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Fog Image Restoration Using Dark Channel Prior Model with Gamma Transformation and Bilateral Filtering

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Abstract**—**Images taken in foggy weather condition often suffer from poor visibility and clarity. Images of the outdoor scene which are captured under bad weather conditions contain atmospheric degradation such as haze, fog, smoke caused by the particles present in the atmosphere resulting in the absorption and scattering of the light, which travels from the scene point of the observer. In this paper, we define Dark Channel Prior Model, Gamma Transformation and Bilateral Filtering for fog removal and show better result.In this paper, to visibility increase with only single hazy image, a haze removal algorithm type is proposed. Firstly, the raw atmospheric transmission map is estimated with dark channel prior use.The experimental outcome shows that the good result as compared to previous gamma transformation and median filtering. The result based on the contrast gain ratio, execution time and entropy.

Keywords**—**Bilateral Filtering, Dark Channel Prior, Gamma Transformation

I. INTRODUCTION

Fog is a ice crystals or water droplets collection draped in the air at or near the surface of earth. Fog in form of cloud is known as stratus cloud. Fog is prominent from mist only by its density. Fog reduces visibility to less than 1 km where as mist reduces visibility between l and 2km. There are few type of fog Radiation fog, Ground fog, Advection fog, Evaporation fog, Arctic sea smoke, Precipitation fog, Upslope fog, Freezing fog, Frozen fog, Artificial fog are some of most recurring fog type [1]. Fog effect can be mathematically realized as an exponential function of the distance from the scene to the camera [2].

Hence the removal of fog requires the estimation of depth map. In order to obtain depth information for systems using single images as input requires prior assumptions to estimate the depth map. Therefore, numerousapproaches have been proposed which use multiple images. Recently, many single image fog removal algorithms have been proposed by applying a assumption or stronger prior. Tan developed the contrast maximization technique for improving the image visibility, due to the observation that enhanced images have higher contrast than images plagued through bad weather. Fattal presented a transmission estimating technique in hazy scenes, in the assumption that model used in the surface and transmission shading are nearby uncorrelated. This method is physically sound and can create impressive outcomes. However, it is deeply based on the color and thus cannot deal with a gray level image. He et al. proposed the dark channel prior technique for deweathering of image, which is based on the big number statistics of haze-free images. Combining a haze imaging model and a soft matting technique, we can estimate the transmission map and attain a important perceptual quality of image improvement. But, soft matting algorithm requires numerous data to obtain the exact transmission at discontinuous edge of depth map. Therefore, it is difficult for real time processing. To overcome these problem Tarel and Hautiere proposed a novel algorithm based on median filter but this method requires many parameters for adjustment. In Fang et al. proposed a method based on the graph-based segmentation. Initial transmission map is estimated according to black body theory and refined by bilateral filter. It is noted that for the foggy image choice of control parameters of segmentation is difficult.

II. WHAT CAUSES FOG?

Fog is occurs due to tiny droplets of water suspended in the air. The thickest fogs try to happen in industrial areas where there are numerous particles of pollution on which droplets of water can grow.).

Basically the images which are captured from outdoor in bad weather are of poor contrast. So due to the bad weather conditions light coming from the camera is scattered throughout in the atmosphere. And due to which quality of image gets degraded which needs to be recovered and hence the additive or extra light comes in picture. This additive light is because of the fog particles this is nothing but Air light .Air light is not uniformly distributed in the image.

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Due to the bad atmospheric condition visibility factor of the image is degraded. Poor visibility degrades perceptual image quality and thus performance of the computer vision algorithms such as surveillance, tracking, and navigation is affected. So, it is very necessary to make appropriate changes in these vision algorithms so as to make them robust to weather changes.Weather conditions depends on size of fog particles.Because of the fog present in the scene whiteness in the scene is increased.Thus increasing whitening effect on the image/scene and resulting into poor contrast of the scene. [3]

III. Fog Removal Techniques

A. BILATERAL FILTERING

This filtering [4] smoothes images without effecting edges, by means of a non-linear combination of nearby image values. In this, filter replaces every pixel by weighted average of its neighbor's pixel. The weight assigned out to each one neighbor pixel diminishes with both the distance in the image plane and the distance on the intensity axis. This filter helps us to get come about quicker as contrast with other. While utilizing bilateral filter we utilize pre-processing and post transforming steps for better comes about. Histogram equalization is utilized as preprocessing and histogram stretching as a post preparing. These both steps help to build the contrast of image previously, then after the fact utilization of two-sided channel. This algorithm is independent of density of fog so can also be applied to the images taken in dense fog. It doesn't require user intervention. It has a wide application in tracking and navigation, consumer electronics and entertainment industries. Bilateral filter is a non-linear, noise-reducing smoothing filter and edge-preserving for images. The intensity value at all pixel in an image is replaced through a weighted intensity values average from nearby pixels. This weight can be based on a distribution of Gaussian. Crucially, the weights depend not only on Euclidean pixels distance, but also on the radiometric variances (e.g. range differences, such as depth distance, color intensity, etc.). This preserves sharp edges through systematically looping byall pixel and adjusting weights to the adjacent pixels accordingly.

B. CLAHE

In general, local histogram of a pixel, x, is the same as the histogram of pixels in a rectangular window with the pixel x into its center. Only the pixels within the local area are considered. But according to the characteristic of human vision, the visual systems change with the region and these systems are affected by the surrounding environment. To solve these problems, S.M. Pizer [5] proposed a method which is called contrast limit Adaptive histogram equalization (CLAHE). The CLAHE method applies histogram equalization to a contextualregion. Each pixel of original image is in the center of the contextual region. The original histogram is clipped and the clipped pixels are redistributed to each gray level. The new histogram is different from the original histogram, because each pixel intensity is limited to a user-defined maximum. So CLAHE limits the noise enhancement. The algorithm proposed in this paper is intended to overcome the limitation of CLAHE algorithm.

The CLAHE method [6] applies histogram equalization to sub-images. Every pixel of original image is in the local point of the sub- image. The first histogram of the sub - picture is cut and the cut pixels are redistributed to each gray level. The new histogram is not quite the same as the first histogram on the grounds that the intensity of every pixel is inhibited to a client determined maximum. Consequently, CLAHE can lessen the enhancement of noise.

IV. Literature Review

Atul Gujral1 et. al[7], present that Fog is a combination of two different components direct attenuation and airlight, degrades the picture value and generates big issue in the video surveillance, navigation and tracking. Thus, to eliminate it from an image, numerous defogging approaches contain been proposed in literature. Defogging can done applying various images and also single image fog elimination technique. One of the prominent approaches in literature for defogging is DCP. This technique by quite effective in eliminating fog from images has most high time complexity. In addition, it does not edges preserve and has halo effect. Therefore, this paper proposes a novel method which overcomes the DCP draw back and at the similar time preserves the quality of picture. The proposed technique is implemented in MATLAB-09 and the simulation outcomes present the proposed technique is quite good.

Jun Mao1 et.al [8], present that Limited visibility in weather of haze strongly influences the accuracy and the common functions of almost driver assistance systems and outdoor video surveillance. Actual weather circumstance is valued knowledge to invoke corresponding methods. Based on the analysis of atmospheric scattering model and the statistics of numerous outdoor images, for most foggy images, we find that the highest and lowest value in color channels tends to be the same atmospheric light values. A function for estimating the haze degree is developed for the automatic detection of the foggy image with different haze degrees. Experimental outcomes present that our haze classification technique achieves high performance.

Hiroshi Kawarabuki et.al [9], present that In this paper, we propose the technique for identifying the snowfall automatically degree even if most of backgrounds are covered with snow and the low visibility through fog. When it snows heavily, fog often happens simultaneously. Moreover, falling snow grains contain low contrast to the background covered with white snow. In order to deal with these circumstances, the proposed technique creates an input image clear through fog elimination. We propose the new fog removel technique which can be applied to not only the common scene but also the full snowy scene. This technique can eliminate the fog influence without depending on the visibility grade because the fog removal degree is changed dynamically. The degree of snowfall is estimated from the falling quantity snow grains, which are removed from the difference between the present defogged image and the background image created by the three-dimensional median. Experiments conducted under various degrees of snowfall have present the effectiveness of the proposed technique.

Naman Chopra et.al[10], present that noise elimination from an image is still a stimulating issue Hiroshi the processing of in image research area. In this paper comparison of two dfferent denoising technique applying fuzzy filter and adaptive wiener filter in wavelet domain is complete. Wavelet transforms are particularly used for compression, Denoising, Thresholding ,reduction of error, reconstruction, and for image synthesis. Discrete wavelets filters and transform are used for image reconstruction in experiments. Performance can be calculated on the basis of two different parameter i.e PSNR (peak signal-to-noise ratio) & RMSE(root mean square error). MATLAB is used for two technique implementation.

S. Bronte el.at[11], In this document, a real-time fog detection system applying an on-board low cost between camera, for a driving application, is presented. This system is based on two different clues: visibility distance estimation, which is calculated from the camera projection equations and the blurring because of the fog. Because of the particles of water floating in the air, sky light gets diffuse and, road zone focus, which is one of the darkest zones on the image. The apparent effect is that particular sky part introduces in the road. Also in foggy scenes, the border strength is reduced in the image upper part. These two different information sources are used to create this system more robust. The final purpose of this system is to develop an automatic vision-based diagnostic system for warning ADAS of possible wrong working conditions. Few experimental outcomes and the conclusions about this work are presented.

Shota Furukawa et.al [12], present that Image processing methods for the haze removal for example fog and smoke from digital images contain been actively researched. In the removing of haze from an image, it is necessary to estimate the transmission map and the global atmospheric light in the image. The authors have proposed the estimation technique based on the minimum and maximum bilateral filters. However, the computational cost of the filters are very high. The purpose of this study is to accelerate the speed of the proposed technique through applying the GPGPU aiming for the proposed technique to be actually used in the practical applications. With the experiments, it is confirmed that the calculation speed of the technique is drastically accelerated enough for the practical use.

V. ALGORITHM

In this algorithm, a kind of fog-removal technique is presented taking only a single foggy image as an input. Firstly, divide the color image into three components such as Red (R), Green (G) and Blue (B). After that, estimate the atmospheric transmission map using the dark channel prior method. Then refined the transmission map using gamma transformation. Gamma transformation is to enhance the contrast and then smoothed using a bilateral filter to vary the depths smoothly across the scene. In the of compensating the non-linearity in order to achieve correct reproduction of relative luminance. The simple form of the gamma transformation is derived by

$$Gamma = a(I)^{\gamma} \qquad (1)$$

Where, a is positive constant. The intensity *I* of each pixel in the input image is transformed as *Gamma* after performing and $\gamma$is a constant.

1. Read Color Image 'I' .
2. Divide Color Image into three components such R, G and B.
3. Take 'n' patch size for minimum intensity with value of n is 2 initially.
4. The adaptive histogram equalized image R,G,B will be defined by

$$(R,G,B)_{i,j}=(floor\ (n-1)\sum_{n=0}^{Ii,j} size(Image))/2$$

where floor() rounds down to the nearest integer.

5. Assuming that the transmission in a local patch n is constant the transmission map, *t* is transmission map, w is local patch with minimum value of all components.
6. The transmission map are estimated appropriately can be obtained by solving equation by

$$t(x) = 1 - \text{wmin}(\min\ (\text{R}, \text{G}, \text{B}))$$

7. Refine transmission map with a minimum value of omega and gamma transformation can be obtained by the equation,

$$Gamma = a(t(x))^{\gamma}$$

8.Estimate dark channel prior using this equation,

$$J1(i,j,1) = \frac{(R(i,j,1) - Ar)}{\min(\max(K\text{^}2/\mathrm{sum}((\mathrm{sum}((\mathrm{wAr} - \mathrm{Ar}).\text{^}2))'),1) * \max(t, t0,1)} + Ar$$

Where J1 is dark channel prior, i, j are row and column of foggy image, R is red component, Ar is max value of atmospheric light of Red component,K is scene depth, wAr is omega of Ar, to is lower bound

9.The airlight and the transmission map are estimated appropriately, the scene radiance can be obtained by this formula:

$$J = \frac{I(R,G,B) - A(R,G,B)}{\max(t(R,G,B), t0)} + A(R,G,B)$$

10.The bilateral filter outcome for a pixel *s* is then:

$$J_s = \frac{1}{k_s} \sum_{p \in \Omega} f(p-s)\, g(I_p - I_s) I_p$$

Where k(s)) is a normalization term:

$$k_s = \sum_{p \in \Omega} f(p-s)\, g(I_p - I_s)$$

In the practice, they utilize Gaussian for *f* in spatial domain, and also Gaussian for the *g* in intensity domain. Therefore, the pixel *s* value is affected mostly through pixel that are close spatially and that has a same intensity. This is the most easy to color images extend, and some metric pixels *g* can be utilized (e.g. CIE-LAB).

8. Calculate gain contrast for defog to fog image can be obtained by this formula:

$$Cgain = CIdefog - CIfog$$

Where, *CIdefog* and *CI fog* are the mean contrast of the defoggy a foggy images respectively.

9. Calculate entropy of an image:
10. E=-$\sum_{i=0}^{N-1} p(xi) \log p(xi)$

Where E: Entropy

N: Maximum gray level value

p(xi): Probability of occurrence of xi

Entropy is a measure of randomness or disorder of an object in this case the difference image between the foggy image and the defog image. Entropy gives the information about the loss of features in the noise free image during the filtering process by finding the power spectrum of the difference image. The lower entropy is better.

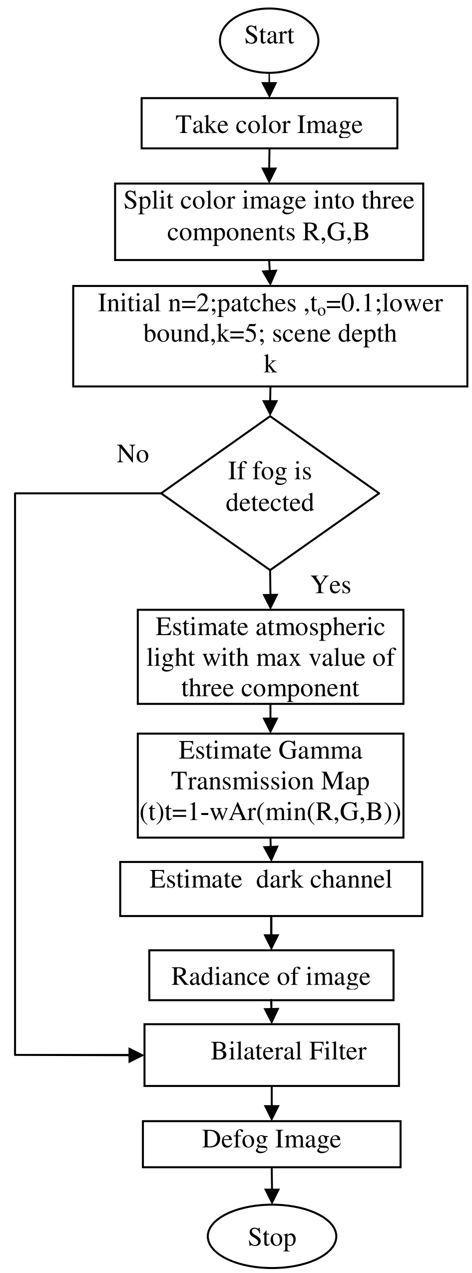


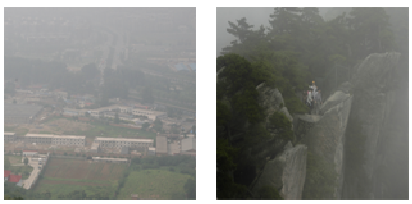
Fig1. Flow Chart of our Proposed Algorithm

VI. SIMULATION RESULT

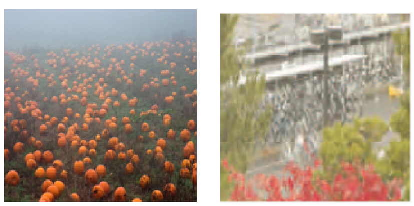
1. Experimental Data

Toysstorm4

Trees cones



Canon mountain



Pumpkinsfog5

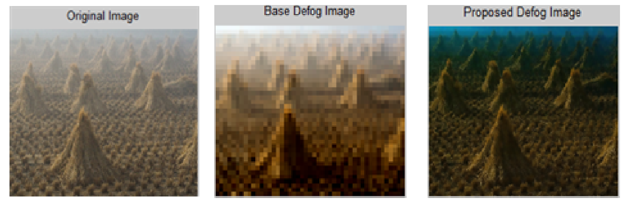
Fig2. Experimental Dataset

2. Performance Analysis of Image (a)

(A) (B) (C)

Fig3. (A) Show original image (B)Show base results (C) Our Proposed result

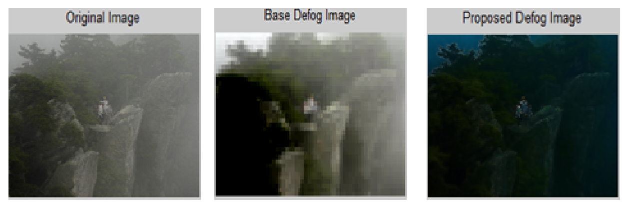
3. Performance Analysis of Image (c)



(A) (B) (C)

Fig4. (A) Show original image (B)Show base results (C) Our Proposed result

4. Performance Analysis of Image (f)



(A) (B) (C)

Fig5. (A) Show original image (B)Show base results (C) Our Proposed result

5. GUI of our Proposed System

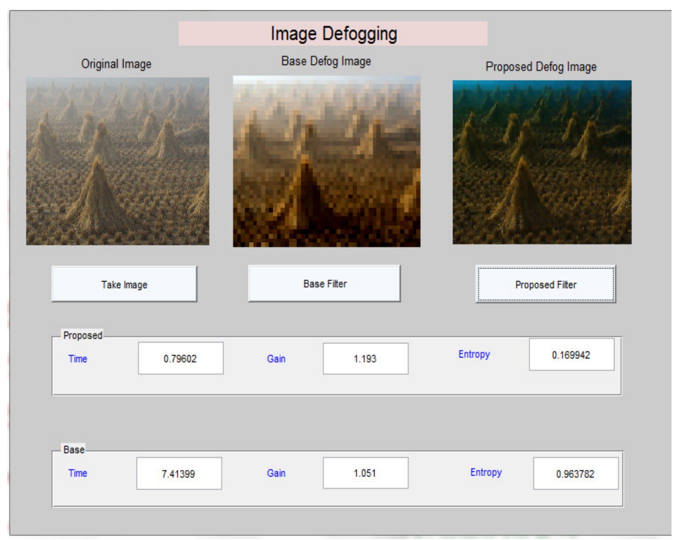


Fig6. Show Proposed Graphical User Interface

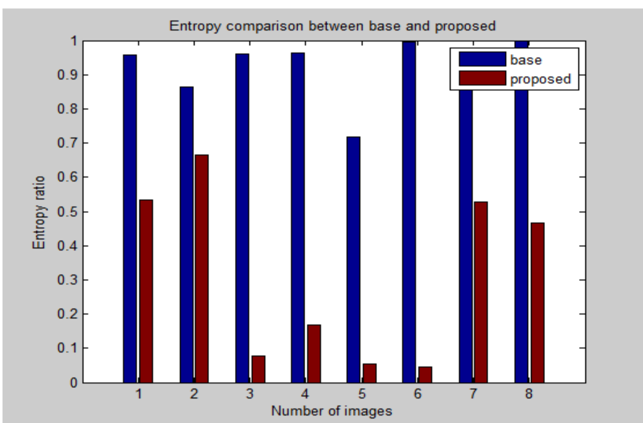
Image	Base Gain	Proposed Gain	Base Time (sec)	Proposed Time(sec)
toys	0.689	0.743	7.487	0.477
Storm4	0.523	0.505	12.599	0.755
trees	1.294	1.402	15.927	0.733
cones	1.051	1.193	7.384	0.796

canon	0.470	0.846	15.540	0.608
mountain	1.174	1.543	10.809	0.566
Pumpkins	1.093	1.169	10.742	0.915
Fog5	0.885	0.927	9.841	0.466

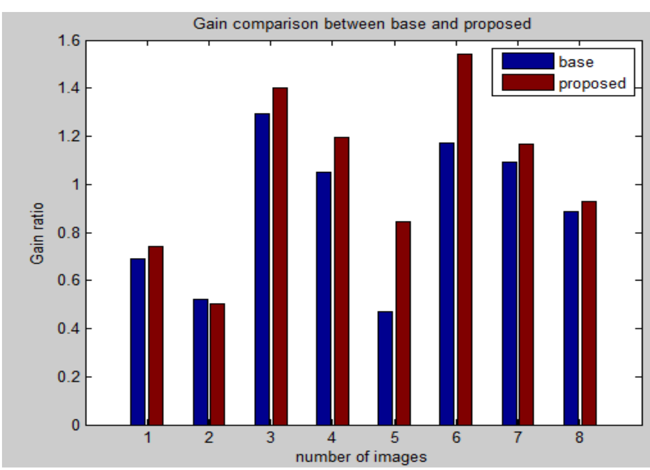
Table1. Gain and Time Comparison between Base and Proposed System

Image	Base Entropy	Proposed Entropy
toys	0.958	0.535
Storm4	0.864	0.664
trees	0.961	0.078
cones	0.963	0.169
canon	0.718	0.055
mountain	0.996	0.044
Pumpkins	0.972	0.529
Fog5	0.999	0.466

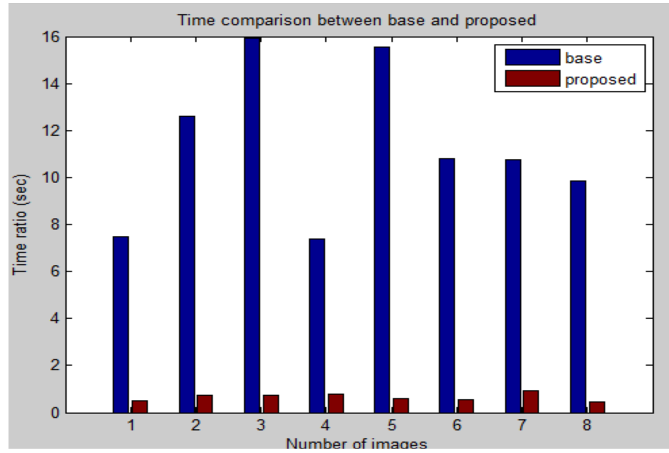
Table2. Entropy Comparison between Base and Proposed System



Graph1. Entropy Comparison between Base and Proposed System



Graph2. Gain Comparison between Base and Proposed System



Graph3.Time Comparison between Base and Proposed System

CONCLUSION

Now a days, image plays an important role in the real world, images are used for describing the changes in the environment and also use of traffic analysis. Both images are captured in open environment due to the bed whether or atmosphere images are not a clear. Therefore main aim of this paper is to focus on the problem of several blurred, foggy and noisy low-resolution image convert into a high-resolution image. In this study, we implemented dark channel prior model, gamma transformation and bilateral filtering for fog removal. In the result analysis, we increased contrast gain for image quality and decrease processing time to speed up the system. And calculate entropy value for check randomness of an image and less value is good for an image.

REFERENCES

[1] Garima Yadav, Saurabh Maheshwari and Anjali Agarwal," Fog Removal Techniques from Images: A Comparative Review and Future Directions", International Conference on Signal Propagation and Computer Technology (ICSPCT), IEEE, pp: 44-52,**2014**.

[2] Apurva Kumari, Philip Joseph Thomas and S.K.Sahoo," Single Image Fog Removal Using Gamma transformation and median filtering",Annual IEEE India Conference (INDICON),**2014**.

[3] Nirali Pambhar and Prof.Priyanka Buch,"Analysis and Survey of Various Methods of Fog Removal", International Journal of Emerging Trends in Engineering and Development Issue 4, Vol.2 Page 363-368(March **2014**).

[4] Yadwinder Singh, Er. Rajan Goyal," A Study Of Various Haze Removal Algorithms", IJIRT | Volume 1 Issue 3, pp:1-7,**2014**.

[5] V. Agarwal, S. Khandelwal, D. Goyal, J. Sharma2 and A. Tiwari3," Two-Pass Adaptive Histogram Based Method

For Restoration Of Foggy Images", International Conference on Pattern Recognition and Image Analysis ,pp: 139- 142,**2014**.

[6] Gagandeep Singh , Gagandeep Singh," Evaluation Of Various Digital Image Fog Removal Algorithms", International Journal of Advanced Research in Computer and Communication Engineering Vol. 3, pp: 7536-7540, Issue 7, July **2014**

[7] Atul Gujral, Shailender Gupta and Bharat Bhushan," A Novel Defogging Technique for Dehazing Images",International Journal of Hybrid Information Technology Vol.7, No.4, pp.235-248 http://dx.doi.org/10.14257/ijhit.2014.7.4.20, **2014**.

[8] Jun Mao, Uthai Phommasak, Shinya Watanabe and Hiroyuki Shioya," Detecting Foggy Images and Estimating the Haze Degree Factor", Mao et al., J Comput Sci Syst Biol , 7:6 http://dx.doi.org/10.4172/jcsb.1000161,Volume 7(6) 226-228 (014),**2014**.

[9] Hiroshi Kawarabuki and Kazunori Onoguchi," Snowfall Detection in a Foggy Scene", 22nd International Conference on Pattern Recognition, IEEE, pp: 877-882, **2014**.

[10] Naman Chopra, Mr. Anshul Anand,"Despeckling of Images Using Wiener Filter in Dual Wavelet Transform Domain", Naman Chopra et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (3) , 4069-4071,**2014**.

[11] S. Bronte, L. M. Bergasa, P. F. Alcantarilla," Fog Detection System Based on Computer Vision Techniques"ITSC,2009.

[12] Shota Furukawa, Takahiro Fukuda, Takanori Koga, Noriaki Suetakeand Eiji Uchin,"High-Speed Min-Max Bilateral Filter-Based Image Dehazing by Using GPGPU", Proceedings of the 2014 International Conference on Advanced Mechatronic Systems, Kumamoto, Japan, IEEE,pp: 459-462, August 10-12, **2014**.

