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A Novel Approach for fast image De-hazing using Weighted guided Filter

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***Abstract*—The atmosphere scattering affect the captured images with blurred and partial white and gray color in haze and haze climate condition. Due to the inconvenience caused by the video surveillance system in this weather the study of an algorithm called de-hazy became more important. Based on the calculation of depth map using HSV color space image we propose a new de-hazing algorithm. The main contribution in our study is the judgment of air light value the algorithm analyzes the physical imaging process in hazy weather and derives an approximate spread by using prior dark filter. A new technique is proposed for the local contrast enhancement which made the algorithm more efficient when matched with other algorithms. The quality of de-hazed images is visually impressive when compared with conventional approaches. The execution time is prominent as the time consuming step in de-hazing is to combine pixel-wise constraints with spatial continuities. The algorithm proposed has a reduced execution time. By using the fast guided filter the speed of the algorithm is increased which has improved the adaptability**

Keywords*— *De-hazing, depth map, air light, local contrast enhancement

I. INTRODUCTION

The quality of image in our daily life is easily estimated by the air suspended in the medium, such as dust and moisture. To improve the image quality it became necessary to remove effective haze. But it is a big challenge to de-haze an image as the haze depends on the scene depth information which is generally unknown. The current methods removes haze in two various categories called image enhancements and restoration of images. Image enhancement improves the contrast of the hazy image, but causes information loss in the image. Image restoration recovers a haze free image from the degraded image. Hazy images are modeled as the inter mixture of scene radiance, Air light and transmission. The major problem or challenge in image de-hazing process is due to multiple densities of haze in different regions in the hazy image, also the weather condition at the time of image capturing. The position of camera also may be a cause for image degradation. Haze in an image is formed by the atmospheric scattering due to air light and attenuation process as shown in Figure.1. Air light increases the whiteness and attenuation decreases the contrast in an image. Haze removal is the process to remove haze effects in captured image. It increase the both local and global contrast of the scene, correct the color distortion caused by air light and produce depth information. Haze removal is highly demanded in image processing, computational photography and vision applications. In multiple images the haze is removed by weather condition based method [1], polarization based method [2],Depth based method.

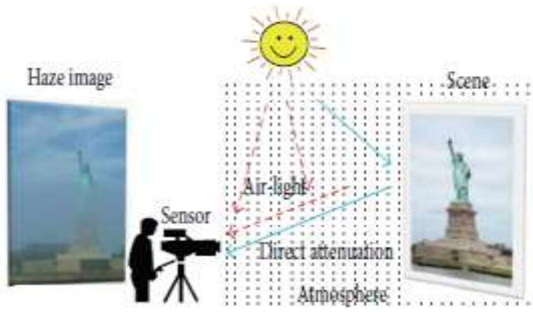

Fig.1.Haze image is formed by Atmospheric Scattering

The automated method [3] is used that requires only a single input image. It based on two observations: the first one is the clear day images have more contrast than haze images. The second one is air light variation depends on the distance of objects to the viewer. This method does not require geometrical information of the input image. It is applicable to both colors and gray images. The refined image formation model [4] used for estimating the optical transmission from a single haze image. This model includes scene transmission and surface shading. In this method eliminates the scatter light, increase the scene visibility and recover the haze free scene contrast. The failure of this method is insufficient SNR. Based on the dark channel prior [5, 6] the haze is removed. The dark pixels are referred to as low intensity pixels in at least one color (rgb) channel. These pixels are used to estimate the haze transmission. For every pixel the transmission map is calculated. The prior is used to estimate the thickness of the haze. The haze image is recovered by combination of haze image model and soft matting technique. Soft matting technique is used for refine the transmission map. It is suitable for RGB images. In the reconstructed image the halo artifacts are present. Instead of soft matting the guided image filter [7] is used for refine the transmission map. It is also based on the dark channel prior. It gives better result than soft matting.

In this paper the weighted guided image filter is used for estimating the transmission map of a haze image. Weighted guided image filter is an edge preserving smoothing technique. This algorithm requires only single filter image rather than multiple images. It is based on the concepts of minimal color channel and dark channel. The atmospheric light is estimated using the quad-tree subdivision method [8]. Then compute the minimal color channel and dark channel of the haze image. The minimal color channel is the minimal value among all color components of the pixels. The dark channel is some pixels have very low intensity in at least one color channel. Using WGIF [9] the dark channel is decomposed into base layer and detail layer. It requires the guidance image. The guidance image is generated from the minimal color channel. The transmission map is estimated from the base layer. The estimated transmission map is used to recover the haze image.

II. LITERATURE SURVEY

Image dehazing is a very challenging problem and most of the researchers have proposed various methodologies, strategies, models, and algorithms to improve the visibility of the images. Yoav Y. Schechaner et al [10] presented an approach for improving the visibility of hazy images based on the fact that usually airlight scattered by atmospheric particles is partially polarized. Their methodology using polarization works instantly, without relying on the weather conditions and they have presented the experimental results of completed dehazing in far from ideal conditions for polarization filtering. Recent researches in the field of visibility restoration of hazy images described that the images can be compensated for haze, and even yield a depth map of the scene. In order to recover the effected scene air light subtraction is necessary.

Generally the recovery requires the parameters of the air light. An approach for blindly recovering the parameters required for separating the air light from the measurement was proposed by S. Shwartz et al [11]. Srinivasa G. Narasimhan and Shree K. Nayer introduced a geometric framework for analyzing the chromatic effects. These authors studied a simple color model for atmospheric scattering and verify it for haze and haze and also derived several constraints on scene color changes based on the physics of scattering caused by various atmospheric conditions. Finally they have proposed an algorithm [12] for computing haze or haze color, depth segmentation, extracting 3 dimensional structures, and recovering the scene color from two or more images taken under different but unknown weather conditions using chromatic constraints. The vision systems are designed to perform only in perfect weather conditions but the real time applications essentially have the vision systems, which are performed in the outdoor bad weather conditions. Ultimately, the computer vision systems must include mechanism that enable them to function (even if somewhat less reliability) in the presence of haze, haze, rain, hail and snow. The authors of [12] have observed that the atmosphere modulates the information carried from a scene point to the observer; it can be viewed as a mechanism of visual information coding. Based on this observation they have developed models and methods [13] for recovering pertinent scene properties such as three dimensional structures from images taken under poor atmospheric conditions. From last two decades, a significant progress has been made in single image dehazing based on the physical model. Under the assumption that the local contrast of the haze-free image is much higher than that in the hazy image, Tan [14] proposes a novel haze removal method by maximizing the local contrast of the image based on Markov Random Field (MRF). Although tan’s approach is able to achieve impressive results, it tends to produce over-saturated images.

Fattal [15] proposes to remove the haze from color images based on Independent Component Analysis (ICA), but the approach is time consuming and cannot be used for gray scale image dehazing, furthermore, it has some difficulties to deal with dense haze images. Inspired by the widely used dark-object subtraction technique [16] and based on a large number of experiments on haze-free images, He et al discover the dark channel prior (DCP) that, in most of the non-sky patches, at least one color channel has some pixels whose intensities are very low and close to zero. With this prior, they estimate the thickness of haze, and restore the haze–free image by the atmospheric scattering model [17]. The nighttime haze removal techniques are important and necessary procedure to avoid ill-condition visibility of human eyes. S. –C. Pei and T. –Y. Lee proposed a method that can be properly applied nighttime haze images even they have some will properties of low overall contrast, low overall brightness, refined Dark channel prior and bilateral filter in local contrast correction. Tremendous amount of research work has been done to improve the visibility of the hazy images under atmospheric conditions. This work aims to develop a methodology using depth estimation concept to improve the visibility of the hazy images.

III. IMPLEMENTATION

A novel and effective algorithm is proposed for single image haze removal that's capable of handling images of gray and color channels. The proposed algorithm introduces Dark Channel Prior (DCP) followed by Weighted Least Square (WLS) and High Dynamic Range (HDR) based haze removal scheme. The qualitative and quantitative analysis is applied for the assessment of de hazed images obtained from the proposed methodology and is additionally compared with the different haze removal algorithms to establish its superiority. The foremost dominant advantage of the proposed algorithm is its capability to preserve sharp details whereas maintaining the color quality. The basic concept of the proposed method as illustrated in figure 1. The images which are captured in the outdoor scenes are subjected to atmospheric troubles such as haze, haze and rain etc. In the proposed method input image is a hazy image.

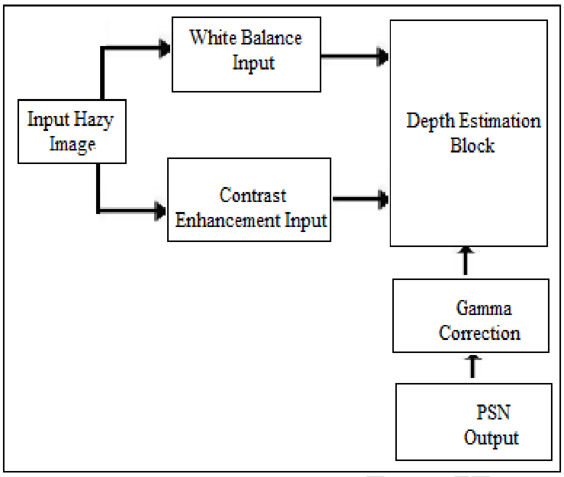

Fig.2. Proposed Methodology

In order to identify the color temperature and the contrast levels the input image is converted into two individual inputs such as white balance input and contrast enhancement image. These two individual images are then applied to depth estimation block to identify the unknown depth information of the image from the camera scene for the visibility enhancement of the hazy images. A gamma correction factor has been applied to the output of the depth estimation process in order to improvising the visibility, which is perfect scene to human eyes. Finally PSNR has been calculated for both depth estimation output and final output after gamma correction. The depth estimation process involve in various segments such as finding the weight maps of individual images (for both white baleen and contrast enhancement), normalization of weigh maps and application of pyramids. The depth estimation process has been illustrated in Fig. 3.

The absorption and scattering effects in the atmosphere causes serious degradation in the images, especially in the form of noise, blur etc. sometimes images may have distortion due to the motion blur and refraction. Reconstruction of images from these atmospheric disturbances we have implemented min max filters for image restoration. Generally a distorted image tends to become flat in final result where we are controlling its luminance gain. It defines the standard deviation between luminance L and every R, G, and B color channels while preserving each input region. This map enhances degraded

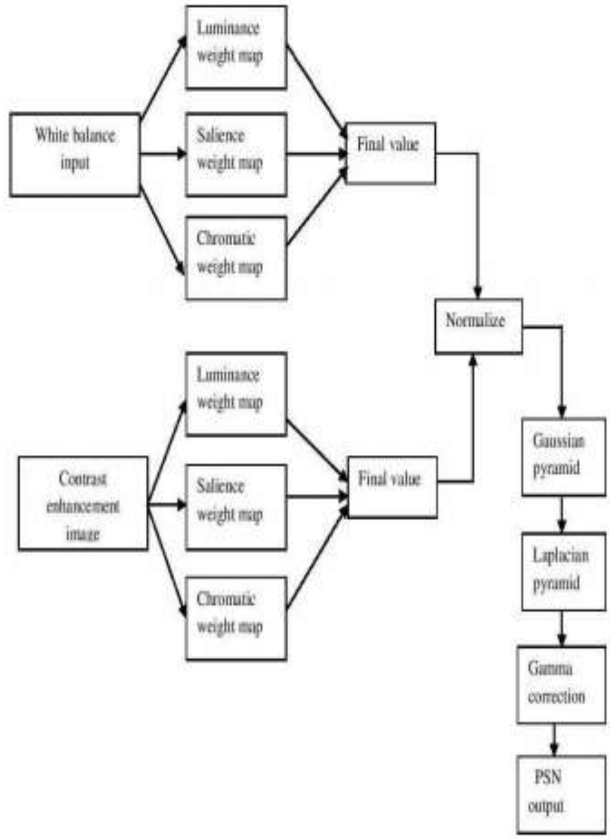

Fig.3. Depth Estimation process

The outputs of each weight maps are normalized and then applied to Gaussian pyramid of length five. The image pyramid is a data structure designed to support efficient scaled convolution through reduced image representation. It consists of a sequence of copies of an original image in which both sample density and resolution are decreased in regular steps. These reduced resolution levels of the pyramid are themselves obtained through a highly efficient iterative algorithm. A five-tap filter was used to generate the Pyramid construction is equivalent to convolving the original image with a set of Gaussian-like weighting functions. These equivalent weighting functions for three successive pyramid levels. Note that the functions double in width with each level. The convolution acts as a low pass filter with the band limit reduced correspondingly by one octave with each level. Because of this resemblance to the Gaussian density function we refer to the pyramid of low pass images as the Gaussian pyramid. The Laplacian pyramid has been described as a data structure composed of

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band pass copies of an image that is well suited for scaled-image analysis. But the pyramid may also be viewed as an image transformation, or code. The pyramid nodes are then considered code elements, and the equivalent weighting functions are sampling functions that give node values when convolved with the image. A gamma correction has been performed to improvising the visibility for human eyes. Finally PSNR for depth estimated image and gamma corrected images are calculated.

IV. GUIDED IMAGE FILTERING

The blocking artifacts appear in the image sometimes. To refine the depth map, we use the guided image filtering to smooth the image. With the estimated depth map, the task of de-hazing is not difficult. These operations have good edge preserving property. [6]

The equation for the calculation of filtered output is given as:

$$q_i = \bar{a}_i I_i + \bar{b}_i \qquad (4.1)$$

Where *q*i is filtered output, *I*i is guidance image, linear coefficients values are calculated by using input image and guidance image. Transmission Map (*t*) can be calculated by using the Equ 5.2. In that equation β is atmospheric scattering coefficient value and *d(x)* is scene depth value after Guided Image Filtering. The constant β value is used in the works which are done previously. As the depth map of the hazy image has been recovered, the distribution of the scene depth is known. Bright regions in the map stand for distant places. [7]

$$\mathbf{A} = \mathbf{I}(x), x \in \{x \mid d(y) \le d(x) \qquad (4.2)$$

By taking the top 0.1 percent brightest pixels in the depth map select the highest intensity pixel in the corresponding hazy image **I** among these pixels as the atmospheric light **A**. Estimate the medium transmission *t* easily according to Equ 5.2 and recover the scene radiance **J** in Equ 5.1.

$$\mathbf{J}(x) = \frac{\mathbf{I}(x) - \mathbf{A}}{t(x)} + \mathbf{A} = \frac{\mathbf{I}(x) - \mathbf{A}}{e^{-\beta d(x)}} + \mathbf{A} \qquad (4.3)$$

J is the required haze-free image. For avoiding too much noise, we restrict the value of the transmission *t (x)* between 0.1 and 0.9. So, the final function used for restoring the scene radiance is expressed as:

$$\mathbf{J}(x) = \frac{\mathbf{I}(x) - \mathbf{A}}{\min(\max(e^{-\beta_s(x)}, 0.1), 0.9)} + \mathbf{A} \qquad (4.4)$$

V. EXPERIMENTAL RESULTS

Linear model calculates the scene depth of the image by using the linear coefficients and random error. In this model saturation values and brightness values are considered. RGB hazy image is converted into HSV color space to obtain saturation and brightness values. Scene depth is calculated Using this brightness and saturation values. The Guided Image Filtering smoothens the raw depth image. This guided image filtering not only smoothens the raw depth image but also avoids blocking artifacts in an image. Filtering output is linear transform of guidance image. To calculate the value of atmospheric light modified raw depth image is considered. By using the values of **I** (hazy image), **A** (atmospheric light) and *t* (transmission medium) the scene radiance is recovered. The resultant image is enhanced using NTSC based filtering.

Fig.4. Input image

Filtering output is direct change of direction image. To compute the judgment of climatic light altered crude profundity image is considered. By utilizing the judgments of I (haze image), an (air light) and t (spread medium) the scene brilliance is recuperated. The resultant image is upgraded utilizing NTSC based filtering. In this work, we gather haze free images from the Internet, and arbitrarily test from them patches of size16×16.Different from [17], these haze free images incorporate those catching individuals' everyday life, yet additionally those of regular and city scenes, since we accept that this assortment of preparing tests can be scholarly into the filters of De darkness Net. Figure 5 shows instances of our gathered haze free image.

Fig.5. De-hazed Extracted image in conventional method

Colors in the little patches of a haze free image for the most part lie on hold experiencing the beginning stage as appeared, in the event that we represent to hues as directions in the RGB space.

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Fig.6. De-hazed output image

VI. CONCLUSION

In our experiment, we have proposed a novel linear dark channel prior, based on the saturation and brightness of the pixels within the hazy image. Very simple smoothing operations are required for getting modified scene depth image. Simple linear model equations are used for scene depth calculation and the required terms are recovered from the linear model and the scene recovery became easier. This simple algorithm can be implemented effectively for outdoor images. As a future work this algorithm can be extended to videos and can also be used for vehicles travelling in foggy conditions.

REFERENCES

[1] Qingsong Zhu, Member, IEEE, Jiaming Mai, and Ling Shao, Senior Member, IEEE," A Fast Single Image Haze Removal Algorithm Using Color Attenuation Prior", IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 24, NO. 11, NOVEMBER 2015

[2] Haoran Xu, Jianming Guo, Qing Liu, and Lingli Ye," Fast Image Dehazing Using Improved Dark Filter Prior, 2012 IEEE International Conference on Information Science and Technology Wuhan, Hubei, China; March 23-25, 2012

[3] Hussein Mahdi, Nidhal El Abbadi, Hind Rustum," Single Image De-Hazing Through Improved Dark Filter Prior And Atmospheric Light Judgment", Journal of Theoretical and Applied Information Technology 15th August 2017. Vol.95. No.15

[4] Vaibhav Khandelwal1, Divyanshi Mangal2, Naveen Kumar," Elimination Of Haze In Single Image Using Dark-Filter Prior", International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 02 | Feb-2018

[5] "A Fast Single Image Haze Removal Algorithm Using Color Attenuation Prior", IEEE Transactions on Image Processing,Volume: 24, Issue 11, Nov. 2015.

[6] [3] "Image Restoration Technique for Haze Degraded Image", International Journal of Computer Trends and Technology (IJCTT), Volume: 18, Number 5, Dec. 2014.

[7] [4] Livingston, M. A., C. R. Garrett, and Z. Ai,"Image Processing for Human Understanding in Low Visibility", ASNE Human Systems Integration Symposium, Oct 2011.

[8] [5] He, K., Sun, J., and Tang, X.: 'Single imagehaze removal using dark filter prior',IEEE transactions on pattern analysis andmachine intelligence, Volume 33 . Issue 12 ,2011, pp .2341–2353.

[9] G. A. Woodell, D. J. Jobson, Z.-U. Rahman, and G. Hines, "Advanced image processing of aerial imagery," Proc. SPIE, vol. 6246, p. 62460E, May 2006.

[10] L. Shao, L. Liu, and X. Li, "Feature learning for image classification via multi objective genetic programming," IEEE Trans. Neural Netw. Learn. Syst., vol. 25, no. 7, pp. 1359–1371, Jul. 2014.

[11] Xu, Zhiyuan, Xiaoming Liu, and Na Ji. "Haze removal from color images using contrast limited adaptive histogram equalization." Image and Signal Processing, 2009.CISP'09.2nd International Congress on.IEEE, 2009.

[12] Tripathi, A. K., and S. Mukhopadhyay. "Single image haze removal using bilateral filter." Signal Processing, Computing and Control (ISPCC), 2012 IEEE International Conference on. IEEE, 2012.

[13] J. Han et al., "Representing and retrieving video shots in human-centric brain imaging space," IEEE Trans. Image Process., vol. 22, no. 7, pp. 2723–2736, Jul. 2013.

[14] J. Han, D. Zhang, G. Cheng, L. Guo, and J. Ren, "Object detection in optical remote sensing images based on weakly supervised learning and high-level feature learning," IEEE Trans. Geosci. Remote Sens., vol. 53, no. 6, pp. 3325–3337, Jun. 2015.

[15] L. Liu and L. Shao, "Learning discriminative representations from RGB-D video data," in Proc. Int. Joint Conf. Artif. Intell., Beijing, China, 2013, pp. 1493– 1500.

[16] K. Elissa, "Title of paper if known," unpublished.

[17] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[18] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[19] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.