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RESTORATION OF COLOR IMAGES BY SEPERATING GAUSSIAN NOISE USING ADAPTIVE HISTOGRAM EQUALIZATION AND GAUSSIAN FILTERING

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Abstract-Image Restoration is an important phenomenon in digital image processing that deals with restoring an image which is as sharp and clear as the original image.Image may suffer deterioration as a result of pixel missing and noise.In order to obtain recovered image very close to the original one from corrupted image employing a mathematical degradation and restoration model. In this paper we are using jpeg images as input and then resizing it to size of 512*512 as we are performing our work on the images of this size only.Later we have performed ROI (Reason of Interest) operation.Then we've applied numerous deterioration levels ,added Gaussian noise and used Gaussian Filtration method along with Adaptive Histogram Equalization for restoration of deteriorated image. We've calculated PSNR (Peak Signal to Noise Ratio) and MSE (Mean sq. Error) so as to calculate the performance.We are getting PSNR value for Lena as 38.77db for 25%, 38.24db for 50% and 37.90db for 75% deterioration at noise=5% while at noise =15%,our proposed method calculated PSNR as 36.97db for 25%,36.22db for 50% and 36.05db for 75% deterioration of image.

Keywords-Image restoration, Deterioration , Region of Interest ,Noise, Gaussian filtration

I. INTRODUCTION

Images are corrupted with various form of noises. Therefore it's terribly difficult to get useful information from noisy pictures as an example, medical pictures obtained by X-ray or computerized tomography CT in adverse conditions, or a mammographic image which can be contaminated with noise that may have an effect on the detection of diseases or the item of interest. In order to get the image free from noise,a proper denoising technique and restoration of original image is required.Our purpose is to have restoration techniques. a number of these techniques give satisfactory ends up in removing noise from pictures and conjointly preserve originality of the image along with fine details present in images. Restoration of image after it is being deteriorated at various levels is a challenging task.A number of restoration algorithm maintain speed however these techniques don't preserve the fine details within the image. Noise plays a vital role in degrading the image at the time of capturing or transmission of the image.While transmission of image it may suffer from missing of pixels too.

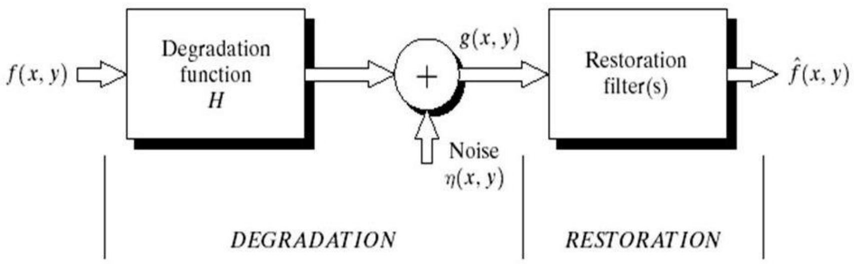

Fig. 1 Flow diagram of degradation and restoration process

Images are deteriorated by different kind of noise [1] such as malfunctioning of pixels in camera sensors, faulty memory locations in hardware or image transmission through a noisy channel and some other causes also [2]. Noise represents unwanted information which affects the image quality [2]. It also affects the accuracy of many image processing applications such as image segmentation, image classification, edge extraction, image compression, etc. [2]. There are several algorithms and filtering techniques that have their own assumptions, merits and demerits relying upon the previous knowledge of the noise. Image smoothening is an important and have a vast use within the image processing.Here, apart from denoising a model is used to attain the original image from the image which is being deteriorated by undergoing pixel-missing and noise

Restoration tries to reconstruct by using a priori knowledge of the degradation phenomenon. It deals with getting an optimal estimate of the desired result. Some restoration techniques are best achieved in the spatial domain, while there are some cases where frequency domain techniques are better suited [3].

II. LITERATURE SURVEY

In the year 2006, Wang Zhiming and Tao Jianhua published a paper[4] "A fast implementation of Adaptive Histogram Equalization" .In this paper, a fast implementation of AHE is proposed which is based on pure software techniques . Three accelerative techniques are combined to form the new fast AHE: First, local histogram is acquired by an iterative approach with a sliding window; Second, in computing cumulative histogram function, not more than half of the histogram is cumulated; Third, by keep the block size W2 equal to the product of grey level number and integral power of 2, all the multiplication and division operations are replaced with fast bitwise shift. The proposed algorithm give effective results both in theoretical analysis and experimental results.

In the year 2011, Rajesh Garg,Bhavna Mittal, Sheetal Garg published a paper[5] "Histogram Equalization Techniques For Image Enhancement".This paper is based on prior knowledge on the Histogram Equalization has been presented. Different image enhancement schemes like Contrast limited Adaptive Histogram Equalization (CLAHE), Equal area dualistic sub-image histogram equalization (DSIHE), Dynamic Histogram equalization (DHE) Algorithm have been implemented on images and compared. analysis of performance of all these methods is done and a number of Practical experiments of real time images have been presented. From the experimental results, it is found that all the three techniques yields Different aspects for different parameters.

In the year 2014,Keyong Shao, Yun Zou, Yuanhong Liu, Cheng Li, Bosi Fu published a paper[6] "Based on Total Variation Regularization Iterative Blind Image Restoration Algorithm", They proposed that in the process of image formation, transmission and recording, because of the imaging system, transmission medium and the equipment is not perfect, it makes the quality of image declined, the key of blurred image restoration is to estimate the Point Spread Function. Because Point Spread Function can't be obtained, we can't get the precise of fuzzy model. This paper used conjointly iterative blind deconvolution, a kind of blind image restoration method and the total variation regularization together.It makes use of Total Variation regularization algorithm in fuzzy identification stage and iterative blind deconvolution algorithm in image restoration stage. In order to obtain the only solution of the algorithm, we also use the image and Point Spread Function constraints in the iterative process. The simulation results show that the proposed algorithm is more effective than some of the existing algorithms.

In the year 2014, Siddharth Saxena,Rajeev Kumar Singh,in their paper[7] "A Novel Approach of Image Restoration Based on Segmentation And Fuzzy Clustering", proposed a method for image restoration based on segmentation and fuzzy clustering. This Method consider the similar image pair which having common feature corresponding to degraded one in another. This proposed method firstly partition the image into specified segments and then it will use fuzzy clustering to cluster the segment based on their PSNR value and provide the segmentsthat needs to restore which will further used for accuracy of method.The performance of the system is evaluated on the basis of PSNR value. The proposed method shows the higher efficiency compared to existing methods.

In the year 2015,Prashant Sangulagi ,in his paper[8]"Performance analysis of effective image restoration techniques at different noises" proposed that researchers are finding image processing as an important topic for research. The image that are obtained from various sensors and satellites are degraded and may not be proper for human perception or further process. The images are degraded by many parameters like noises in the environment or blurring of the image during image acquisition or during processing of the image. To improve the quality of the image so that the required objects can be accessed from the sensed images, the image restoration method is used in the image processing. It improves the objectivity of the image and removes the noise and blurry content in the image. In this paper they are analysing Wiener Filter, Lucy-Richardson Method, Blind De-Convolution and regularized filter. The performances of these techniques are evaluated and compared. Different performance parameters are considered to check the efficiency of above mentioned techniques.

In the year 2016, Pankajshan Megha,Mandava Swarna,V. Sowmya and K.P.Soman in their paper[9] “Low contrast satellite image restoration based on Adaptive Histogram Equalization and Discrete Wavelet Transform” told that Normally pictures that is captured from satellites are a kind of low-contrast images that hides major data carried by the image i.e. we are not able to gain the required information properly. Hence, image restoration is important within the image processing domain to extract all the knowledge present in the pictures. The low contrast satellite image restoration supported adaptive histogram equalisation combined with discrete cosine transform (DCT) and discrete wavelet transform (DWT) is proposed by this paper. The proposed technique is experimented on 3 totally different satellite pictures. The effectiveness of the strategy introduced by this paper is shown by comparison among the present techniques based on gamma correction and histogram equalisation combined with DCT and DWT. The comparison is done on the quality parameters known as Peak Signal to Noise ratio (PSNR) and variance. By the analysis we find that adaptive histogram equalisation combined with DWT is simpler approach compared to adaptive histogram equalisation combined with DCT.

In the year 2017, Zecheng He, Ketan Tang and Lu Fang in their paper[10]“Cross-Scale Color Image Restoration Under High Density Salt-and-Pepper Noise” proposed that High-fidelity color image restoration is dependably of high demanding for high-density noise defiled images. Such issue turns out to be additionally testing if the corrupted image and the normal reestablished image are of various resolutions, as conventional 'cascaded: denoising took after by inspecting' and 'task on RGB channel freely' strategies instigate mistake amplification and color artifacts. They proposed a technique which is a cross-scale and cross RGB-channel Salt-and-Pepper Noise (SPN) removal scheme, i.e., the denoising and interpolation are directed at the same time inside a unified model, which further assesses RGB cross-channel correlations. Trials demonstrate that the proposed algorithm beats conventional state-of-the-art techniques as far as both objective PSNR assessment and subjective image quality, particularly for to a great degree high-density noise ruined color images.

In the year 2017,Hongyang Lu, Sanqian Li, Qiegen Liu published a paper[11]“MF-LRTC: Multi-filters guided low-rank tensor coding for image restoration”.In this paper they proposed that Image earlier data is a determinative factor to handle with the not well postured issue. In this paper, they show a multi-filters guided low-rank tensor coding (MF-LRTC) model for image restoration. The interest of building a low-rank tensor is evident much of the time for data that normally originates from various scales and directions. The MF-LRTC takes focal points of the low-rank tensor coding to catch the sparse convolutional features created by multi-filters portrayal. Utilizing such a low-rank tensor coding would decrease the redundancy between highlight vectors at neighboring locations and enhance the efficiency of the general sparse portrayal. In this work, they are focused on accomplishing this objective by convoluting the target image with filters to figure multi-features images. At that point similarity-grouped cube set extricated from the multi-features images is viewed as a low-rank tensor. The potential effectiveness of this tensor development methodology is shown in image restoration including image deblurring and compressed sensing (CS) applications.

In the year 2017, Y. Dar, A. M. Bruckstein, and M. Elad in their paper[12] titled,“Image restoration via successive compression,” proposed a method in order to solve various issues related to imaging inverse using complexity regularization that leverages existing compression techniques. Lossy compression has already been projected within the past for Gaussian denoising – the simplest inverse problem. However, extending this approach to a lot of difficult inverse problems (e.g., deblurring, inpainting, etc.) gave the impression to result in intractable optimization tasks. During this work, they tend to address this issue by decomposing the difficult optimization drawback via the half Quadratic splitting approach, leading to a sequential solution of a simpler regularized inverse problem followed by a rate-distortion optimization, replaced by an efficient compression technique. In their proposed work,they used an improved complexity regularizer that quantifies the average block-complexity within the restored signal, that in turn, extends our algorithmic rule to consider averaging multiple decompressed pictures obtained from compression of shifted pictures. Sparseness is indirectly enclosed within the regularization of the proposed restoration since many compression techniques consider sparsity-seeking procedures .They demonstrate the proposed scheme for inpainting of corrupted pictures, using leading compression techniques such as JPEG2000 and HEVC.

In the year 2018,Yan-Tsung Peng, Keming Cao and Pamela C. Cosman in their paper[13] “Generalization of the Dark Channel Prior for Single Image Restoration”proposed that Images corrupted by light scattering and absorption, for example, hazy, sandstorm, and underwater images, regularly endure shading twisting and low contrast in view of light going through turbid media. So as to enhance and reestablish such images, they first gauge ambient light utilizing the depth-dependent shading change. At that point, by means of ascertaining the distinction between the watched intensity and the ambient light, which we call the scene ambient light differential, scene transmission can be assessed. Furthermore, adaptive shading correction is joined into the image development model (IFM) for evacuating shading casts while reestablishing contrast. Test comes about on different corrupted images exhibit the new strategy beats other IFM based strategies subjectively and unbiasedly.

III. PROPOSED ALGORITHM

The proposed algorithm has several steps.The Algorithm steps are as follows

1.Upload image such that Pixel P_1,P_2………P_n where P =matrix in multidimension.
First we upload a color image.Here ,we are taking inbuilt digital images of MATLAB.The uploaded image is the image that we need to restore after being deteriorated.

2.Image Resizing such that

$$I_p = [\ I_1\ ,I_2 \ldots\ldots I_x\ ]_{512*512} \quad \ldots\ldots\ldots (1)$$

The image is resized after uploading it.As in our base paper the image of size 512*512 is used and implementation has been carried out on that,we are also resizing the images into 512*512.we get the resized image.

3.Evaluate Region Of Interest(ROI)

A region of interest (ROI) is a portion of an image which we want to be filtered or we want any operation to perform on it .It is said to be a subset of an image or a dataset identified for a specific purpose. The ROI is defined by giving boundaries of an image .

$$ROI = [\ R_x \quad I_p\ ] \ldots\ldots\ldots (2)$$

4.Generate Missing Pixels and Add Gaussian Noise .

Assume image values are available only for the pixels

$$X(n,m) \text{ for } n,m = (n_1,m_1),(n_2,m_2)\ldots\ldots(n_M,m_M) \ldots\ldots\ldots (3)$$

Based on the available pixels, we form an image y(n,m) that assumes the values of the original image at the positions of available pixels.For the pixels that are not available we will set their value to zero.This new image is-

$$y(n,m) = \begin{cases} x(n,m), if\ (n,m)=(n_1,m_1),\ldots\ldots,(n_M,m_M) \\ 0\ ,elsewhere \end{cases} \ldots\ldots\ldots (4)$$

For missing pixels we can assume any value in the initial step,since the algorithm should reconstruct the original image values at this position.For graphical image representation of missing pixels we will use the value 255 instead of 0.

Images with missing pixels are generated.

Gaussian noise is added to the images.
Gaussian noise is most commom type of noise generally caused by natural sources like thermal vibration of atoms and discrete nature of radiation coming out of warm objects[*].It is also known as electronic noise because it usually arises amplifiers or detectors. .In color cameras ,there is more amplification in the blue color channel than in the green or red channel and there may be more noise in blue color channel.amplifier noise is an imporatant part of the "read noise" of an image sensor, or we may say, of the constant noise level in dark areas of the image.

$$P(g)=\sqrt{\frac{1}{2\pi\sigma^2}}\,e^{\frac{-(g-\mu)^2}{2\sigma^2}} \quad \ldots\ldots(5)$$

Using the above form we introduce Gaussian noise to the image.
We get deteriorated image with missing pixels and Gaussian noise.

5.Perform restoration using Adaptive Histogram Equalization

AHE stands for Adaptive Histogram Equalization. AHE is not global like other ordinary Histogram Equalization.It computes many Histograms for different parts of an image.Therefore it is possible to enhance the local contrast of an image through AHE. With AHE, the information of all intensity ranges of an image can be viewed simultaneously and thereby solving the problem of many ordinary devices which are unable to depict the full dynamic intensity range. Here, first, a contextual region is defined for every pixel in the image. The contextual region is the region centered about that particular pixel. Then, the intensity values for this region are used to find the histogram equalization mapping function. The mapping function thereby obtained is applied to the pixel being processed in the region and hence, the resultant image produced after each pixel in the image is mapping differently. This results in the local distribution of intensities and final enhancing are based on local area rather than the entire global area of the image. This is the main advantage of AHE. But, sometimes, AHE tends to over enhance the noise content that may exist in some homogeneous local block of the image by mapping a short range of pixels to a wide one.

$$F(x) = P(X \leq x) \ldots\ldots(6)$$

Where X lies in semiclosed intervals

$$P(X) = F_x[b] = F_x[a] \ldots\ldots(7)$$

Where P is the probability distribution functions

$$F(x) = \int_{-\infty}^{x} f(x)(t)dt \quad \ldots\ldots(8)$$

Where F(x) = continuous function which is having discrete function or component.

6. Apply Gaussian Filteration on F(x) such that the image will be having contrast levels

$$g(x,y) = \frac{1}{2x\sigma^2}\,e^{\frac{-x^2+y^2}{\sigma}} \quad \ldots\ldots(9)$$

where σ is the variance level for the applied standard deviation and g(x,y) is Gaussian filter which is showing amount of noise.

7. Perform evaluation in terms of PSNR and MSE.

PSNR calculates peak to noise ratio between two images.

$$PSNR= 10\log_{10}\left(\frac{255^2}{MSE}\right) \ldots\ldots(10)$$

The MSE represents the cumulative squared error between the original and deteriorated image and original amd restored image.

$$MSE= sum(sum(X_0 - X_r))/(M*N) \ldots\ldots(11)$$

We show our proposed algorithm in flow diagram in Fig.2

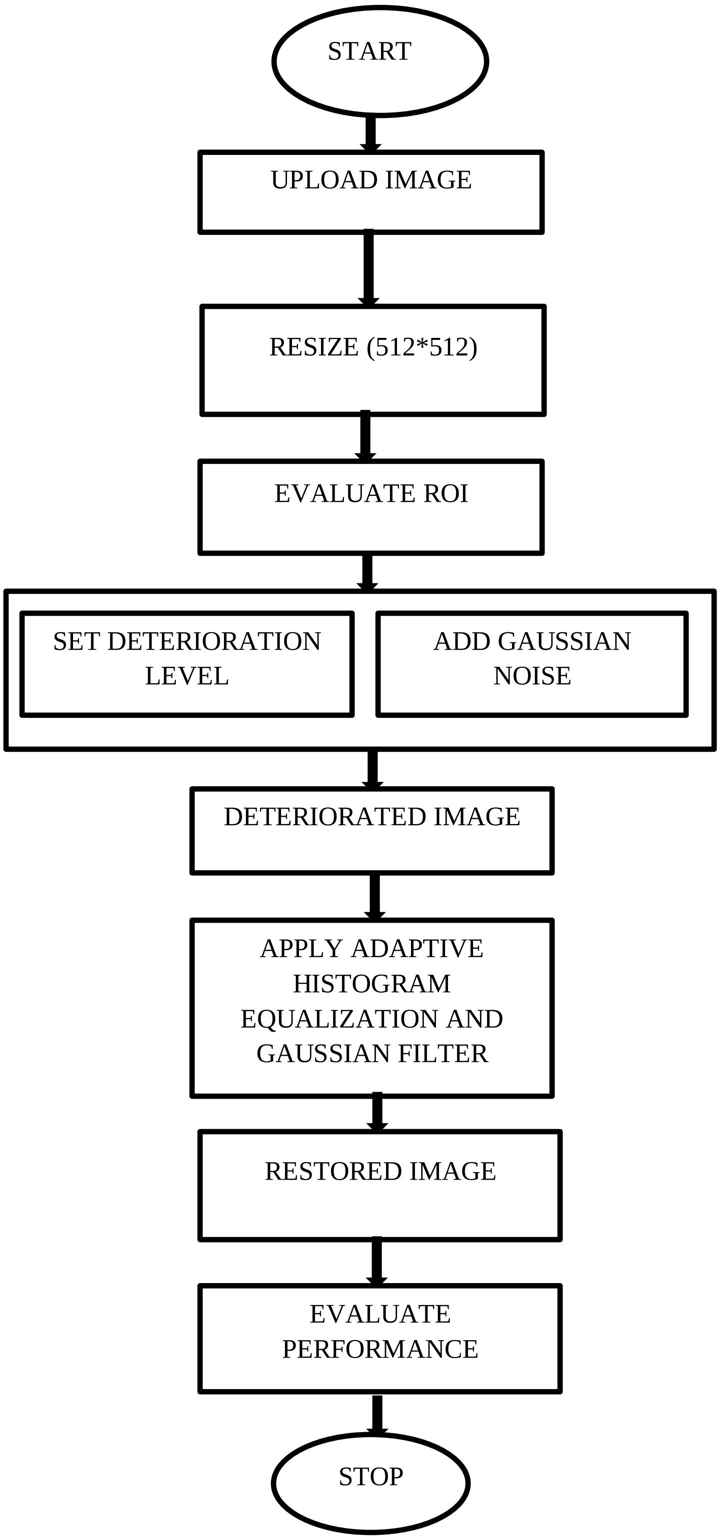

Fig.2.Flow chart of proposed Algorithm

IV. RESULT

In this we have worked on the image restoration and compare the performance in terms of the peak signal to noise ratio and mean square error rate and shows that our restored image is having peak signal to noise ratio than the deteriorated. We have evaluated the peak signal to noise ratio and mean square error rate among the original image and deteriorated image and also for the restored image and original image and then the performance is evaluated for the same by varying the variance and deteriorated level for the uploaded samples.

We have made the graphical user interface for the whole image restoration process using MATLAB. Firstly we have uploaded the image sample and then we have resized the image in the dimension 512*512 and then we have found the Region of interest.

After that we have used the different deterioration levels and varying variance and then add the noise and after that we have use the Gaussian filtration process for the restoration and then we have evaluated the peak signal to noise ratio and mean square error rate.

We have got high performance of restoration in terms of high peak signal to noise ratio and mean square error rate which is the best way to achieve high efficiency of our system with less error rate probabilities.

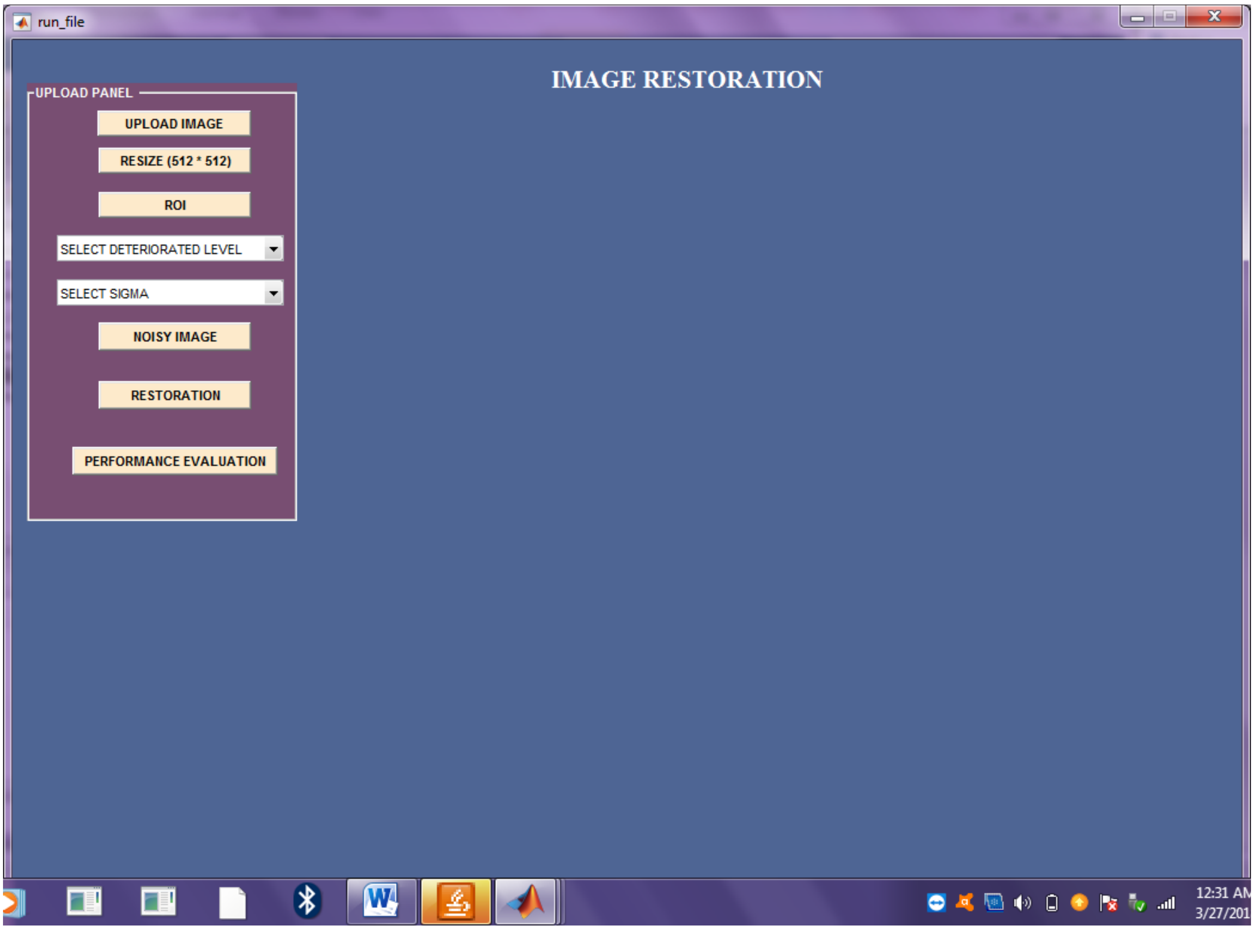

Fig 3. Main Panel

The above figure shows the main panel which is made using graphical user interface in MATLAB environment.

The figure.4. shows the resizing of input image.The image is resized to 512*512 on which the deterioration and restoration operation is performed.

Fig 4.Original Image and Resized image

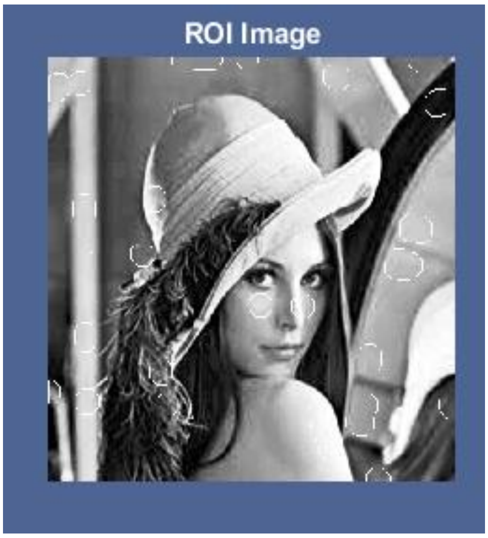

Fig 5: ROI image

The fig 5 shows the ROI image which shows the region of interest in the image in which the image pixel can be restored.

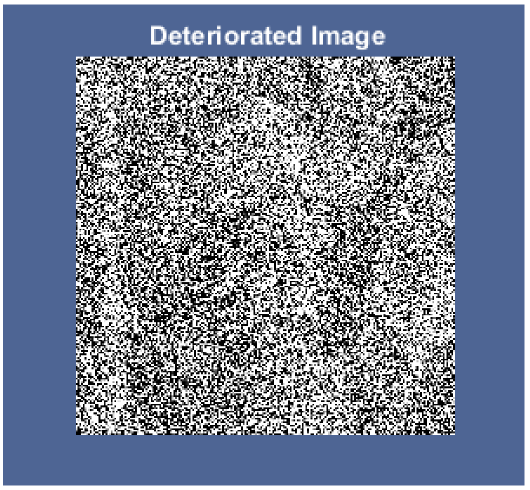

Fig 6. Deteriorated Image

The above figure shows the noisy image which shows the noisy image and disturbed pixel values.

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Fig 7: Restored Image

The figure 7 shows the restored image which shows the image restored after applying Gaussian Filtration and Adaptive Histogram Equalization.

PSNR and MSE is calculated using the MATLAB tool.PSNR is used to measure the quality of reconstruction of lossy and lossless compression.For images. the PSNR is said to be peak noise to sound ratio and its unit is decibel while MSE is the squared value differences between original and restored image.

Deteriorated image is generated after applying random deterioration function so PSNR value may vary based on the level of deterioration .Here we are taking average of 10 PSNR values for each class.

Table 1. PSNR Results at Noise=5

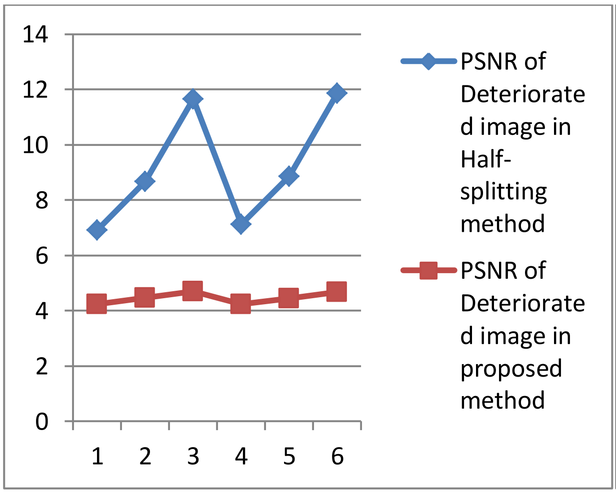
Image 512*512	Missing Pixels	Half Splitting Restoration Function at noise=5		Proposed Approach at noise = 5	
		Deteriorated PSNR values	Restored PSNR values	Deteriorated PSNR values	Restored PSNR values
Lena	75%	6.92	31.16	4.25	37.90
	50%	8.67	34.47	4.46	38.24
	25%	11.66	36.54	4.71	38.77
Barbara	75%	7.13	25.29	4.23	39.10
	50%	8.87	28.97	4.45	39.12
	25%	11.87	32.71	4.68	39.75

Table 2. PSNR Results at Noise=15

Image 512*512	Missing Pixels	Half Splitting Restoration Function at noise =15		Proposed Approach at noise=15	
		Deteriorated PSNR values	Restored PSNR values	Deteriorated PSNR values	Restored PSNR values
Lena	75%	6.86	28.27	2.45	36.05
	50%	8.57	29.12	2.54	36.22
	25%	11.46	29.21	2.78	36.97
Barbara	75%	7.06	24.36	2.76	38.20
	50%	8.77	26.70	2.80	38.35
	25%	11.67	28.26	2.91	37.80

Table 3. MSE values

Image 512*512	Missing Pixels	Deteriorated MSE values at noise =5	Restored MSE values at noise=15
Lena	75%	0.022	0.0007
	50%	0.017	0.0009
	25%	0.007	0.0010
Barbara	75%	0.021	0.0004
	50%	0.020	0.0005
	25%	0.017	0.0007



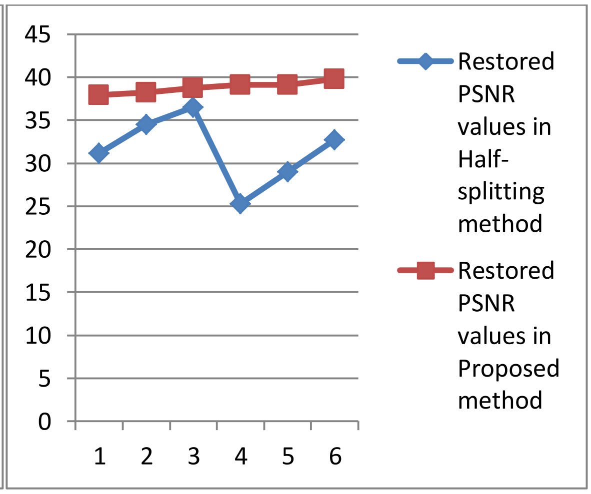
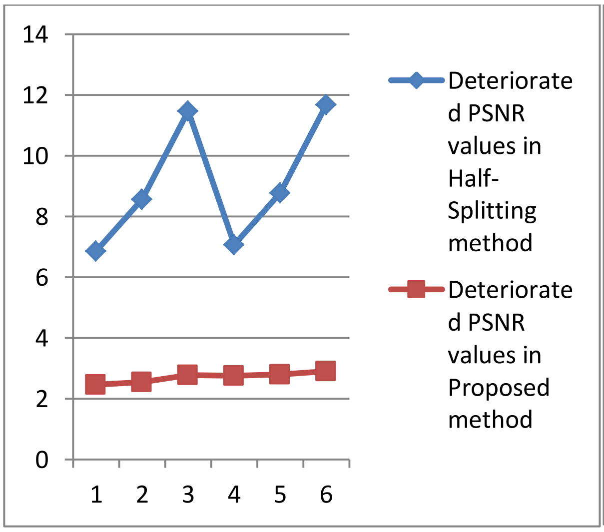


Fig.8.Graph showing PSNR of deteriorated images at noise=5

Fig.9.Graph showing PSNR of Restored images at noise=5



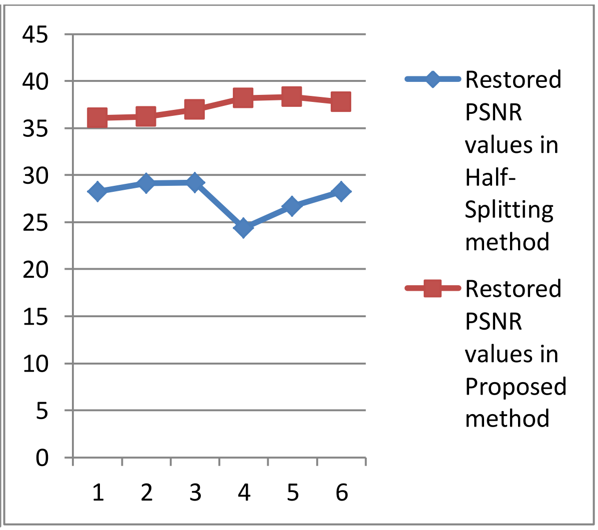


Fig.10.Graph showing PSNR of Deteriorated image at noise=15

Fig.11.Graph showing PSNR of Restored images at noise=15

IV. CONCLUSION

1. From Table.1and Table.2 we can conclude that in our proposed work the PSNR between original and deteriorated image is less as compared to previous given method that means the degradation level of images is high.

2.From Table 1 and Table.2 we find that the PSNR between original and restored image is high which shows that our proposed method is highly efficient and we have got better result .

3.Table.3.shows the MSE values of images.

4.From Fig.8 and Fig.9. ,we can see graphs showing PSNR of deteriorated images and Restored images at noise=5.Deterioration level in our proposed method is high and PSNR of restored image in our proposed method is high.

5.From Fig.10 and Fig.11 , we can see graphs showing PSNR of deteriorated images and Restored images at noise=15.Deterioration level in our proposed method is high and PSNR of restored image in our proposed method is high.

V. FUTURE WORK

In this paper,a framework of image restoration method has been given which is based on Gaussian filtering and Adaptive Histogram Equalization.The future methodology for this work will be the use the proposed technique on other kind of images as satellite image or under-water images.We can also use other restoration technique to increase the performance.

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