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Image Defogging and Contrast Enhancement

Darsana V [1], Rahul M Nair [2]
[1]Applied Electronics and Communication System, Nehru College of Engineering and Research Centre, India,
[2]Department of Electronics and Communication Engineering, Nehru College of Engineering and Research centre, India

***Abstract**: The importance of image processing is increasing day by day. Image defogging and contrast enhancement is an important area in image processing. Haze is a natural phenomenon and has turned into noteworthy issue in a large portion of the low temperature regions. Images captured in hazy atmosphere is often degraded in terms of low contrast and faded colors, this influences the working of most of the applications such as object detection, CCTV camera, driverless cars, and many more. We can tackle this problem by proposing a defogging algorithm for removal of fog from hazy images. However, the effect of fog will reduce the contrast of the images, so it is clear that removing the fog alone won't give a quality image and for this reason we introduce an algorithm which will first remove the fog and after will increase the contrast of the image which provides a better quality image. Here we use Gaussian based dark channel technique and fusion based transmission estimation for defogging and intrinsic image decomposition for contrast enhancement.*
***Keywords**: Defogging, contrast enhancement, Gaussian based dark channel technique, fusion based transmission estimation, intrinsic image decomposition*

I. INTRODUCTION

The images captured using camera in poor weather conditions such as fog or haze gets degraded in terms of low contrast and faded colors. The solution to this problem is to develop an algorithm for removing fog from these images. The existing methods focus on over all contrast enhancement of images and even removal of fog without quality contrast enhancement. Here we propose a method which initially removes the fog and then the haze free image is given as input to the contrast enhancement algorithm so that we get a better quality image with effective fog removal and contrast enhancement. The defogging algorithm uses Gaussian based dark channel technique to calculate the atmospheric light and the fusion based transmission estimation technique to estimate the transparency function. After the restoration the haze free image is contrast enhanced using the intrinsic image decomposition method. The combination of defogging and contrast enhancement algorithm provides a better quality image.

II. LITERATURE SURVEY

Research on defogging and contrast enhancement has been conducted by many researchers and has proposed different algorithms. Traditionally overall contrast enhancement were done for the removal of fog but this does not give the quality results. Then came the defogging algorithm using single and multiple images as input. However, the usage of multiple images proved computationally complex and takes more processing time than single image defogging technique. The method presented in [7] focused on the restoration of scene contrast and colors through user interactions which is capable of good restoration but it uses multiple images as input that increases complexity in computation and has limited practical applications. He et al [2] used the dark channel prior information to estimate the depth of the scene and atmospheric light and used alpha matting technique was used to refine the transmission map but this usage increases the complexity of the image processing. Jing Ming Guo et al [3] proposed an efficient defogging technique based on fusion map but do not give a good quality contrast enhanced image. To increase the contrast of the defogged image we have to impose efficient contrast enhancement technique to the defogging algorithm. Contrast enhancement algorithm basically are of two types retinex based and histogram equalization based methods. Histogram [6] based method modify the histogram distributions [12] by flattening the histogram and stretching the dynamic range of the intensity levels. This method is simple and effective but might result in over/under enhancement of images. Whereas the retinex based method assumes the scene in human eye as product of reflectance and illumination layer. [8] Proposed retinex based method which decomposed illumination and reflectance layer and adjusted the reflectance layer for contrast enhancement but this destroys the naturalness of the image. Intrinsic image decomposition was first proposed by H.

Barrow et al [4] which decomposed image into reflectance and illumination layer. In this paper we proposed an effective defogging and contrast enhancement model. We combined the defogging algorithm and efficient contrast enhancing algorithm that gives good peak signal to noise ratio compared to the existing methods.

III.PROPOSED METHOD

The proposed image defogging and contrast enhancement will be explained in detail in this section. First the model that is used for the formulation of the hazy image to get the dehazed image is explained. After this the overall description of the proposed method will be briefly explained. Then the Gaussian based dark channel technique, fusion based transmission estimation and contrast enhancement by intrinsic image decomposition will be explained in detail.

A. Optical Scattering Model

According to the model called optical scattering model proposed by Koschmieder [10] the hazy image can be formulated as

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

Where I(x) is the image containing haze, J(x) is the image that is free from haze, T(x) is called as the transparency function between the scene objects and camera lens, atmospheric light is denoted by the term A. The term J(x)T(x) denotes the multiplicative mapping process that represents the attenuation during the propagation through hazy medium, whereas the term A(1-T(x)) is the light pattern, resultant from propagation loss and scattering. In the case where the propagation medium is homogeneous, the transparency function T(x) can be modelled as

$$T(x) = e^{-\beta d(x)} \quad (2)$$

Where β is scattering coefficient, d(x) is scene depth. Objective of the model is to restore the haze free image J(x) from the image that contains haze, I(x) by estimating the atmospheric light A and the transparency function T(x).

B. Overview

The block diagram of proposed method is shown in Fig.1. The hazy image I(x) is taken as input image. On the basis of optical scattering model, we have to estimate the atmospheric light, A and transparency function, T(x) for the removal of fog. Gaussian based dark channel technique is used for atmospheric light estimation and fusion based transmission estimation is used for transparency function estimation. And then the haze free image J(x) is restored from the hazy image I(x). After restoration, the haze free image J(x) is contrast enhanced using intrinsic image decomposition method to get a better quality contrast enhanced haze free image.

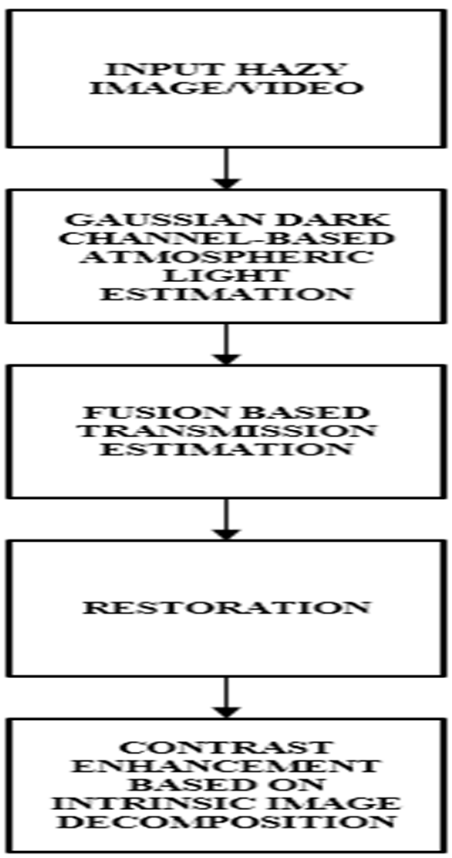

Fig. 1 Block Diagram of Proposed Method

C. Gaussian Based Dark Channel Technique

Gaussian based dark channel technique is used to calculate the atmospheric light, A which is mentioned in equation (1). Traditionally, A was considered as the brightest pixel in the input image by assuming there are no saturated pixels but this assumption do not work in all practical cases. According to He's method [2], the atmospheric light can be obtained correctly by the selection of part of the brightness pixels in the dark channel of the normalized input.

$$I_{dark}(x) = \min_{Y\in\Omega(x)} \min_{C\in\{r,g,b\}} \frac{I^c(y)}{A^c} \quad (3)$$

Where A^c is the atmospheric light of color channel, C and I^c is the input image of color channel, C. Local path is denoted by $\Omega(x)$ and I_{dark} is the channel of image, I. But, for complicated scenes two min operators seems computationally expensive and might degrade the accuracy of the estimation. To overcome this deficiency, a Gaussian based dark channel I_{Gdark} is introduced

$$I_{Gdark}(x) = W(x)*M(x) \quad (4)$$

Where minimum component of I is denoted by M, and Gaussian function is denoted by w(x) and

$$M(x) = \min_{c\in\{r,g,b\}} I^c \quad (5)$$

$$W(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{X^2}{2^{2K}}} \quad (6)$$

$$K=\max(\mathrm{size}(I^c(y))) \quad (7)$$

The original patch based min operator is replaced with Gaussian blur operator in such a way that each pixel is subjected by the Gaussian average value instead of the minimum in the local patch to reduce sensitivity. According to its physical properties the Gaussian based dark channel also subject to the constraint

$$I_{Mdark}(x) = \min(I_{Gdark}(x), M(x)) \quad (8)$$

Here, we explained the estimation of the atmospheric light, A. In restoration procedure after calculating transparency function, T(x) we make use of atmospheric light, A to get the light pattern A(1-T(x)) and thereby the haze free image.

D. Fusion Based Transmission Estimation

In this section we estimate the transparency function T(x) discussed in equation (1).The estimation of the transparency function is to calculate the degradation component contributed by haze or fog. Here we combine both the strong and weak enhancement levels to the fusion weighting function. We consider $T_s(x)$ as one with strong enhancement level and $T_w(x)$ as one with weak enhancement level. The hazy images can be categorized into the one with extremely limited visibility, which is heavy haze regions and the other with less amount of haze with low contrast. The canny edge detection and dilating morphological operations are done to partition the image into the two type of regions and Guided filter is used for reducing noise [9]. The effective defogging in these regions is conducted by using fusion weighting scheme in which it assigns greater weighting to $T_w(x)$ for heavy haze regions for preserving the natural appearance of the image and greater weighting to $T_s(x)$ for less haze portions of the image that restores the original scene.

$$W(x) = GF(I_{edge}(x), I(x)) \quad (9)$$

$$T(x) = (1-W(x))T_w(x) + W(x)T_s(x) \quad (10)$$

The region with heavy haze will be the sky region and the one with less haze will be the land area in outdoor scenes. The sky regions will be at the top portion of the image and land region at the bottom portion this helps the assigning of weighting coefficients to be distributed appropriately the corresponding transparency functions. It can be observed that T(x) will be largely influenced by $T_s(x)$ for larger value of W(x) and T(x) will be influenced largely by $T_w(x)$ for lower value of W(x).As a final step we apply guided filter to T(x) for further refinement to obtain a better quality dehazed image as output.

E. Contrast Enhancement by Intrinsic Image Decomposition

The haze free image obtained after the restoration procedure will be considered as the image to be contrast enhanced. The input haze free image is first converted in to HSV representation. Then, we decompose the value (V) channel alone into illumination and reflectance layer using the intrinsic image decomposition model [5]. After this the illumination layer (L) is illumination adjusted by Gamma mapping function and the illumination adjusted layer is represented by L_a. Now, L_a is multiplied with reflectance layer (R) to get the enhanced V channel represented by V_e. Since the mapping function is performed globally, we adopt contrast limited adaptive histogram equalization (CLAHE) [11] to further enhance the local contrast of V_e. This is represented as $\widehat{V_e}$. And finally the HSV image is converted in to RGB image which gives the final contrast enhanced haze free image. The main modules are intrinsic image decomposition [1] and illumination adjustment [5].Block diagram of contrast enhancement is shown in Fig. 2

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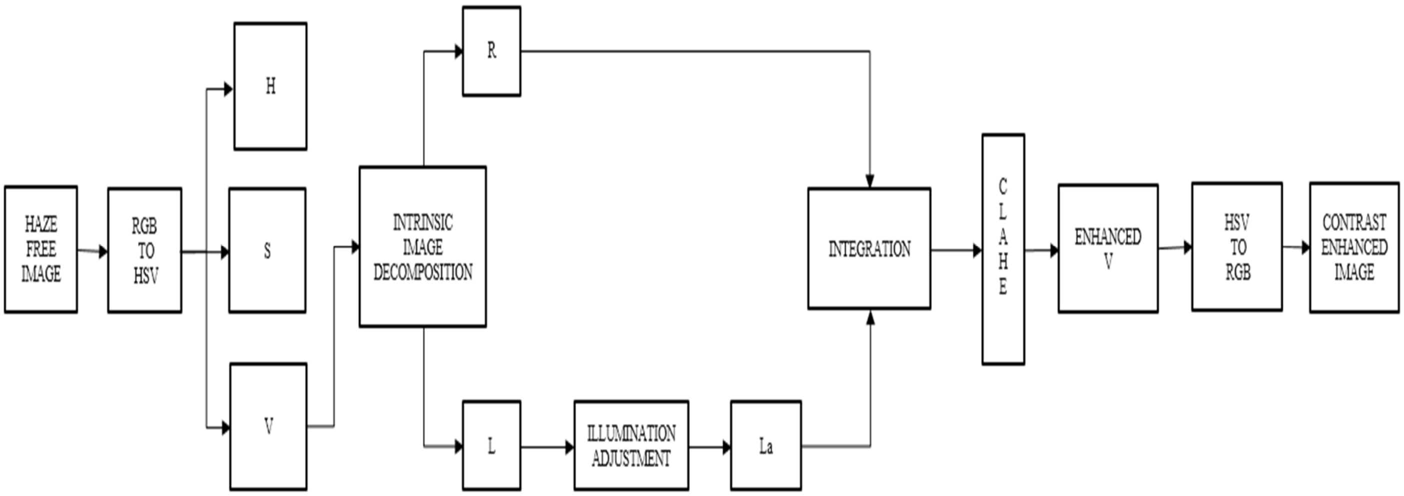

Fig. 2 Block Diagram of Contrast Enhancement

Algorithm for contrast enhancement
1. Haze free image after restoration is taken as input
2. Convert RGB to HSV space
3. V channel is decomposed into L and R layer
4. L Layer is illumination adjusted to achieve L_a
5. $L_a \times R = V_e$, enhanced V channel
6. CLAHE is used to enhance the local contrast of V_e to obtain $\widehat{V_e}$
7. Enhanced HSV image is converted to RGB space
8. The obtained output is the contrast enhanced image.

IV. RESULT AND DISCUSSION

The input hazy images are loaded into MATLAB. The proposed method was evaluated on different variety of input hazy images. Experimental results demonstrate that the proposed method give better quality image in terms of reduced MSE(Mean Squared Error) good PSNR(Peak Signal to Noise Ratio) value of 59.2859 and good SSIM(Structural SIMilarity index). The final outputs are shown in fig.3,fig.4 and fig.5.

Fig.3.Hazy input image,

Fig. 4 Restored haze free image

Fig.5 Contrast Enhanced haze Free image.

V. CONCLUSION

This paper proposes a method for both defogging and contrast enhancement. We use single image defogging technique and the output of the defogging algorithm is then made to enhance the contrast. The major advantage is that we not only remove the fog from image but also enhance the contrast of the dehazed image. The Gaussian based dark channel technique and fusion based transmission estimation combined with contrast enhancement by intrinsic image decomposition gives us quality results. The experiment results shows that the proposed method outperforms the existing methods in terms of MSR, PSNR and SSIM values. Moreover, the good computation efficiency makes it suitable for many real time applications. In future, it is versatile to do more inventions having increased efficiency even in highly dense hazy regions. Also removal of rain droplets or snow along with fog can be incorporated to increase its applications.

VI. ACKNOWLEDGMENT

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REFERENCES

[1] S. M Pierre-Yves Laffont, Jean-Charles Bazin,"Intrinsic Decomposition of Image Sequences from Local Temporal Variations", Computer Vision (ICCV),IEEE International Conference ,pp. 433-441, Dec 2015

[2] K. He, J. Sun, and X. Tang, "Single Image Haze Removal Using Dark Channel Prior," IEEE Trans. Pattern Anal. Mach. Intell., vol. 33, no. 12, pp. 2341–2353, Dec. 2011.

[3] Jing-Ming Guo,Jin-yu Syue, Hua Lee, "An Efficient Fusion-Based Defogging", IEEE Transaction on Image Processing, Volume: 26, Issue: 9, PP4217 - 4228.Sept. 2017

[4] H. Barrow and J. Tenenbaum, "Recovering intrinsic scene characteristics," Comput. Vis. Syst., A Hanson & E. Riseman (Eds.), pp. 3–26, 1978

[5] Huanjing Yue,Xiaoyan Sun, Feng Wu, Chunping Hou,"Contrast Enhancement Based on Intrinsic Image Decomposition", IEEE Transactions on Image Processing, Volume: 26, Issue: 8,PP. 3981 - 3994 Aug. 2017

[6] H. Ibrahim and N. S. P. Kong, "Brightness preserving dynamic histogram equalization for image contrast enhancement," IEEE Transactions on Consumer Electronics, vol. 53, no. 4, pp. 1752–1758, 2007.

[7] S. G. Narasimhan and S. K. Nayar, "Interactive (De) Weathering of an Image Using Physical Models," in Proc. IEEE Workshop Color Photometric Methods Comput. Vis., vol. 6. France, 2003, p. 1.

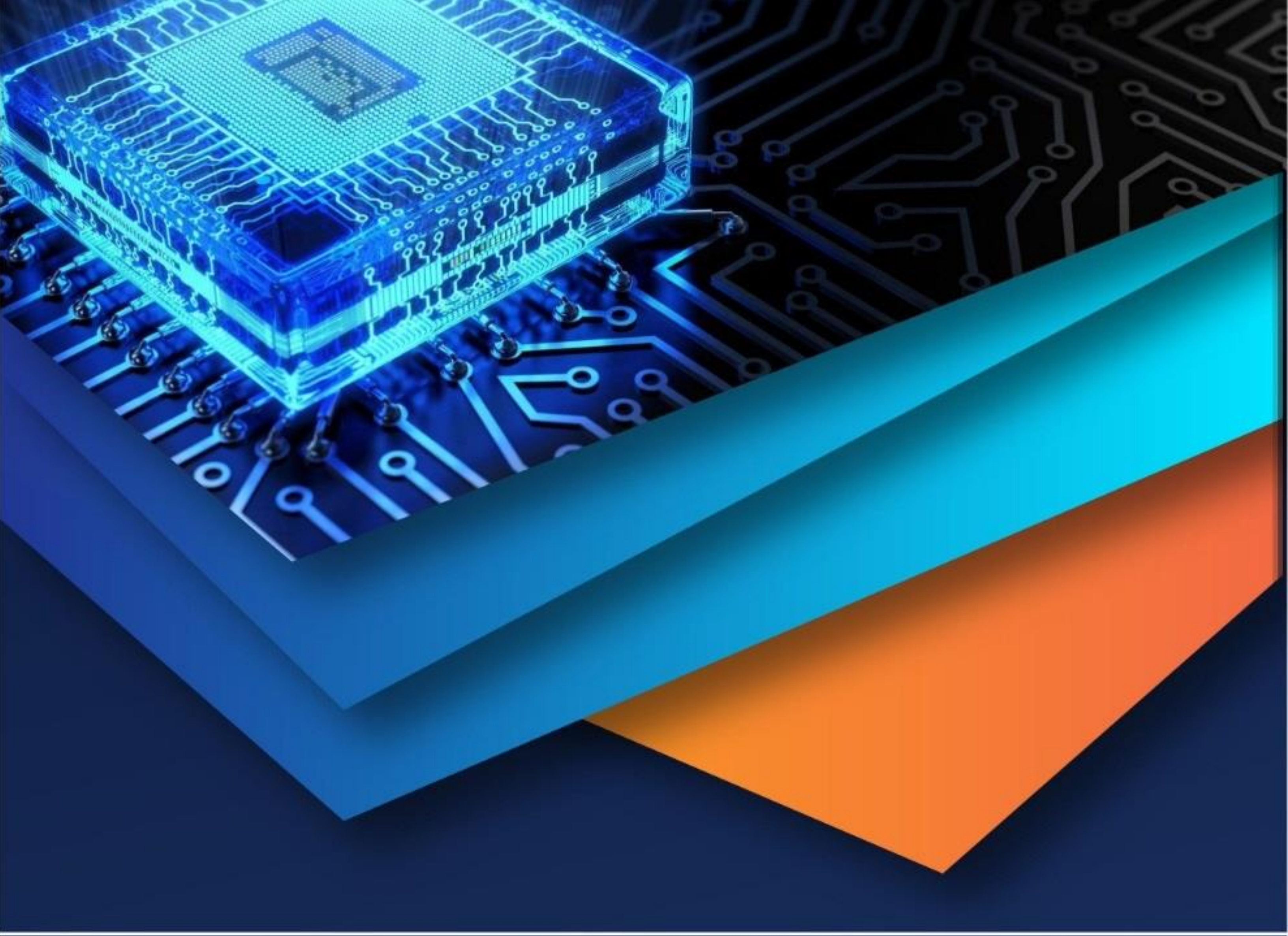
[8] M. Herscovitz and O. Yadid-Pecht, "A modified multi scale retinex algorithm with an improved global impression of brightness for wide dynamic range pictures," Machine Vision and Applications, vol. 15, no. 4, pp. 220–228, 2004.

[9] X. Kang, S. Li, and J. A. Benediktsson, "Spectral–Spatial Hyper spectral Image Classification with Edge-Preserving Filtering," IEEE Trans. Geosci. Remote Sens., vol. 52, no. 5, pp. 2666–2677, May 2014.

[10] H. Koschmider, "Theorie der horizontalen Sichtweite," in Proc. Beiträgezur Phys. der Freien Atmos., 1924, pp. 171– 181.

[11] A. M. Reza, "Realization of the contrast limited adaptive histogram equalization (clahe) for real-time image enhancement," Journal of VLSI signal processing systems for signal, image and video technology, vol. 38, no. 1, pp. 35–44, 2004.

[12] C. Wang and Z. Ye, "Brightness preserving histogram equalization with maximum entropy: a variational perspective," IEEE Transactions on Consumer Electronics, vol. 51, no. 4, pp. 1326–1334, 2005.



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