity of the picture.

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