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An Improved algorithm for Low Contrast Hazy Image Detection using DCP

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Abstract — *Area of Image Processing includes image quality enhancement, tracking or detecting object, video quality enhancement, video analysis etc. The aim of video analysis is to develop intelligent systems that can take decisions as per the situations.. Therefore existing work mainly concentrated on video quality enhancement and detect particular object from the video. Following report focuses on those problems, that occurs during bad weather condition (ex. fog, haze, snow or rainy conditions). Existing work shows quality enhancement for low resolution videos or for single images, but few algorithms are developed for enhancing bad weather condition videos, which normally have low resolution, high noise and compression artifacts. To remove the fog from the sequence of frames is one of the most challenging task of video processing. Proposed method works with DCP method for improve the performance of fog removal process. The propose method first recognize wather input image is a foggy image or low contrast image by CLAHE algorithm and then DCP method apply if input image is foggy image.*

Keywords- *Fog Removal, Airlight map, Dark Channel Prior, Contrast Enhancement, Bilateral Filter, Restoration, Contrast Limited Adaptive Histogram Equalization(CLAHE)*

I. INTRODUCTION

The outdoor scene is often degraded due to fog, rain or snow, which prevent the clear observation of objects in the scene and also degrades the performance of computer vision tasks such as object detection, tracking and recognition. Hence there have been much efforts for the dehazing, i.e., haze removal. Low contrast images degrade the performance of various image processing and computer vision algorithms. Dehazing is the process of removing haze from hazy images and enhancing the image contrast.

Several dehazing algorithms have been proposed to estimate object depths using multiple images or additional information. For example, Kopf et al. [5] employed the prior knowledge of the scene geometry for dehazing. These algorithms can estimate scene depths and remove haze effectively, but require multiple images or additional information, which limits their applications.

Recent researches mostly focus on single image dehazing, which usually require the depth information of the scene or some kind of strong assumptions on haze and haze-free images. For example, Fattal [3] assumed that the albedo of a local patch has the same vector direction. Tan [2] assumed that haze-free image has better contrast compared to the hazy image. More recently, dark channel prior assumption was proposed to estimate the depth information based on the comparison between the hazy and clean image [1], which is proved to be a very powerful prior in single image dehazing. He et al. [1] estimated object depths in a hazy image based on the dark channel prior, which assumes that at least one color channel should have a small pixel value in a haze-free image. They also applied an alpha matting scheme to refine the object depths. There is also a contrast enhancement approach for dehazing [4], which is also quite effective in removing the haze.

In the Existing work, Dark Channel Prior gives bad result on dark background and low contrast because it merges the scene with the thick haze. If the input image is low contrast image and large area with background, DCP method will obtain an indistinct and dim result. Existing work removes the fog by using Dark Channel Prior(DCP) method. This method estimates transmission map and air-light to recover original image from foggy image. To estimates the transmission map, it uses the lowest intensity pixel of image in 3 colour planes in patch sizes of different values. Method results perfectly for foggy image under certain condition.

In this work, we propose a dehazing algorithm for videos based on the optimized contrast enhancement. The proposed algorithm is based on our preliminary work on video dehazing [6]. We increase the contrast of a restored image to remove haze. However, if the contrast is overstretched, some pixel values are truncated by overflow or underflow. DCP algorithm accept foggy image as input and gives defoggy image as output. The airlight estimation and transmission map estimation done on input image. Instead of that proposed method use first contrast enhancement technique to recognize if it is foggy image or low contrast image. In the contranst Enhancement of CLAHE technique the input image checks if it is low contrast image or foggy image. If it is low contrast image then it is discarded by CLAHE method. The CLAHE method passes only foggy image. Then the foggy image is goes to Airlight Estimation and Transmission Map Estimation. Then output of contrast enhancement technique used as input of DCP algorithm.

The rest of the paper is organized as follows. Section II gives the detail of Literature Survey for video analysis, which encompasses the methods of image registration. Section III gives the proposed work in Dark Channel Prior(DCP) method video analysis, Section IV represents implementation methodology and Section V presents experimental results. Finally, Section VI concludes this work.

II. LITERATURE SURVEY

Fog removal methods are used in image processing systems. Various fog removal methods have been proposed in the literature to reduce fog effects. These methods enhance the quality of image by removing the fog and the quality of the image is improved.

Kaiming He et al [1] has proposed a efficient image prior dark channel prior to eliminate fog from a single input image. It is based on a key inspection that most of the local areas in outdoor fog free images have some pixels which have low power in one of the color channel. Using this prior with the fog imaging depiction, a the thickness of the haze is approximated and get better high-quality haze-free image.

Gibson et al [7] has proposed a fast single image defogging method that uses a novel approach to refining the estimate of amount of fog in an image with the Locally Adaptive Wiener Filter. Gibson et al [7] provide a solution for estimating noise parameters for the filter when the observation and noise are correlated by decorrelating with a naively estimated defogged image. This method is 50 to 100 times faster than existing fast single image defogging methods and that our proposed method subjectively performs as well as the Spectral Matting smoothed Dark Channel Prior method.

Wei-Jheng Wang et al [8] has proposed visibility restoration techniques have been developed and play an important role in many computer vision applications. A complete haze removal from a single image with a complex structure is difficult for visibility restoration techniques to achieve. He proposes a novel visibility restoration method which utilizes a combination of the median filter operation and the dark channel prior in order to achieve effective haze removal in a single image with a complex structure.

Tarun Arora et al [9] has proposed a new fog removal technique IDCP which will integrate dark channel prior with CLAHE and adaptive gamma correction to remove the fog from digital images. Fog in image reduces the visibility of the digital images. Poor visibility not only degrades the perceptual image quality but it also affects the performance of computer vision algorithms such as object detection, tracking, surveillance and segmentation. Various factors such as fog, mist and haze caused by the water droplets present in the air during bad weather leads to poor visibility. The proposed algorithm is designed and implemented in MATLAB using image processing toolbox. The comparison among CLAHE (contrast limited adaptive histogram equalization) and the proposed algorithm is also drawn based upon certain performance parameters.

Yanjuan Shuai et al [10] presented an image haze deduction of wiener filtering based on dark channel prior. The algorithm is mostly to approximate the median function in the use of the media filtering method based on the dark channel, to make the media function more exact and unite with the wiener filtering closer. So that the fog image restoration problem is altered into an optimization problem, and by minimizing mean-square error a clearer, fog free image is finally obtained.

A. K .Tripathi and S.Mukhopadhya[11] have proposed a novel and efficient fog removal algorithm which uses anisotropic diffusion to improve scene contrast. Proposed algorithm is independent of the thickness of fog and does not need user interference.

Tripathi et al. [12] have studied that fog formation is due to attenuation and airlight. Airlight enhancess the whiteness in the scene and Attenuation reduces the contrast. Proposed method uses bilateral filter for the judgment of airlight and improve scene contrast. Proposed method is independent on the density of fog and does not need user interference. This algorithm is applicable on both color as well as grey scale images. Histogram equalization is used as a preprocessing step. This results better estimation of airlight map. The final airlight map is refined using bilateral filter. Histogram stretching of output image is performed as post processing step. This results a final defogged image.

III. PROPOSED METHOD

In Existing work, removes the fog by using Dark Channel Prior(DCP) method. This method estimates transmission map and air-light to recover original image from foggy image. To estimates the transmission map, it uses the lowest intensity pixel of image in 3 colour planes in patch sizes of different values. Method results perfectly for foggy image under certain condition. This method estimates transmission map and air-light to recover original image from foggy image. The term is used in Dark Channel Prior is below:

Airlight Estimation : The airlight will be properly estimated amongst the pixels having thick haze. The group of brightest pixels, belonging to the dark channel, are estimated by the algorithm that finds the max R, G, B values amongst them to assemble the airlight. It may be chosen by two methods:

1. One can find the region where the scene appears to be farthest from the camera and use a rectangle to select it.
2. Compute local dark channel in the rectangular region.

The airlight component arises from photons which were not originally incident on the observer being scatter towards the observer. The airlight component arises from ambient light which was scattered towards the camera.

Transmission Map Estimation : Transmission Map is roughly estimated using a dark channel prior and it is refined by solving the matting Laplacian matrix.

Soft Matting : It is able to reduce the artifacts introduced by large patches.

Bilateral Filter : The purpose of applying bilateral filter is to smoothen the small scale textures of image.

Image Restoration : In this step, image is restored.

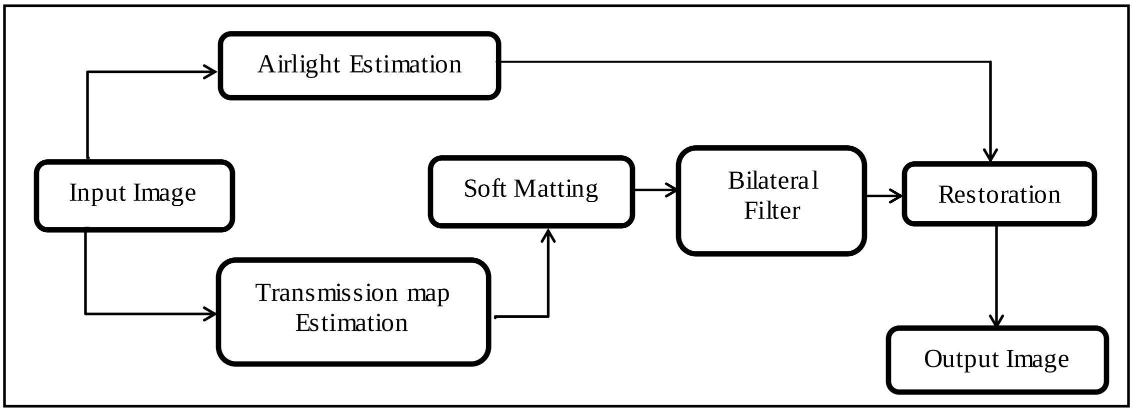

Figure 1. Block Diagram of DCP Algorithm

Now Dark Channel Prior have some limitation that it gives bad result on dark background and low contrast because it merges the scene with the thick haze. If the input image is low contrast image and large area with background, DCP method will obtain an indistinct and dim result.

We develop a method which combines the two existing methods of fog removal and CLAHE is applied to it. It is found that the proposed method is more suitable for obtaining the better quality of the image than the most of the existing methods. Current DCP algorithm accept foggy image as input and gives defoggy image as output. As shown in figure 2 airlight estimation and transmission map estimation done on input image. Instead of that proposed method use first contrast enhancement technique to recognize if it is foggy image or low contrast image.

The results produced by the existing dark channel prior method have less PSNR value and more MSE. Therefore the overall objective is to improve the results by combining CLAHE with Dark channel prior method. The proposed algorithm is designed and implemented in MATLAB using image processing toolbox. The detailed algorithm for the proposed approach is given below:

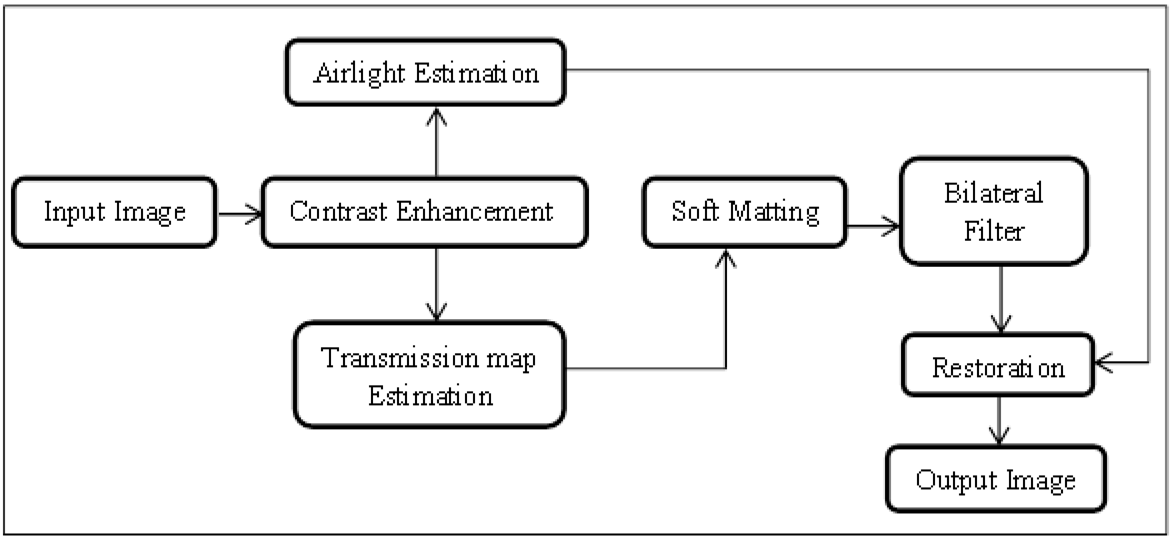

Figure 2. Block Diagram of DCP Algorithm with contrast enhancement

In the contranst Enhancement of CLAHE technique the input image checks if it is low contrast image or foggy image. If it is low contrast image then it is discarded by CLAHE method. The CLAHE method passes only foggy image. Then the foggy image is goes to Airlight Estimation and Transmission Map Estimation. Then output of contrast enhancement technique used as input of DCP algorithm.

Dataset consist of different kinds of parameter like video resolution, frame rate, length and size of video etc. Each parameter tested for the getting the good quality of result. Every parameter which is consider in dataset can make effect on the results. Videos are taken from different camera or with difffrent resolutions. In this dataset we are considering only 3 sample videos for experiment. For further result analysis we can take more number of videos for the experiment.

IV. EXPERIMENTAL RESULTS

In this section we will compare the results of the videos by the existing and the proposed approaches. The videos of the existing and the proposed approaches are shown as under:

Step 1: In the first step of fog removal process, we divide our video in the sequence of frames. We have set the frame rate 25 so, from the video of 1 second it extract 25 frames.

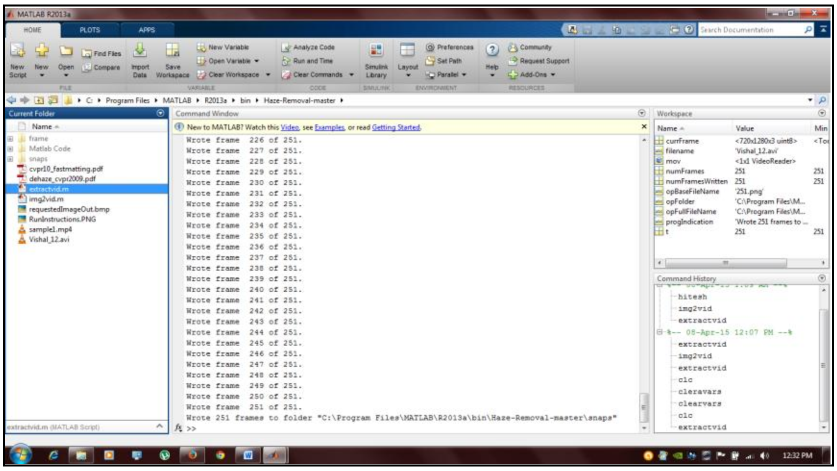

Figure 3. Divide our Video in the Sequence of Frames

This are the result of 1st step of fog removal process. How frame are extract in matlab and paste in destination folder.

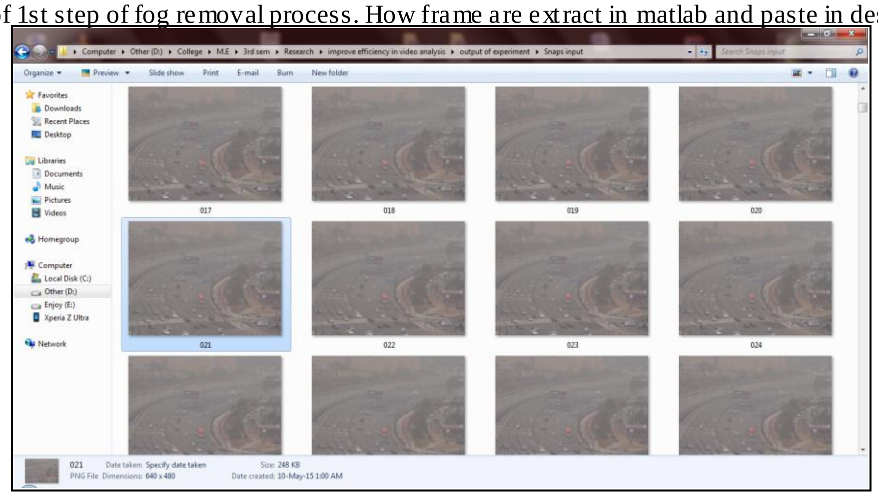

Figure 4. Extract frames from video

Step 2: In this second step, each frame are processed individually for removing fog from it. Result shows how fog is removed from the single frame.

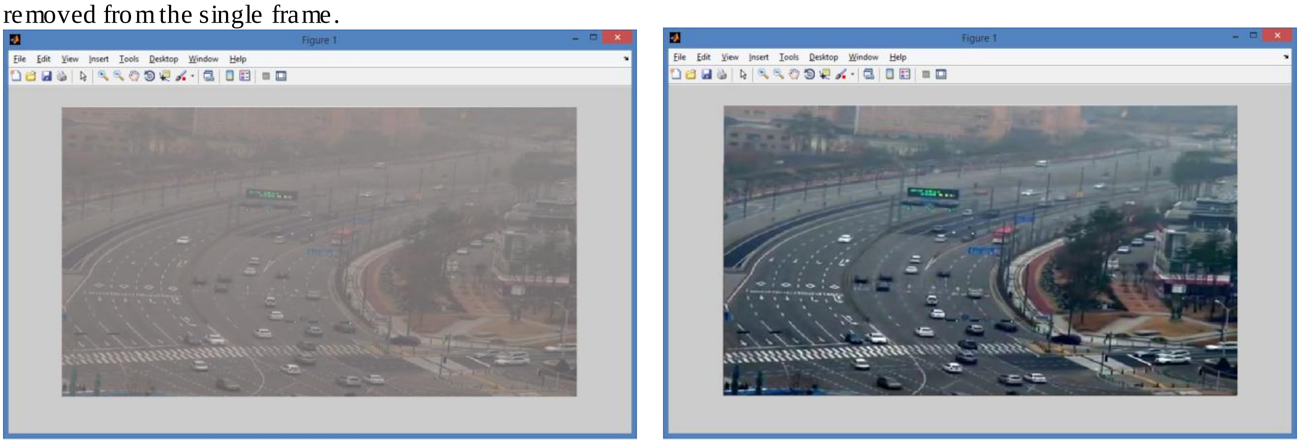

Figure 5 (a), (b). 169th frame of Fogy Image & Defogy Image

Step 3: After removing fog from each frame we recombine the all frames to create video. Results shows how frames are combined and creates one video.

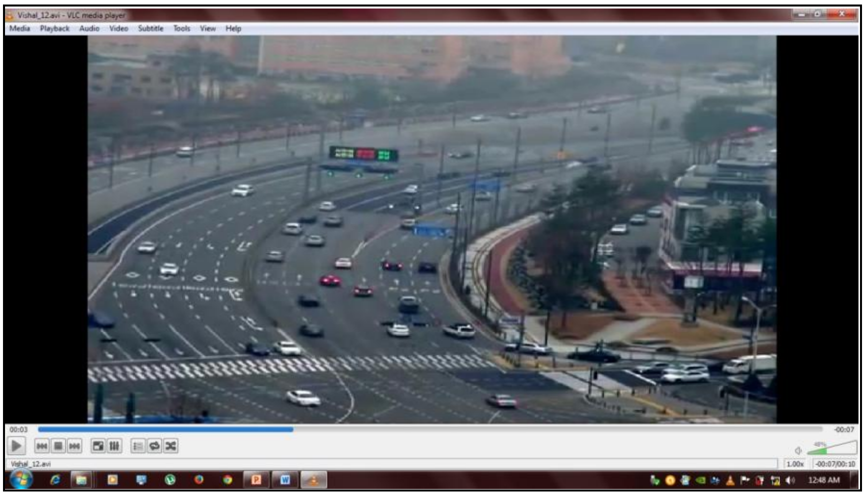

Figure 6. Combine each defog frames and make video

V. PERFORMANCE ANLYSIS

Table 1 has shown the mean square error comparision. As mean square error need to be reduced therefore the proposed algorithm is showing the better results than the available methods as mean square error is less in every case.

Table 1. Combine each defog frames and make video

Frames	Existing	Proposed
Test_1_149	21.691	21.538
Test_1_223	21.709	21.489
Test_1_494	21.717	21.477
Test_1_553	21.629	21.577
Test_2_056	20.321	20.185
Test_2_268	20.519	20.278
Test_2_554	20.529	20.393
Test_2_841	20.114	19.978

Figure 7 has shown analysis of the mean square error. As mean square error need to be reduced therefore the proposed algorithm is showing the better results than the available methods as mean square error is less in every case.

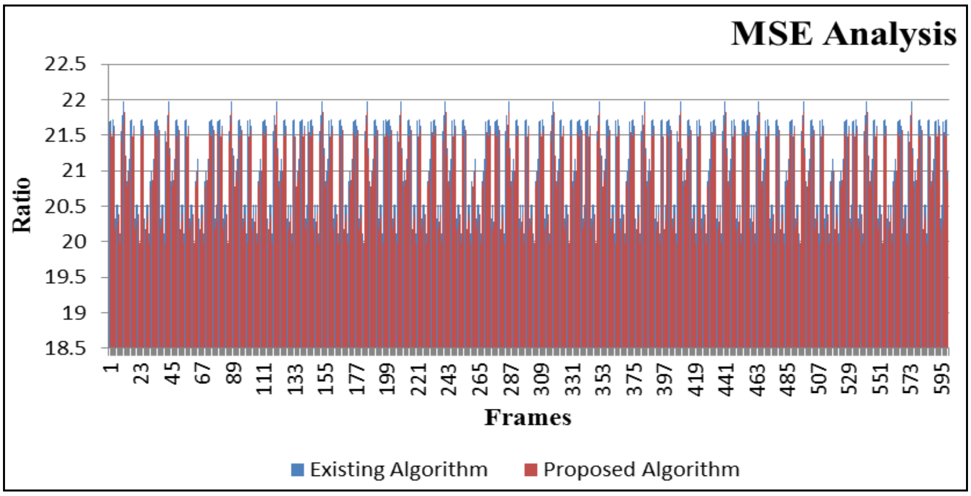

Figure 7. Meaen Squre Error (MSE) (600 Frames)

Figure 7 shows the graph based analysis of MSE for sample video test_fog_1.avi. video has 600 frames therefore graph becomes to complex for understanding MSE analysis. For the simplicity purpose we have devides the 600 frames into the 100 frames interval shown in figure 8. We are taking average of MSE for every interval of 100 frames.

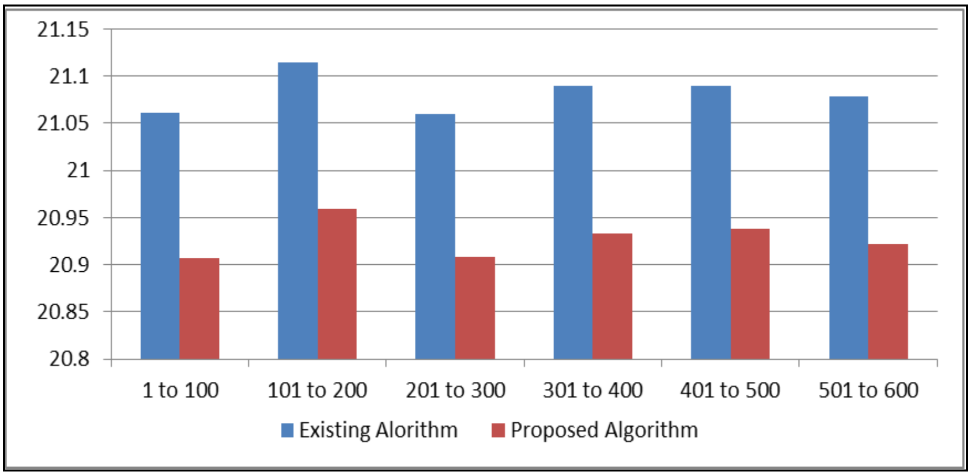

Figure 8. Meaen Squre Error (MSE)

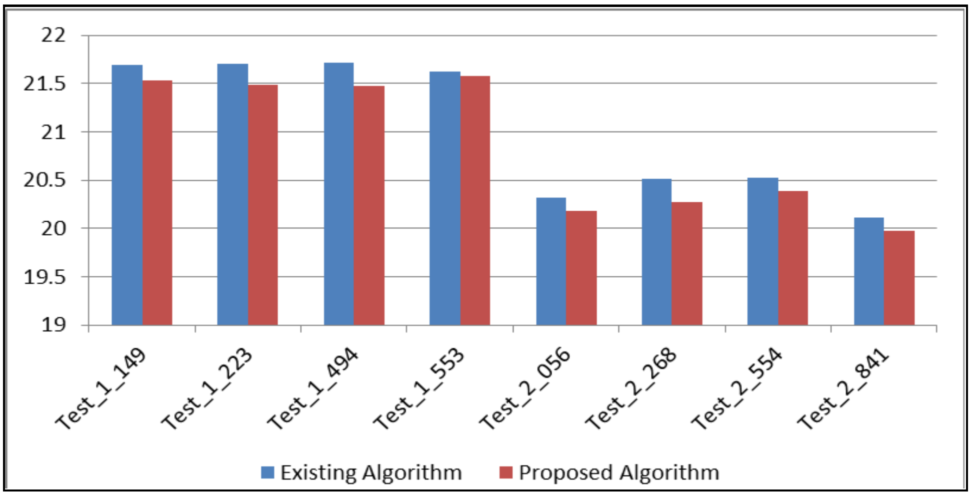

Figure 9. Graph of Table 1

This is the graphical representation of Table 2. It shows the comparison of MSE values of existing work and proposed work.

Table 2. Peak Signal to Noise Ratio Comparision

Frames	Existing	Proposed
Test_1_149	25.3240	25.4723
Test_1_223	25.3250	25.9281
Test_1_494	25.4179	25.9458
Test_1_553	25.1020	26.0744
Test_2_56	25.0374	25.5363
Test_2_268	24.6249	24.6600
Test_2_554	24.4599	24.9087
Test_2_841	24.4730	24.7669

Table 2 is showing the comparative analysis of the Peak Signal to Noise Ratio (PSNR). As PSNR need to be maximized; so the main goal is to increase the PSNR as much as possible. Table 2 has clearly shown that the PSNR is maximum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the available methods.

Figure 10 is showing the comparative analysis of the Peak Signal to Noise Ratio (PSNR). As PSNR need to be maximized; so the main goal is to increase the PSNR as much as possible. Figure 11 has clearly shown that the PSNR is maximum in the case of the proposed algorithm therefore proposed algorithm is providing better results than the available methods.

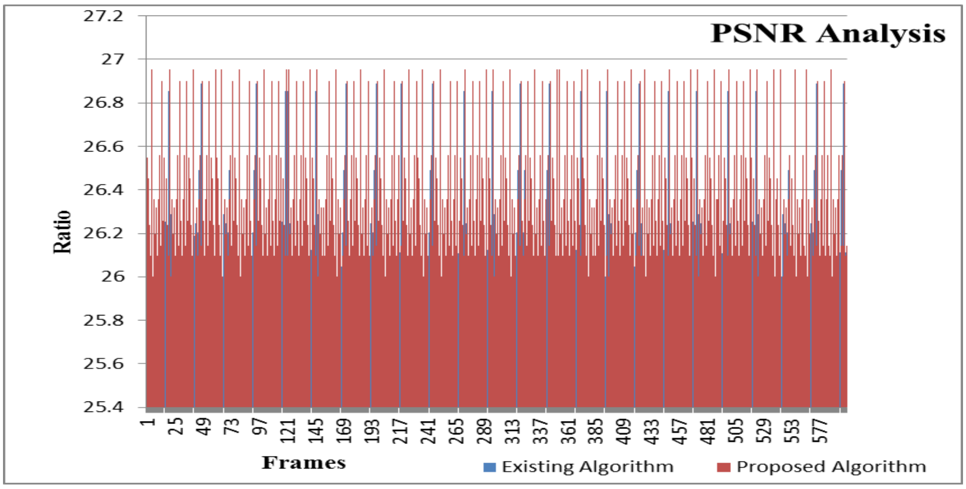

Figure 10. Peak Signal to Noise Ratio (PSNR) (600 Frames)

Figure 10 shows the graph based analysis of PSNR for sample video test_fog_1.avi. video has 600 frames therefore graph becomes to complex for understanding PSNR analysis. For the simplicity purpose we have devides the 600 frames into the 100 frames interval shown in figure 11. We are taking average of PSNR for every interval of 100 frames.

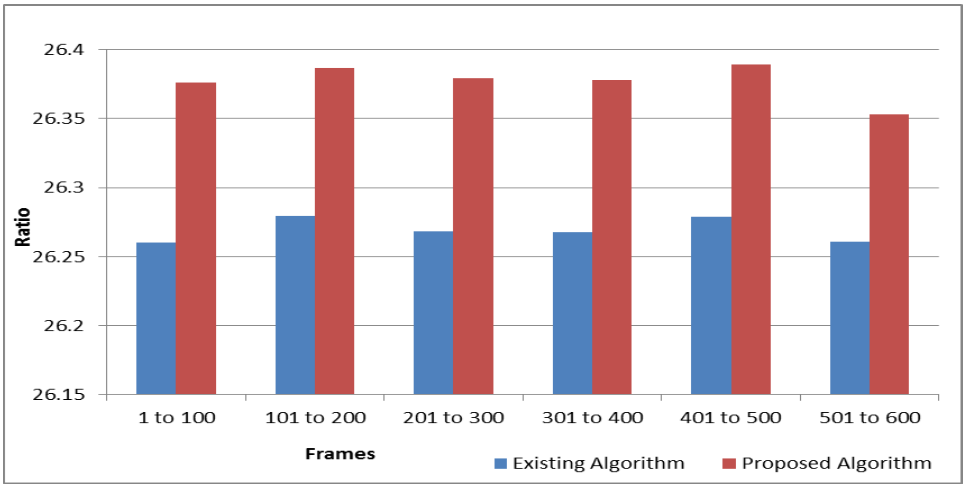

Figure 11. Peak Signal to Noise Ratio (PSNR)

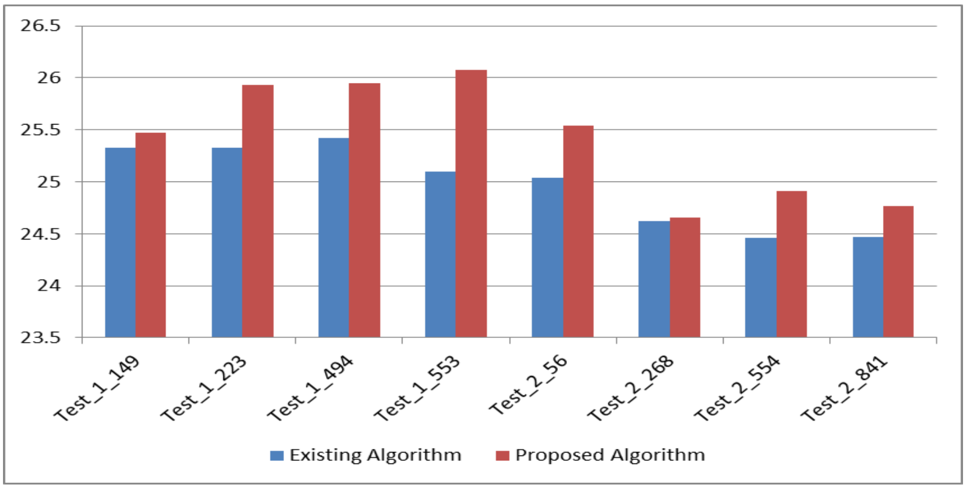

Figure 12. Graph of Table 2

This is the graphical representation of Table 2. It shows the comparison of MSE values of existing work and proposed work.

VI. CONCLUSIONS

Bad weather condition is the one of the most common problem in the area of image processing. Many techniques are developed for removing the fog, rain-drops, hazes, snowflakes etc. some techniques give best result but they have also some limitations. DCP is the one of those technique which returns efficient result for foggy image. Proposed method works with DCP method for improve the performance of fog removal process. DCP cannot differentiate the low contrast image and thick hazy image. DCP consider low contrast image as it is foggy image. So the propose method first recognize the low contrast image by CLAHE algorithm and then DCP method apply to fog removal process. Proposed method may increase the performance of DCP algorithm.

We can add scene selection feature in digital camera or mobile just like night mode, sports mode, document mode,etc. So we can add one more feature of fogy in camera.

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