International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 20 Issue 2 – FEBRUARY 2016.

SINGLE IMAGE HAZE REMOVAL USING CHANGE OF DETAIL PRIOR ALGORITHM

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***Abstract*--The reliable method for dehazing image was proposed by using haze removal algorithm. The simple but effective prior is change of detail prior (CoD) algorithm is developed based on the multiple scattering phenomenon in the propagation of light. By using Change of detail prior algorithm we can estimate the thickness of Haze from single input image and also effectively recover a high quality image. The proposed method achieved better results than several state of-the-art methods, and it can be implemented very quickly. This technique can handle both the color and grayscale images**.

Keywords: Dehazing, defog, image restoration, depth restoration.

I. INTRODUCTION

Haze (mist, fog, and other atmospheric phenomena) is a main degradation of outdoor images, weakening both colors and contrasts, resulting from the fact that light is absorbed and scattered by the turbid medium such as particles and water droplets in the atmosphere during the process of propagation. Moreover in most automatic systems, which strongly depend on the definition of the input images, this may fail to work normally caused by the degraded images. Hence image hazing is a challenging task in computer vision application. Therefore, haze removal is highly desired to improve the visual effect of these images. Early researches uses a traditional technique to remove haze from the single image in image processing. First, uses a histogram based [2]-[4] dehazing effect is limited because, it possibly losses the infrequently distributed pixels in intensity due to global processing on the entire image, and also the histogram modification technique is difficult to implement in real time application due to large amount of computational and storage requirements. Later, researches try to improve the dehazing effect with multiple images. In [6]-[8] Polarization based methods are used for dehazing effect with multiple images, in this polarization filtered images can remove the visual effects of haze. This method may fail in situations of fog or very dense haze. In [11],[12] Narasimhan et al. proposes a haze removal approaches with multiple images of the same scene under different weather conditions. The conventional image enhancement techniques are not useful in this method since the effects of weather must be modeled by using atmospheric scattering principles that are closely tied to scene depth. Tan [14] proposes a novel haze removal method is Markov Random Field (MRF) which is based on maximizing the local image contrast.

Tan‘s approach is tends to produce the over saturated values in images and also produce halo effects in the images. Fattal [19] proposes a method to remove haze from the color images which is independent component analysis (ICA), this approach is time consuming and cannot be used for gray scale images. The main drawback is it has some difficulties to deal with dense hazy images. He et al [5] proposes a novel Dark Channel Prior (DCP), it is mostly used in non sky patches and any one of color channel has some pixels whose intensities are very low and close to zero. By using this prior we can estimate the thickness of haze and can retrieve the original haze free images.

The DCP method is simple and very effective in some cases and also applicable for sky images. Some improved algorithms [17],[18],[19] are proposed to overcome the weakness of the DCP approach because the main drawback of this method is it may fail to recover the true scene radiance of the distant objects and they remain bluish. For effective haze free image Tarel [9] at el proposed a novel guided image filtering which can be used for edge-preserving smoothing operator, it is fast and non approximate linear time algorithm. This method is effective and efficient in a computer vision applications. The main drawback guided/bilateral filters would concentrate the blurring near these edges and introduce halos.

In this paper proposed a novel is change of detail prior algorithm for single image dehazing. This is simple but effective prior it can estimate the thickness of haze from hazy image and recover a original image. The remainder of this paper is organized as follows: In Section 2, we review the atmospheric scattering model which is widely used for image dehazing .In Section 4, we discuss the proposed approach of airlight is the combination of smoothing and sharpening filters. In Section 5, we present and analyze the experimental results. Finally, we summarize this paper in Section 6.

II. BACKGROUND

In this method, a commonly used model establishing the formation of a haze image is it can be defined as follows

$$\mathrm{I} = \mathrm{L_0}.\mathrm{T} + \mathrm{L_A}.(1 - \mathrm{T}) \qquad (1)$$

Where I is the observed luminance at the pixel, L_0 represents haze free representation at the same pixel, L_A represents the atmospheric luminance. To estimate the optical transmission it is defined as

$$\mathrm{T}=e^{-\beta d} \qquad (2)$$

β is the scattering co efficient and d is the scene depth of the image. Mostly in many methods that the particle size is larger when compared with the wavelength of light. The proposed method is to recover the intrinsic luminance L_0 from its haze free image representation.

To recover a haze free images it requires a three steps

- Estimate the atmospheric luminance LA
- Estimate airlight A for each pixel in I.
- Calculate per-pixel intrinsic luminance L0

As shown in figure (1) the haze removal methods for estimating atmospheric model and airlight are discussed in next two sections

III. ATMOSPHERIC SCATTERING MODEL

As reported in previous work, the atmospheric luminance considered to be constant in an single image and relatively high intensity in intrinsic luminance. He et al. [10] proposed the dark channel prior and improved the estimation of atmospheric luminance. The top 0.1 percent brightest pixels in the dark channel are first selected, which are usually the most haze-opaque.

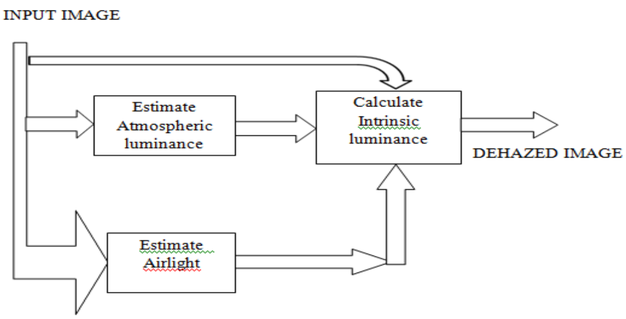

Fig 1 Dehazing Process

Among these pixels, the pixels with highest intensity in the input image I are selected as the atmospheric luminance. The Dark channel is defined as

$$I^{dark}(x) = \min_{y\in(x)}(\min_{c\in\{r,g,b\}} I^c(y)) \qquad (3)$$

where I^c is a color channel of I, and Ω(x) is a local patch centered at x. In this paper, an improved version of He [5] et al.'s method is used to estimate LA. We filter each color channel of an input image by a N x N minimum filter with a moving window. Then the maximum value of each color channel is taken as the component of atmospheric luminance LA. When dealing with gray scale images, the filter is operated on input and then the maximum value is selected as LA. This method produces a similar result but performs more efficiently.

IV. ESTIMATE AIRLIGHT

This section focus on the approach of estimating airlight A. The airlight model quantifies how a column of atmosphere acts as a light source by reflecting environmental illumination towards an observer. In eq(2), the first term $L_0.T$ is called direct attenuation. The second term $\mathrm{L_A}.(1 - \mathrm{T})$,indicates the thickness of haze. Hence the term is defined as

$$L_O = \frac{L_A.(I-A)}{L_A-A} \qquad (4)$$

The change of detail prior (COD) is inspired by two common observations. Firstly, an image will be blurred more due to haze in a local region were haze is very thicker in image. Secondly, if we sharpen and smoothen a blurred image separately means producing a I_{sharp} and $I_{smoot\ h}$ images respectively, so intensity between these two images will be negatively correlated due to blurring strength. By using equation (4) can estimate the thickness of haze.

4.1 Sharpening Operator

Sharpness is actually the contrast between different colors. The purpose of sharpening an image is to enhance the details attenuated by the scattering model and make it as close to the haze-free image as possible. Image sharpening is done by gradient domain. In this method, image information detail is represented by 1 D profile of gradient magnitude which is perpendicular to image edges as shown in fig(2).

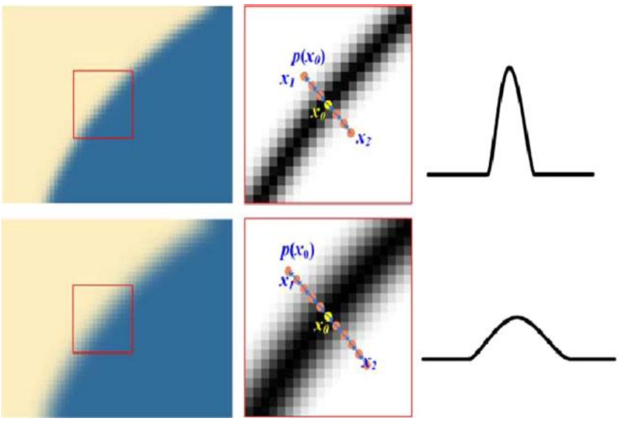

Fig 2 Gradient Profile Domain

In this gradient profile domain is defined in starting from edge pixel x_0, a path is traced from p(x_0) along the gradient directions(two sides) pixel by pixel until the gradient magnitude no longer decreases.

The prior knowledge of the gradient profiles are learned from a large collection of natural images, which are called gradient profile prior. Sub pixel technique is used to trace the curve of gradient profile.

4.2 SMOOTHING OPERATOR

Smoothing operator is done by Gaussian filter. Gauss filter is used to smooth the clear image from the input. As smoothing operator is used to simulate multiple scattering effect. As analyzed in previous method results multiple scattering is very complex process. The gauss filter works by using 2D distribution as a point spread function..The PSF is defined as

$$H(m,n) = \exp(-\beta\sqrt{m^2+n^2}) \quad (5)$$

Gaussian PSF do not produce the halo effects in the images.

4.3 COMPARISON

After sharpening and smoothing an image ,a stability criteria is desired to evaluate the difference between them. The PSNR is not suitable for dehazing because its criteria is based on the neighborhood pixels, while in smoothing and sharpening filters have already uses the neighborhood information. So the use of PSNR is redundant. Hence sharpening and smoothing are a pair of opposite operations, so we need not to compare with the input images.

Since airlight A is the component of input image I and its negatively correlated to difference between the two filter images. so hazy image is subtracted from criteria, and multiply by a co efficient to get airlight A result.

V. RESULTS AND DISSCUSION

In this section the of change of detail prior algorithm results are discussed. The execution is carried out in MATLAB 2013a tool. The PSNR value of output image is found to be better than the input image.

5.1 SIMULATION RESULTS USING MATAB

Fig 3 a) Input Image

Fig 3 b) Dehazed Image

5.2 ANALYSIS REPORT

Table 1 analysis report

S.NO	Parameters	Existing method	Proposed method

1	**PSNR**	94.4991	95.6071
2	**MSE**	5.212	5.1623

Table 1 shows the analysis report of PSNR value and MSE value is compared with the existing technique and proposed technique. Input hazy image contain more error by using visibility approach the error has been minimized.

VI. CONCLUSION AND FUTURE WORK

In this paper, we proposed a simple but effective prior is called change of detail algorithm for single image dehazing. This algorithm is based on the multiple scattering phenomena so the input image becomes blurry. When this method is combined with haze imaging model, single dehazing image becomes simple and effective. This algorithm is based on local content rarer than color and this can be applied to large variety of images. This method is meaningful for color based images for all application. In haze removal method there is a still common problem is to be solved , that is scattering co efficient β in atmospheric scattering model cannot be regarded as constant in atmospheric conditions. To overcome this problem some more physical models can be taken into account.

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