International Journal of Current Trends in Engineering & Technology
ISSN: 2395-3152
Volume: 03, Issue: 04 (JULY–AUGUST, 2017)

Survey and Analysis on Foggy Image Enhancement Techniques

Anjali Soni[1], Ratnest Kumar Dubey[2], Vineet Richhariya[3]
Computer Science & Engineering Department LNCT, Bhopal
[1]Anjali.soni91[at]yahoo[Dot]com, [2]ratneshdub[at]Gmail[Dot]com, [3]Vineetrich100[at]Gmail[Dot]com

Abstract— Due to the inadequate lighting during image acquiring as well as nonlinear image intensities mapping, many images like satellite images, medical images, aerial images and even real life photographs may suffer from poor contrast and noise. So it is required to enhance the contrast and remove the noise to increase image quality. So Image Enhancement play important role in image enhancement. Frequency domain and spatial domain are two techniques to classify Image enhancement into two groups. Recently, the fuzzy set theory becomes a popular and it has been widely utilized by many researchers. Fuzzy set theory is based on mapping the pixel gray tone intensity into a fuzzy set by using a membership function and a membership function denotes the degree of belonging to specific property. In this paper we present an overview on fuzzy based contrast image enhancement techniques, classification of image enhancement techniques, researches done in the field of fuzzy based image enhancement, shortcoming comes after reviews and general needs required in this field of active research and in last we will point out promising directions on research for image enhancement for future research.

Keywords: — Frequency Domain, Fuzzy Domain, Low Contrast.

I. INTRODUCTION

Visibility of images often suffers due to fog, mist, and haze present in atmosphere. However, it plays very important role in day to day life such as in video surveillance, navigation control, satellite imaging like environmental studies, weather studies, web mapping and vehicle driving, railway and road traffic analysis. Images which are captured under foggy or hazy weather contains atmospheric degradation particle, as a result light incident on scene get absorbed and scattered. There are many elements which reflect the incident light, bring downs saturation level. This affects low as well high frequency components of the image. Moreover, this degraded image suffers severe contrast loss, bad visibility, very poor performance. Due to contrast loss image dim especially in distant regions and blurred with surrounding area. In order to get rid of this problem, it is necessary to defog the degraded image [7] [8]. Fog formation occurs due to condensation of water vapor into tiny droplets suspended in the air. Water vapor is added to the air in various ways such as wind convergence, water fall, heating of water due to sunlight cause evaporation of water from the surface of oceans, estuary and transpiration from plants and lifting Air Mountain. Produced water vapor begin condensing on dust, ice, salt and other particles which are present in atmosphere, in order to form cloud. Fog forms when a cool, stable air mass is trapped underneath a worm and humid air mass, this process make substantial effect on images and lack visibility and visual vividness in a real time system.

II. FOGGY IMAGE MODEL

Fog is a physical phenomenon caused by tiny dusts or droplets of water in the air. Such environment causes poorer performance on vision based surveillance system than normal condition. Recently, the difference of RGB color space used for single input image [20]. Also, a dark channel prior is used for single image [21]. This particular work has shown a good performance for "de-haze" effect. However, the details by using multiple images can provide more information than using single. Multiple images of same scene in different weather conditions are used. In this paper, we obtain more detailed information by using two-images of same scene with different weather (or time) and propose a simple relative depth estimation model, without the use of exact parameters [22]. The most conventional fog image model is that model modified this model by adding the variable of sky intensity and pixel value [19, 22].

$$E = I_\infty p e^{-\beta d} + I_\infty (1 - e^{-\beta d})$$

Where E is a pixel value, I_∞ is sky intensity, P is normalized radiance of a scene point, β is scattering coefficient of the atmosphere, and d is an optical depth between camera and object. If depth is zero (d = 0), then E = I_∞ P. If depth is very far (e.g. d = ∞), the pixel value E is equal to the sky intensity I_∞. This paper adopts the Narasimhan model for foggy image and assumes three properties concerning sky intensity ∞ I, scattering coefficient β and P.

III. LITERATURE REVIEW

Conventional schemes of image capture result in a degraded image in bad weather conditions which is difficult to reconstruct. Haze removal from a single image remains a challenging task as haze is dependent on unknown depth information. Over the years many researchers have attempted to overcome this turmoil.

Mohammad Javad Abbaspour et.al. (2016) proposed a new method in order to enhance the contrast in foggy images. The proposed method develops an image atmospheric model which is based on the Koschmieder's theory of the atmospheric vision. Morphological operators are used to achieve an outline of strength of the fog in the different areas. Quantitative analysis and qualitative judgment illustrate that the proposed method has reached to the same or even better results than other ones. In addition, low complexity gives us the opportunity to use it in real-time applications.

Veeranjaneyulu Toka ET. al. (2016) proposes a method that uses single frame for enhancing foggy images using multilevel transmission map. The method is fast and free from noise or artifacts that generally arise in such enhancement techniques. A comparison with existing methods shows that the proposed method performs better in terms of both processing time and quality. The proposed method works in real time for VGA resolution. The proposed work also presents a scheme to remove fog, rain and snow in real-time.

Muna F. Al-Sammaraie (2015) proposed a method to enhance visibility in bad weather. Methods that work on visible wavelengths, based on the type of their input, can be categorized into two approaches: those using polarizing filters, and those using images taken from different fog densities. Both of the approaches require that the images are multiple and taken from exactly the same point of view. While they can produce reasonably good results, their requirement makes them impractical, particularly in real time applications, such as vehicle systems. Considering their drawbacks, our goal is to develop a method that requires solely a single image taken from ordinary digital cameras, without any additional hardware.

Negru et al. (2014) proposed an algorithm that was suitable for the image enhancement for the day time fog conditions. The fogginess turns the image processing applications slow and makes them sensitive. This proposed work is based on the mathematical model of the koshmieder's law for computing the atmospheric veil. In this paper, both the quantitative and qualitative evolutions are performed on both the real camera pictures and synthetic images. The main advantage of using this model is the ability to adapt as per fog conditions. This model is also applicable for both the grey scale and colored images. The main application of this algorithm is that it can be ported into mobile phones and provide the driving assistance as a low cost solution [6].

Jin Wu (2013) has given a review on the image defogging methods. Here, firstly image fogginess is detected and then different image restoration methods are applied to enhance the image quality. The models discussed by the author are global histogram equilibrium; local histogram equilibrium, image defogging based on multi-scale retinex and image defogging based on guided filters are discussed. The results obtained from the different methods shows the guided filter algorithm as better defogging method [7].

Tarel (2012) used a modification of a common physical model. The issue of depth estimation is not considered in this model which can lead to decreasing the complexity of the proposed algorithm. However, too many parameters should be adjusted which can lead to the limited application of this method. In [2], two versions of the original image were used as the inputs weighted by specific maps. Three weight maps (luminance, chromatic and saliency) were used as weighting components. The basic idea in this fusion-based method was to combine these input images into a single one. The proposed method is very fast and easy to implement. As a consequence, it can be widely used in real-time applications [12].

Wang and Yang (2012) proposed a fast method for foggy image enhancement. This is a three step process. In this first step, the depth of the fogginess is extracted, in the second step transmission ratio of the atmospheric light is extracted and in the end gamma adjustment is used to get the final enhanced image. This method is compared with the retinex methods of deblurring and found to have the better results in the proposed algorithm [8].

Zhang et al. (2012) proposed a novel approach for the visibility enhancement using filtering approach. Here, it is considered that haze is due to outer layer of the noisy image part. The main reason for being this algorithm fast is that it is based on median filtering using a low-rank technique for visibility enhancement. Due to less computational complexity of low rank techniques, the proposed algorithm is fast and can achieve the better & efficient results as compare to single image dehazing. The drawback of this algorithm is that it does not perform well in case of heavy and great depth fog [9].

He et al (2009)[5] used guided image filtering, and proposed simple but effective method for haze removal using dark channel prior method. Most images contain haze free portion which has very low intensity in at least one color. Therefore, thickness of haze may be directly calculated. Output of one filter may be the input for the next guided filter. It can be used for edge preserving and smoothening, and has better results than the popular bilateral filter. It has a significantly faster processing time. A high quality depth map is also created. May not work for images with objects inherently similar to the atmospheric light, transmission then will be underestimated as dark channel has statistical dependence.

IV. QUALITY PARAMETERS

Every above method is compared by statistical point of view by using some standard quality measures.

A. Peak signal to noise ratio (PSNR)

The PSNR depicts the measure of modification in the original image. This metric is used for discriminating between the original and enhanced image. The easy computation is the advantage of this measure. It is formulated as:

$$PSNR = 10 \log (L\text{-}1)^2 / MSE$$

Where MSE is MEAN SQUARE ERROR .The method should not significantly amplify the noise level and thus a high value of PSNR is required A low value of PSNR shows that the constructed image is of poor quality.

B. Absolute Mean Brightness Error (AMBE)

Difference in mean brightness between two images is calculated by Absolute Mean Brightness Error. AMBE is defined as the difference between the input and output mean. Mathematical expression to calculate AMBE between two images is given as:

$$AMBE = |X_m - Y_m|$$

Where Xm and Y_m are mean brightness of input and processed image respectively.

C. Entropy

Discrete entropy E(X) measures the richness of details in an output image after enhancement.

$$E(p) = -\sum_{k=0}^{L-1} p(k) \log_2 p(k)$$

D. Contrast (C)

The enhanced image must obtain optimum image contrast (C) to distinguish between the object and the background. The contrast for enhanced image ought to be close to the contrast of the original image to attain good image quality. C is calculated using following equation.

$$C = \sqrt{\sum_{m=0}^{L-1} (m - m_{avg})^2 \, p(m)}$$

V. CONCLUSION

Image enhancement algorithms offer a wide variety of approaches for modifying images to achieve visually acceptable images. The choice of such techniques is a function of the specific task, image content, observer characteristics, and viewing conditions. In this paper, we have given the literature survey of various fog removal techniques. The different techniques of frequency domain based and spatial domain based algorithms are used for the enhancement of the algorithms. One is using synthetic foggy image as reference image to assess defogging algorithm. The other is computing the fog density for gray level image or constructing assessment system for color image from human visual perception to assess defogging algorithm without reference image. The results of different algorithms vary as per the input density of foggy image.

REFERENCES

[1]. Khairunnisa Hasikin and Nor Ashidi Mat Isa, "Enhancement of the low contrast image using fuzzy set theory"14th International Conference on Modelling and Simulation, IEEE,2012.

[2]. S.S. Bedi1, Rati Khandelwal2," Various Image Enhancement Techniques- A Critical Review" International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, Issue 3, March 2013

[3]. Raman Maini and Himanshu Aggarwal," A Comprehensive Review of Image Enhancement Techniques" JOURNAL OF COMPUTING, VOLUME 2, ISSUE 3, MARCH 2010, ISSN 2151-9617.

[4]. M. Hanmandlu and D. Jha, "An Optimal Fuzzy System for Color Image Enhancement," Image Processing, IEEE Transactions on, vol. 15, pp. 2956-2966, 2006.

[5]. Manpreet Kaur, Jasdeep Kaur, Jappreet Kaur," Survey of Contrast Enhancement Techniques based on Histogram Equalization" (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 7, 2011.

[6]. Yeong-Taeg Kim, "contrast Enhancement using Brightness Preservation Bi-histogram Equalization", IEEE Transaction on Communication, Networking and Broadcasting, Page: 1-8, Publication year: 1997.

[7]. H.D. Cheng, Huijuan Xu, "A novel fuzzy logic approach to contrast enhancement", Pattern Recognition, 33, 2000, 809-819.

[8]. S.K. Naik, C.A. Murthy, "Hue-preserving color image enhancement without gamut problem", IEEE Trans. Image Process., 12, 2003, 1591–1598.

[9]. Madasu Hanmandlu, Member, IEEE, and Devendra Jha," An Optimal Fuzzy System for Color Image Enhancement" IEEE transactions on image processing, vol. 15, no. 10, October 2006.

[10]. ZhiYu Chen and Besma R. Abidi "Gray-Level Grouping (GLG): An Automatic Method for Optimized Image Contrast Enhancement" IEEE transactions on image processing, vol. 15, no. 8, august 2006.

[11]. Gyu-Hee Park, Haw- Hyan Cho, "A Contrast Enhancement Method using Dynamic Range Separate Histogram Equalization", IEEE Transactions on Communication, Networking and Broadcasting, Page: 1981-1987, Publication year: 2008.

[12]. Kong. N. S. P, Ibrahim. H, "Color Image Enhancement using Brightness Preserving Dynamic Histogram Equalization" IEEE Transaction on Communication, Networking and Broadcasting, Page: 1962-1968, Publication year: 2008.

[13]. Madasu Hanmandlu, Senior Member, IEEE, Om Prakash Verma, Nukala Krishna Kumar, and Muralidhar Kulkarni, "A Novel Optimal Fuzzy System for Color Image Enhancement Using Bacterial Foraging", IEEE transactions on instrumentation and measurement, vol. 58, no. 8, august 2009

[14]. Gang Li, Yala Tong, Xinping Xiao, "Adaptive Fuzzy Enhancement Algorithm of Surface Image based on Local Discrimination via Grey Entropy", Elsevier Procedia Engineering 15 (2011) 1590 – 1594, 2011.

[15]. D. Ghimire and J. Lee, "Nonlinear Transfer Function-Based Local Approach for Color Image Enhancement," IEEE Transactions on Consumer Electronics, Vol. 57, No. 2, May 2011.

[16]. Khairunnisa Hasikin and Nor Ashidi Mat Isa, "Enhancement of the low contrast image using fuzzy set theory"14th International Conference on Modelling and Simulation, IEEE,2012.

[17]. R. K. Jha, R. Chouhan, P. K. Biswas ," Noise-induced Contrast Enhancement of Dark Images using Non-dynamic Stochastic Resonance," 978-1-4673-0816-8/12S ©2012 IEEE.

[18]. A. R. Rivera, B. Ryu, and O. Chae, "Content-Aware Dark Image Enhancement Through Channel Division" IEEE Transactions On Image Processing, Vol. 21, No. 9, September 2012.