IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319 5940
International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 11, November 2016

Increasing the Visibility of Image under Haze and Low Light Conditioning Environment

Priya Turkhade[1], Prof. A.P. Dhande[2]

P.G. Student, Electronics and Telecommunication Department, P. R. Patil College, Amravati, India [1]

Associate Professor, Electronics and Telecommunication Department, P. R. Patil College, Amravati, India [2]

Abstract: This paper describes the problem of visibility of outdoor images under haze and poor light condition. Visibility is a very important issue in case of computer based surveillance, crime analysis, driver assistance system designs etc. The most important challenge related to visibility is the atmospheric haze and poor lighting. The problem becomes more challenging if haze is too dense and lighting during night is extremely poor. The image processing is the vast emerging field in the era of technology of machine vision, machine intelligence and automation for real time processing or the post processing of the image captured in different atmospheric conditions. The image captured in the outdoor scene are highly degraded due to the poor lighting condition or over lighting condition or due to the presence of different suspension particle like the water droplets or dust particles. So due to these particles the irradiance coming from the object is scattered or absorbed. And hence the phenomena of haze, smoke and fog occurs. The haze removal is very essential in the field of image processing because the different computer vision algorithm assumes the input image as the original scene radiance or scene reflectance. But in most outdoor processing the images are degraded due to hazy, hence the input image is hazy image not the original radiance. In this paper we presented a technique Dark channel prior and Adaptive Histogram Equalization to improve visibility of outdoor images for different atmospheric condition. We have calculated performance parameters such as RMSE, PSNR and correlation coefficient.

Keywords: haze, poor lighting, dark channel prior method, adaptive histogram equalization, MSE, PSNR.

I. INTRODUCTION

Poor visibility conditions due to bad weather, dust and smoke severely affect the performance of vision systems. In the atmospheric absorption and scattering, the emission of rays received by the camera from the scene point is attenuated along the line of sight and the incoming light is blended with the air light. This phenomenon, called haze or fog, can significantly degrade the visibility of the scene. Most computer vision applications, such as image segmentation and object tracking, usually suffer from the poor visibility of the hazy images. Therefore haze removal is highly desired in many practical applications.

Image Enhancement is the improvement of digital image quality, without knowledge about the source of degradation. The aim of image processing is to use data contained in the image to enable the system to understand, recognize and interpret the processed information available from the image pattern. Image Enhancement is the improvement of digital image quality, without knowledge about the source of degradation. Image Enhancement is the technique to improve the interpretability or perception of information in images for human viewers. In most outdoor processing the images are degraded due to hazy, hence the input image is hazy image not the original radiance. If the haze can be removed then the scene will have proper brightness, contrast and the information contents in the image will be high. The haze removal process is very complicated because the haze depends upon the unknown depth of the object in the scene. The other problem which has been considered is enhancement of image when it is captured under night condition. In this case the object is rarely visible and hence the captured image has less amount of information. To resolve these problems we proposed the method of haze removal using dark channel prior and Adaptive Histogram Equalization. In this Dark channel prior method calculates the haziness of image and adaptive histogram equalization enhances the outdoor images in extremely poor visibility condition.

II. LITERATURE REVIEW

In the field of haze removal different methods are present which basically built on the priority of strong assumptions. There are different papers in which many methods have been proposed by using multiple images by different authors are as follows.

Robby T. Tony [1] have been proposed method which is based on two basic observations: first, images with enhanced visibility (or clear-day images) have more contrast than images plagued by bad weather; second, air light whose variation mainly depends on the distance of objects to the viewer, tends to be smooth. The method does not require the geometrical information of the input image, and is applicable for both colours and gray images.

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319 5940
International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 11, November 2016

Srinivasa G. Narasimhan and Shree K. Nayar [2] have been presented a physics-based model that describes the appearances of scenes in uniform bad weather conditions. Changes in intensities of scene points under different weather conditions provide simple constraints to detect depth discontinuities in the scene and also to compute scene structure.

A.J. Preetham, P. Shirley and B.Smits [3] presented an inexpensive analytic model that approximates full spectrum daylight for various atmospheric conditions. These conditions are parameterized using terms that users can either measure or estimate. It also presents an inexpensive analytic model that approximates the effects of atmosphere (aerial perspective). These models are fielded in a number of conditions and intermediate results verified against standard literature from atmospheric science. The importance of the phenomena modelled in this paper is emphasized in the psychology and art literature.

Huifang Li, Liangpei Zhang [4] presented a principal component (PC)-based haze masking (PCHM) method is developed for the masking of haze in visible remote sensing images covering land surfaces at middle latitudes. Developed an haze masking method by using only the visible channel are highly correlated and haze can be easily confused with land surfaces in all these channels. It is only suitable for locally regional Haze masking where locally means that there must be clear surfaces existing in the scene and regional means that resolution is not very large.

III.PROPOSED WORK

The image captured in the outdoor scene are highly degraded due to the poor lighting condition or over lighting condition or due to the presence of different suspension particle like the water droplets or dust particles. So due to these particles the irradiance coming from the object is scattered or absorbed. And hence the phenomena of haze, smoke and fog occurs. So the images are degraded and the colours, contrast are shifted from its original irradiance at the time of capture of the image. The following fig shows the block diagram of proposed work which will used to remove the haze and to enhanced the image.

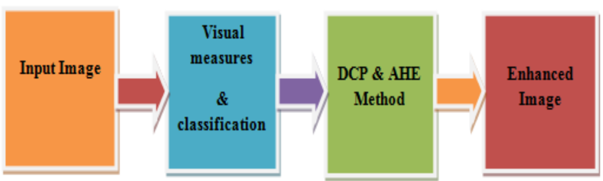

Fig.1. Block diagram of Proposed Work.

By taking different types of images first detect the type of image and classify the image i.e. is it degraded by haze or low light. After that by it will detect the amount of haziness present in the input hazy image. On the basis of that the image is degraded by haze or low light apply the proper method one is Dark channel prior method (DCP) and other is Adaptive histogram equalization(AHE).After applying method we get enhanced image. The basic block diagram of proposed work consists of four blocks: Input Image, Visual measures & classification, DCP and AHE method, Enhanced image.

We have proposed a highly efficient and integrated algorithm to enhance both hazy outdoor images and the low light images. The algorithm integrates both the algorithms for hazy image as well as the night images. In this method we will use dark channel prior method and adaptive histogram equalization so as to de-haze the image as well as to increase the contrast of the image. Flow diagram of the proposed work to determine the input image and then process with histogram based dark channel prior method. The formulated algorithm is shown in the Figure.

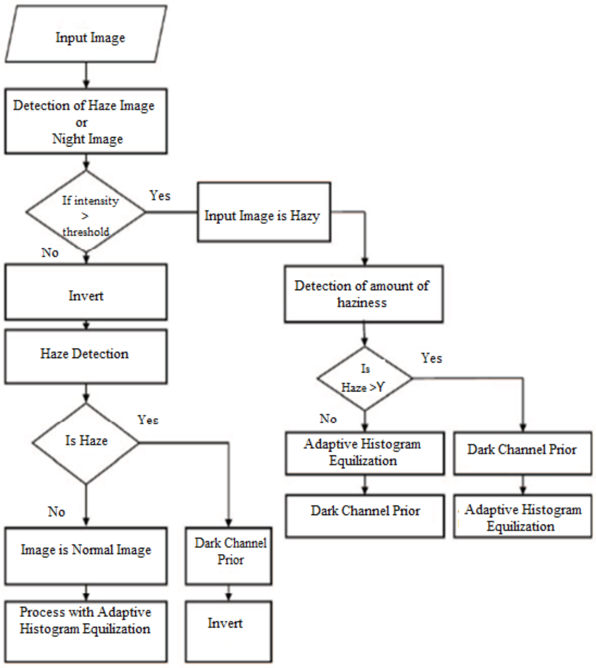

Fig.2. Flow chart of the module to determine the input image and then process with histogram based dark channel prior method.

A. Input Image

The haze removal is very essential in the field of image processing because the different computer vision algorithm assumes the input image as the original scene radiance or scene reflectance. But in most outdoor processing the images are degraded due to hazy, hence the input image is hazy image not the original radiance. If the haze can be removed then the scene will have proper brightness, contrast and the information contents in the image will be high. The haze removal process is very complicated because the haze depends upon the unknown depth of the object in the scene.

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319 5940
International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 11, November 2016

B. Visual Measures & Classification

In order to detect, whether the image is degraded by haze during day light or it is degraded due to insufficient lighting during night time, the following algorithm has been used.

Step1: Plot the histogram of the input image

Step2: Determine the mean of the intensity distribution (let it be 'm')

Step3: Compare this mean with the pre-defined threshold to decide, whether the image is degraded by haze during day light or it is degraded due to insufficient lighting during Night time.

Step4: Take a threshold (say λ) If m > λ Then the image is degraded by haze if not then the image is degraded due to insufficient lighting of scene during night.

Once the type of degradation is decided, then the corresponding enhancement algorithms can be used to enhance the scene visibility. The flow diagram of the algorithm to detect the input images is shown in Figure.

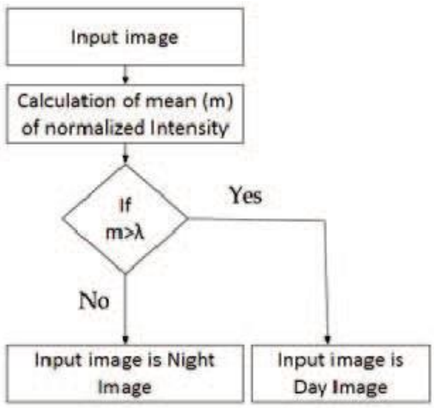

Fig.3. Flow chart to detect the input image

We have decided threshold (λ) value on the basis of histogram of input image.

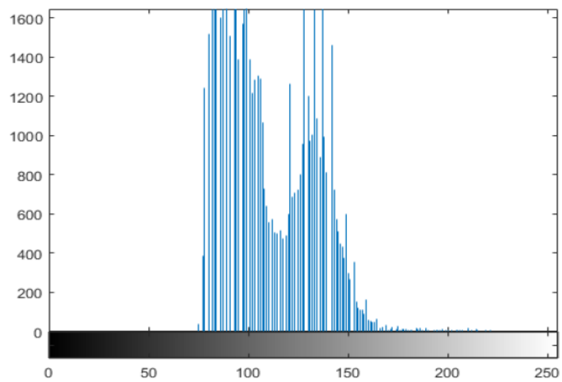

Fig.4. Histogram of input image

Based upon that it will classify the type of image .The images captured in the outdoor hazy condition suffer in the deviation of different colour channel of the RGB components present in a pixel of the image. But the sky region have the high intensity as compared to the object which we capture. So the non-sky region of the image have the lower intensity of the pixel value and hence the image may be considered as the hazy image due to the deviation of colour of the different objects present in the image. Once the type of degradation is decided, then the corresponding enhancement algorithms can be used to enhance the scene visibility.

C. Dark Channel Prior Method and Adaptive Histogram equalization: Image Dehazing

The images captured in the outdoor hazy condition suffer in the deviation of different colour channel of the RGB components present in a pixel of the image. But the sky region has the high intensity as compared to the object which we capture. So the non-sky region of the image has the lower intensity of the pixel value and hence the image may be considered as the hazy image due to the deviation of colour of the different objects present in the image. When the image is a haze-free, then the minimum intensity of the different pixel value is very low in numbers. But when the image is a hazy one then the number of pixel having intensity low are high. So according to the dark channel prior method the amount of minimum intensity value can be described as a function and denoted as $J^{dark}(x)$ and it can be represented as:

$$J^{dark}(x) = \min_{y\in\Omega(x)}\left(\min_{c\in\{r,g,b\}} J^{c}(y)\right)$$

Where J^{C} is a color channel of J and Ω(x) is a local patch cantered at x. It is the outcome of two minimum operator $\min_{c\,\varepsilon\{r,g,b\}}$ i.e. Minimum operator that operates on each pixel and $\min_{y\,\varepsilon\,\Omega(x)}$ is the minimum filter that operates on the patch of size Ω(x). So according to the concept of dark channel prior method $J^{dark}(x)$ has to be defined for hazy images. If the image is a hazy image then the intensity of J's dark channel will be low and it tends to zero value:

$$J^{dark}(x) \rightarrow 0$$

This expression is called as dark channel prior. This priority is utilized to de-haze the images.

$$I(x) = J(x)t(x) + A(1 - t(x))$$

Where **I** is the observed intensity of the scene, **J** is the original scene radiance, **A** is the atmospheric light and **t** is the medium transmission coefficient which describes the amount of light propagate to the camera without scattering. The original scene radiance **J(x)** can be calculated from the other parameter if we can estimate the t(x) and A properly. The **I(x)** is our observed intensity. And hence a haze free image can be estimated as:

$$J(x) = \frac{I(x) - A}{t(x)} + A$$

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 11, November 2016

And this is the expression of haze free images derived from above equation. Hence the dark channel prior method can be implemented to successively recover the original image radiance from the observed degraded hazy images. In the next step the transmission coefficient t(x) has to be derived by applying the dark channel prior technique. The t(x) can be calculated from the haze model. The transmission coefficient t(x) is taken outside the minimum filter as this can be considered as constant in a patch. As the scene radiance **J** is a haze-free image, the dark channel of **J** is close to zero due to the dark channel prior:

$$J^{dark}(x) = \min_{y\in\Omega(x)}\left(\min_{c} J^{c}(y)\right) = 0.$$

As A^c is always positive, this leads to:

$$\min_{y\in\Omega(x)}\left(\min_{c}\frac{J^{c}(y)}{A^{c}}\right) = 0.$$

Now from above equations, we can eliminate the multiplicative term and estimate the transmission t(x) simply by:

$$t(x) = 1 - \min_{y\in\Omega(x)}\left(\min_{c}\frac{I^{c}(y)}{A^{c}}\right).$$

Here,

$$\min_{y\in\Omega(x)}\left(\min_{c}\frac{I^{c}(y)}{A^{c}}\right)$$

is the dark channel of the normalized hazy image

$$\frac{I^{c}(y)}{A^{c}}$$

It directly provides the estimation of the transmission coefficient.

When the haze of an image is completely removed then it may look like unreal and physically invalid or the depth of the image may be loosed. So to keep some aerial perspective or the depth of the image it is very much required to keep some amount of haze so that the image will be visually pleasant and contains high amount of visual information. To keep some haze a parameter ω($0 < \omega \leq 1$) is introduced in the transmission coefficient:

$$t(x) = 1 - \omega \min_{y\in\Omega(x)}\left(\min_{c}\frac{I^{c}(y)}{A^{c}}\right)$$

The value of ω depends upon different input conditions. Its value varies from scene to scene. But for the hazy images its value can vary in between 0 .75 to 0.95 with respect to the amount of haziness of the image. If the quantity of haze is very high then and ω is taken 0.95 then the transmission of different color channel is affected and the shift of color in the original radiance is deviated. Often the hazy images become darker or mostly bluish in color. So the selection of this weight parameter ω undergoes a haze based algorithm which calculate whether the ω value will be higher (ω =0.75) or lower (ω =0.95). So it is now adaptive to choose an appropriate value of weight ω. The original radiance of the scene can be calculated and hence a haze-free image can be recovered i.e.

$$J(x) = \frac{I(x) - A}{t(x)} + A$$

The very conventional method to increase the visibility of the image is to take the histogram equalization of the degraded or dull images. But when this equalization process is applied, the contrast level increase to a certain amount but the haze also increases simultaneously. At the same time the dark channel prior can remove the haze and give proper radiance of the scene. So a new algorithm has been proposed which integrates both dark channel prior method and adaptive histogram equalization method. But between dark channel prior method and adaptive histogram equalization method, which has to be processed first it has to be taken carefully by using certain algorithm Otherwise this algorithm will not be adaptive and in certain case the images willl be degraded entirely. By taking different types of haze image it observed that when the amount of haze is extremely high then if adaptive histogram equalization is applied, then image will be hazier.

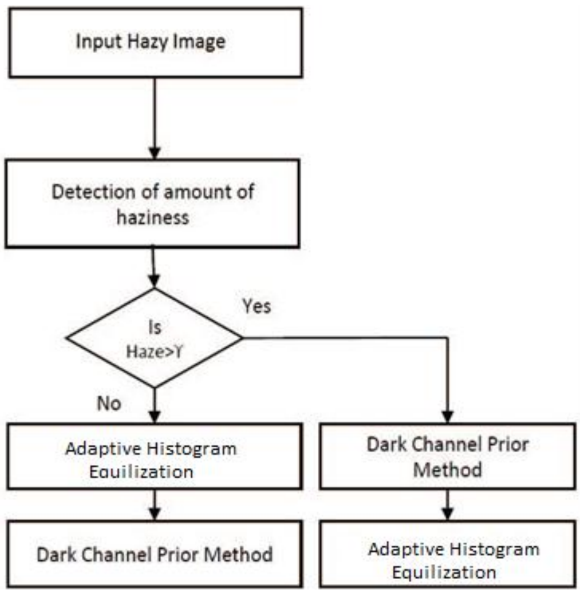

Fig.5. Flow diagram to detect amount of haziness present in the input hazy image

IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 11, November 2016

So in this case the dark channel prior will be applied first and then the adaptive histogram equalization process will be very effective. And the result will be haze free as well as high contrast image. In the second observation when the amount of haze is little lower then first equalization will be applied and then dark channel prior will be applied and output will be more pleasant than the dark channel prior image alone.

When adaptive histogram equalization process is applied to the recovered image obtained. So by taking this observation we have defined the algorithm. We have taken a threshold value (let λ). When amount of haze is greater than λ, then the image is said to be extreme hazy image. And when amount of haze is less than λ, then it is called less hazy image as shown in Figure.

Enhancement of Night Images: Increasing Visibility in Night. The low-light images or the night images contain very less amount of visual information. So to extract information we have to go for image negative. But when images are inverted then inverted images has very similar statistics as the hazy images.

In both type of images i.e. inverted night images and hazy images have the same characteristics that the intensity of background pixel is always high in all color channel and the intensity of object is very less in at least one color channel. So by using the statistics the dark channel prior method can be implemented to the low-light images or night images after the inversion of the input images. So the inversion process can be represented as:

$$R^c(x) = 255 - I^c(x)$$

where c is the color channel i.e. RGB, Ic (x) is the intensity of the pixel of an input low light image. Here R c(x) is the same intensity of the inverted image R. Hence the haze model for the inverted night / low-light image can be represented as:

$$R(x) = J(x)t(x) + A(1 - t(x))$$

Where A is the atmospheric light and J(x) is the original intensity of the object or scene. Here t(x) is the transmission coefficient as described in the (10). So now for night image or low-light image the transmission coefficient can be expressed as:

$$t(x) = 1 - \omega \min_{y \in \Omega(x)} \left(\min_{c} \frac{R^c(y)}{A^c} \right)$$

Where ω is the weight parameter and it is taken lower than that of ω taken for the hazy images. Its typical value is taken as 0.85 in this paper. The value of atmospheric light A can be calculated from the pixel of the input image. The maximum value of all color channel i.e. RGB is calculated and the maximum values calculated are taken as (A). The recovered image is represented as:

$$J(x) = \frac{R(x) - A}{t(x)} + A$$

After the recovery of the value J, then the again it has to be inverted so as to get the enhanced output images. So we have proposed an integrated algorithm which will detect as well as process both night images and day hazy images. This proposed algorithm also adaptively chooses the value of weight parameter ω.

D. Enhanced Image

Using above method we will get de-hazed or enhanced image which was degraded by haze during day light or it is degraded due to insufficient lighting during night time.

IV. EXPERIMENTAL RESULT

The Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) are the two error metrics used to compare image quality

A. Mean Square Error (MSE):

The MSE is the cumulative square error between the encoded and the original image defined by:

$$MSE = \frac{\sum_{M,N} [I_1(m,n) - I_2(m,n)]^2}{M * N}$$

Where, I_1 is the original image and I_2 is the uncompressed image. The dimension of the images is m x n. Thus MSE should be as low as possible for effective compression.

B. Peak Signal to Noise Ratio (PSNR):

PSNR represents a measure of the peak error. Higher the value of PSNR, lower the error. To compute the PSNR, the block first calculates the mean squared error using the following equation

$$PSNR = 10 \log_{10} \left(\frac{R^2}{MSE} \right)$$

C. Correlation Coefficient:

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(B_{mn} - \bar{B})}{\sqrt{\left(\sum_m \sum_n (A_{mn} - \bar{A})^2 \right) \left(\sum_m \sum_n (B_{mn} - \bar{B})^2 \right)}}$$

DOI 10.17148/IJARCCE.2016.51131

IJARCCE
ISSN (Online) 2278-1021
ISSN (Print) 2319 5940
International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 11, November 2016

TABLE I ANALYSIS OF DIFFERENT PERFORMANCE PARAMETER OF IMAGES FOR DIFFERENT ATMOSPHERIC CONDITION

	Performance Parameter		
Images	RMSE	PSNR	CORR
Image 1	12.9311	37.0145	0.7761
Image 2	10.7572	37.8138	0.6882
Image3	3.7516	42.3886	0.9712
Image 4	7.2075	39.552	0.7609

TABLE II COMPARISON BETWEEN RESULT OF PROPOSED WORK AND EARLIER METHOD IN TERMS OF PSNR.

Performance Parameter	Ref.No.[15]	Proposed Work
PSNR	26.39dB	39.19dB

Here, we have showed the results of sample images which are captured in different atmospheric condition.

Image1: Hazy Image

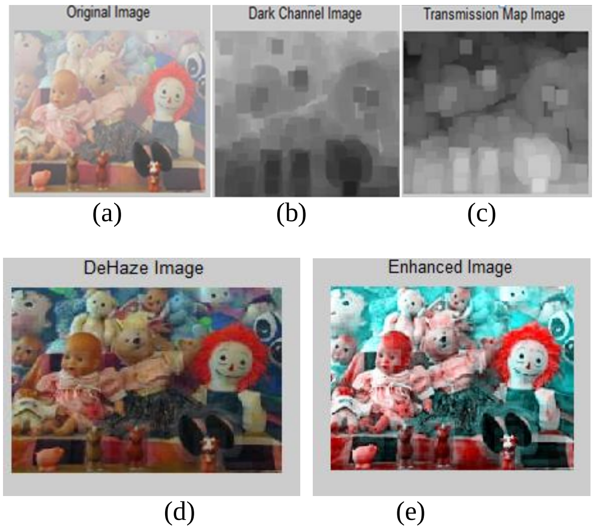

Fig: 6. Original image (a), dark channel prior image (b), transmission map image (c), dehazed image (d), enhanced image (e).

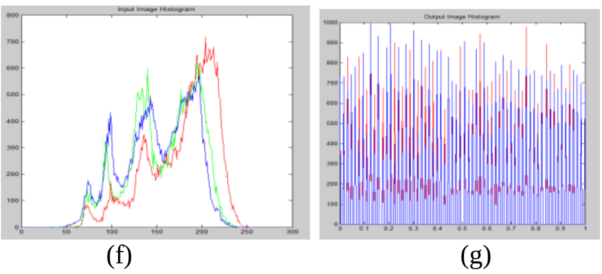

Fig.7. Input image histogram (f), Output image histogram (g)

Image 2: Less Hazy Image

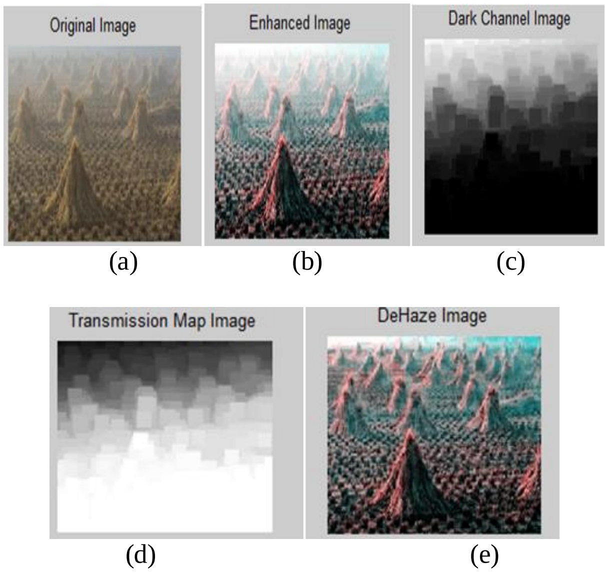

Fig.8. Original image (a), enhanced image (b), dark channel prior image (c), transmission map image (d), dehazed image (e).

Image 3: Low light Image

Fig.9. Original image (a) enhanced image (b).

Image 4: Low light Image degraded by haze

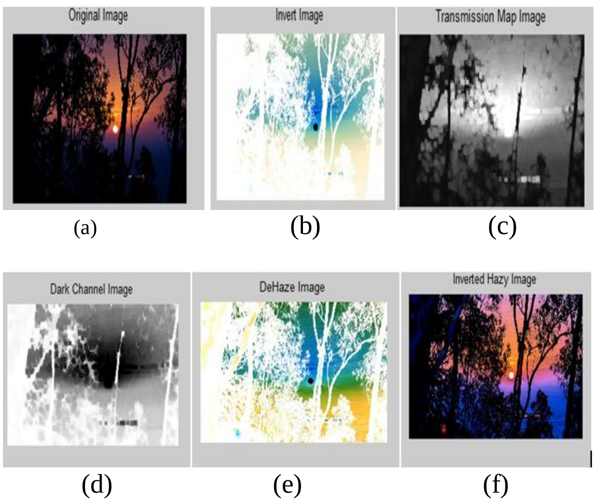

Fig.10. Original image (a) invert image (b), transmission map image(c), dark channel prior image (d), dehazed image (e), Inverted hazy image (f).

V. CONCLSION

In this project we have proposed algorithm which will first detect and then process with proper algorithm for different atmospheric condition. This proposed work eliminates the drawbacks arising in other existing methods. We can see that our results are better than the existing method's result. The PSNR value of our proposed work is higher than the existing method's, but it is observed that the weight parameter "ω" widely varies from scene to scene. So it becomes very important parameter to deal with the haze image. Our approach is based on the dark channel prior and adaptive histogram equalization. The proposed approach accomplishes a higher degree of visibility recovery for images captured in extreme haze condition, as well as low light condition. The present study is confined to the removal of haze, but in future new algorithm can be developed to enhance image in more dense condition or more haze condition. We leave this for future work so that a more efficient algorithm can be developed to remove the haze. We can use de-noise technique to enhance the image in higher degree of visibility. We can implement this technique in video also.

REFERENCES

[1] R. Tan. "Visibility in Bad Weather from A Single Image," in Proc. IEEE Conf. Computer Vision and Pattern Recognition., Anchorage, Alaska, pp. 1-8, Jun. 2008.

[2] G. Narasimhan and S. K. Nayar, "Contrast Restoration of Weather Degraded Images," IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 25, no.6 pp. 713-724, June 2003.

[3] A.J. Preetham, P.Shirley, and B.Smits, "A Practical Analytic Model for Daylight," Proc. ACM SIGGRAPH '99, 1999.

[4] A Principal Component Based Haze Masking Method for Visible Images Huifang Li, Liangpei Zhang,Senior Member, IEEE, and Huanfeng Shen, Senior Member, IEEE ieeegeoscience andremotesensingletters,vol.11,no.5,may2014

[5] S.G. Narasimhan and S.K. Nayar, "Chromatic Framework for Vision in Bad Weather," Proc. IEEE Conf. Computer Vision and Pattern Recognition, vol. 1, pp. 598-605, June 2000.

[6] Quality Assessment for Comparing Image Enhancement Algorithms Zhengying Chen, Tingting Jiang and Yonghong Tian∗ School of Electronics Engineering and Computer Science, Peking University

[7] S.G. Narasimhan and S.K. Nayar, "Vision and the Atmosphere," Int'l J. Computer Vision, vol. 48, pp. 233-254, 2002.

[8] R. Fattal. "Single Image Dehazing," in ACM SIGGRAPH '08, Los Angeles, CA Aug. 2008.

[9] K.He, J.Sun and X.Tang. "Single Image Haze Removal Using Dark Channel Prior," in Proc. IEEE Conf. Computer Vision and Pattern Recognition, Jun 2009.

[10] S.G. Narasimhan and S.K. Nayar, "Interactive De weathering of an Image Using Physical Models," Proc. IEEE Workshop Color and Photometric Methods in Computer Vision, in Conjunction with IEEE Int'l Conf. Computer Vision, Oct. 2003.

[11] X. Dong, G. Wang, Y. Pang, W. Li, J. Wen, W. Meng, and Y. Lu, "Fast efficient algorithm for enhancement of low lighting video," in Multimedia and Expo (ICME), 2011 IEEE International Conference on. IEEE,2011.

[12] Wei-Jheng, Wang Bo-Hao, Chen Shih-Chia Huang "A Novel Visibility Restoration Algorithm for Single Hazy Images" International Conference on Systems, Man, IEEE 2013.

[13] Enhancement of imagery in poor visibility conditions Glenn Woodella, Daniel Jobsona, Zia-urRahmanb, Glenn Hinesa a NASA Langley Research Center, Hampton.

[14] Yishu Zhai, Dongjiang Ji " Single image dehazing for visibility improvement "Dept. of Science, Tianjin University of Technology and Education, Tianjin.

[15] X. Dong, G. Wang, Y. Pang, W. Li, J. Wen, W. Meng, and Y. Lu, "Fast efficient algorithm for enhancement of low lighting video," in Multimedia and Expo (ICME), 2011 IEEE International Conference on. IEEE, 2011