

Comparative Study of Different Image Enhancement Technique

¹Palak Khandelwal, ²Gagandeep Kaur

^{1,2}Dept. of ECE, Manav Rachna International University, Faridabad, Haryana, India

Abstract

In image research, most vital and difficult technique is image enhancement. Main objective of this is to improve visual appearance of an image or to provide better transformed image. Many images like in medical, satellite suffer from poor contrast and noise, so to improve the image quality, contrast is enhanced and noise is removed. Especially in detection and analysis of medical images, image enhancement improves the clarity, enhance contrast, remove blurring and noise and reveal details of an image. Improving image quality has always been a need and image enhancement technique is the best solution to this. Various technique are there which can be used to improve the quality of an image. And for measurement of quality of image, parameters like PSNR and MSE can be used. In this paper, different technique has been discussed and a new technique, erosion enhancement technique has been proposed and the results of various techniques are compared using PSNR and MSE. As per application and objective, techniques differ from each other and selection of technique differ as per application. The experimental results shows that proposed enhancement technique provides better results and better values of PSNR and MSE i.e it works better to improve the contrast and brightness of an image thus making its visual quality more better.

Keywords

Inversion, Gamma, Background, Erosion, PSNR and MSE

I. Introduction

An image is better or not, this perception may vary from person to person. One may consider, a bright image as better but for another low contrast may be required so there is no way to check quality of an image especially by its visual appearances. Sometimes the noise which may get added to an image while capturing or transferring it from device to device, also degrades its quality to a large extent, that also need to be corrected. Moreover, contrast adjustment is also a way which proves to be a significant tool to improve the quality of an image. So image enhancement using different algorithms and techniques make an image subjectively looks better than the original image. In speech recognition, medical image processing, HDTV, video processing applications by altering the intensity pixel of an image, image enhancement can be improved. The work done by various scientists and researchers have been discussed as M.knee et al 2015 [1], proposed an inversion technique which takes the negative of an image i.e. image inversion, black pixels to white pixels and white to black pixels but the results were not that good. Moreover, MSE was very high and PSNR was low. So there was a need of a technique which could improve these values.

S. Asadi et al 2011 [2], proposed a gamma correction technique in which image was divided into overlapping window and gamma value was estimated. This method was quite good to increase the brightness of the image but both MSE and PSNR value were not good as former being very high and latter being very low. So not much improvement was seen in terms of PSNR and MSE value.

Min goo boon et al 2009 [3], has used a sharp filter to achieve image enhancement. The method was successful enough to get low MSE and high PSNR value but side regions were not clearly visible. Then focus was made to improve clarity of an image.

H. Hassan et al 2011 [4], has also used gamma adjustment technique. It again fail to show clear visibility of side regions but has obtained satisfactory results in terms of MSE and PSNR values.

Bhattacharya et al 2014 [5], devised that contrast enhancement plays a pivotal role in this field but global enhancement lead to loss of information that's why a technique was introduced to carry out localized image enhancement named as singular value decomposition, SVD. It has improved the quality of an image to a much extent but still much better results were required.

Mohammed F.K et al 2012 [6], presented bi-histogram and multi histogram methods. One was preserving brightness at the cost of deteriorating natural display and the other was preserving natural display but won't be able to maintain the intensity or contrast. So, input image was divided into different sectors thus reducing the decomposition error of input histogram. But then also there was a scope of improvement.

These different technique were good upto some but a new techniques are still required to deal with all the above stated shortcomings.

II. Image Enhancement Technique

As image processing is an important field, and there is always a room for improvement in lieu of achieving better efficiency, and clearance, brightness, and contrast of an image. Out of various techniques available, majorly classification is made into:

- Spatial domain methods
- Frequency domain methods

It's a technique whose implementation leads to individually altering the pixel values. It alters the grey levels of pixels and thus improving the overall contrast of an image. These methods directly operate the pixel values.

While frequency domain has various transformations like Fourier transforms, Discrete Transforms (DWT) and Discrete Cosine Transforms (DCT) directly operate on transform coefficient of an image. It directly performs mathematical operations on image pixels. Under these methods, various techniques are used that alter the pixel value of an image and hence changes original image into an improved image. To check the efficiency and performance of various techniques, their resultant images are compared, their PSNR and MSE values are considered.

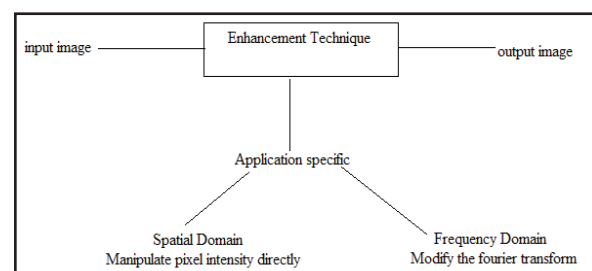


Fig. 1: Types of Enhancement Technique

III. Peak Signal to Noise Ratio

It is the ratio between max signal power and noise power that affects the representation of an image. It is expressed in decibel scale. It's basically a measure of quality reconstruction of image. Here original data is our signal and introduced error is noise. High PSNR value defines high quality of an image. It is defined via MSE and corresponding distortion matrix.

Here 8 bits per sample represents a pixel where max is maximum pixel value of image. This pixel range is 0-255 with three RGB value per pixel.

$$\begin{aligned} \text{PSNR} &= 10 \cdot \log_{10} [(255)^2 / \text{MSE}] \\ &= 20 \cdot \log_{10} (255) - 10 \cdot \log_{10} (\text{MSE}) \end{aligned}$$

IV. Meansquare Error

By the difference between values of an estimate and true quality certified value, MSE can be calculated. It is only one of many ways that can be used. Corresponding to expected value of squared error, a risk function MSE is measured. It is the second moment of error, and thus uses both estimate's variance and bias.

MSE is equal to sum of variance and squared bias of estimator. Lower the MSE value of an image, higher the quality of an image.

V. Related Work

As the numerous techniques are available for image enhancement but here majorly 6 techniques are taken into account for improving the quality of an image that are effective to quite a great height to make an image visually more acceptable.

- A. Inversion technique
- B. Gamma correction technique
- C. Threshold Technique
- D. Background technique
1. Subtraction technique
2. Contrast enhancement technique

A. Inversion technique

Invert the pixels of an image i.e take negative of all the pixels that comprise an image [1]. For instance in an image of size $M \times N$, each pixel is subtracted from 255 as

$$g(x, y) = 255 - f(x, y) \text{ for } 0 \leq x \leq M \text{ and } 0 \leq y \leq N.$$

In a normalized grey scale, This method is helpful majorly in enhancing greyer and whiter details embedded in darker regions of an image.

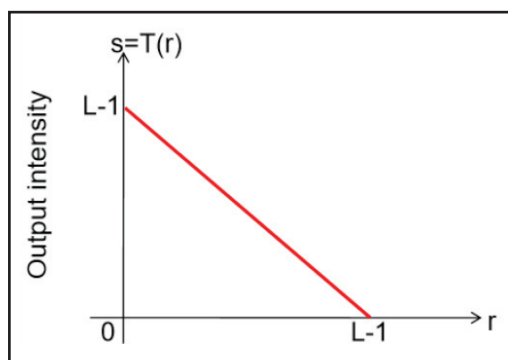


Fig. 2: Image Inversion Graph [1]

In an image with pixels having intensity level in between $[0, L-1]$, the intensity transformation would be given as

$$s = C \log(1 + |r|).$$

B. Gamma correction technique:

In gamma correction (also called power law transformation), relation between pixel values of $f(x, y)$ and $g(x, y)$ share the relation $s = c \cdot r^\gamma$, where c and γ have positive values and s is the output image obtained after gamma correction technique [2]. This technique is used when intensity level values of image have extremely large and small range.

If $\gamma < 1$, low range grey levels are mapped to wider range of grey levels i.e. expansion of brighter values and compression in darker values. Here gamma transformation is called Log transformation and hence given by the relation as $s = L - 1 - r$.

This technique increases details of lower intensity pixel values i.e. brightens the intensity of an image. It brings out the detail of low intensity values. Converse case is also possible. If $\gamma > 1$, narrow range darker values are mapped to wider range of bright values and wider range brighter values to narrow range. This is called inverse log transformation. Family of possible transformation on varying value of γ with $C=1$.

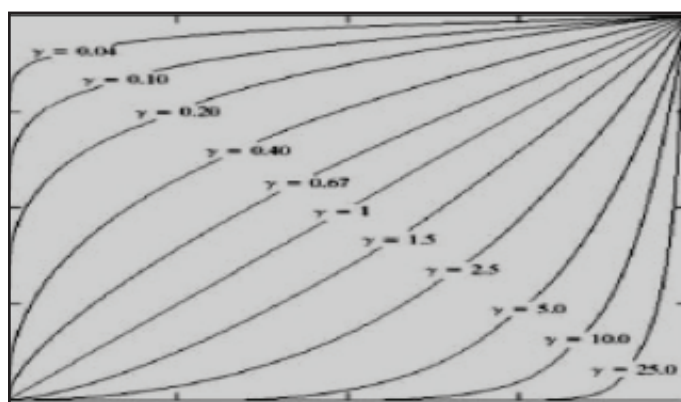


Fig. 3: Possible Curves for $C=1$ [2]

C. Threshold Technique

A normal threshold is either 0's or 1's so $g(x, y)$ is often termed as binary image [3]. This technique is used to enhance an image for image segmentation. A global threshold is calculated, pixel values less than that are mapped to 0 and pixel values greater than that are set to 1.

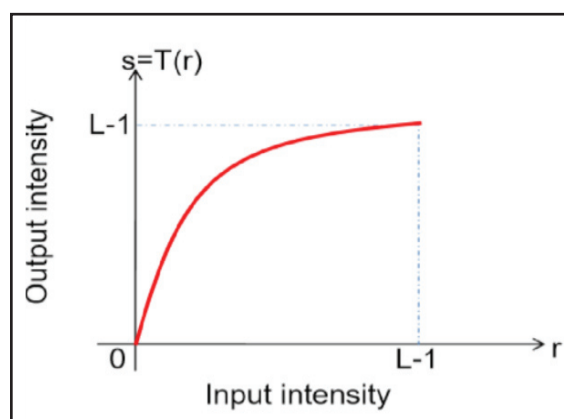


Fig. 4: Image Thresholding Graph

This enhances the image to a great extent. If further enhancement is required, local threshold can also be set.

D. Background Technique:

In background enhancement technique [5], enhancement is provided by two simple steps: Subtraction and Contrast

enhancement. Initially, subtraction is performed which subtracts the background image from original image, thus enhancing the details of an image. Image obtained by this technique is quite good and even show satisfactory value of PSNR and MSE parameters but then also second step of contrast enhancement is provided to give an extra edge to image enhancement which proves to be quite beneficial to improve the visual quality, PSNR and MSE values of an image.

VI. Proposed Technique

In this paper, various image enhancement techniques have been compared in terms of observed results and parametric values like PSNR and MSE but to further improve the quality of an image, a new technique is proposed i.e. erosion image enhancement technique. The results obtained from this technique, shows much enhanced image in terms of contrast, brightness, visual quality, high PSNR value and low MSE value.

A. Erosion Technique

In this paper, proposed technique is erosion technique [14]. It's also a two-step technique – masking and filtration. Here, an elliptical mask is masked on an image defining the information like centred pixel, radius, x and y intercept etc. As masking, do enhances the quality of an image but then also filtration is performed for further improving the quality of an image. Resultant image obtained, and calculated parametric values like PSNR and MSE definitely proves that the proposed technique is definitely a revolution in the field of image enhancement. Output image clearly enhances every details of an image, preserves edges, brightens intensities level, obtained PSNR value is highest and MSE value is least.

VII. Flow Chart

Used methodology for proposed technique is as:

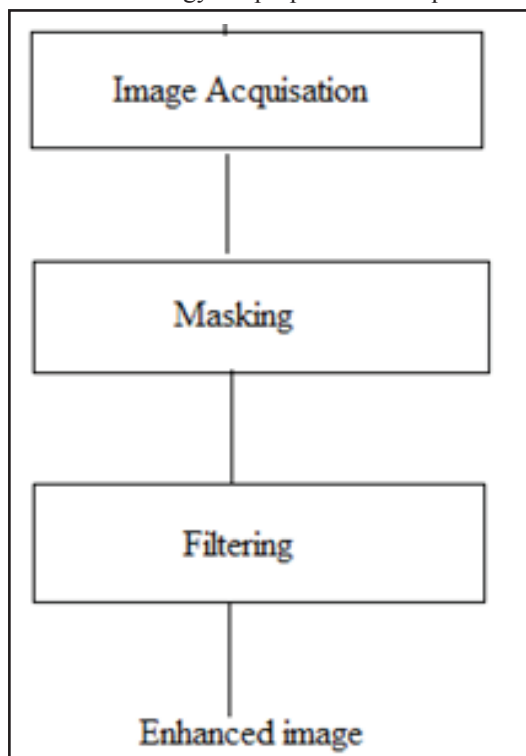


Fig. 5: Adopted Methodology

Here, acquired image is masked to have an area where next step of technique could be performed. It would be an elliptical mask, this would be followed by a filtering operation to improve the

contrast of an image. Hence, this two-step method finally provides us an enhanced image with better visual properties and improved PSNR and MSE value.

VIII. Experimental Results

All the above mentioned technique can be compared using the obtained output images. And to justify this comparison their PSNR and MSE values are also there to verify the feasibility of a technique.

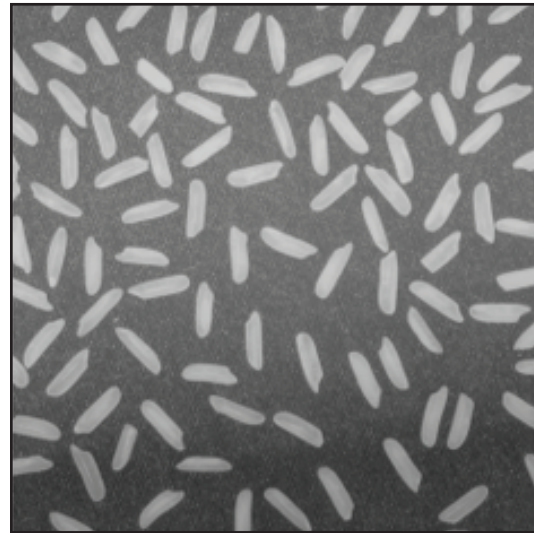


Fig. 6: Original Image

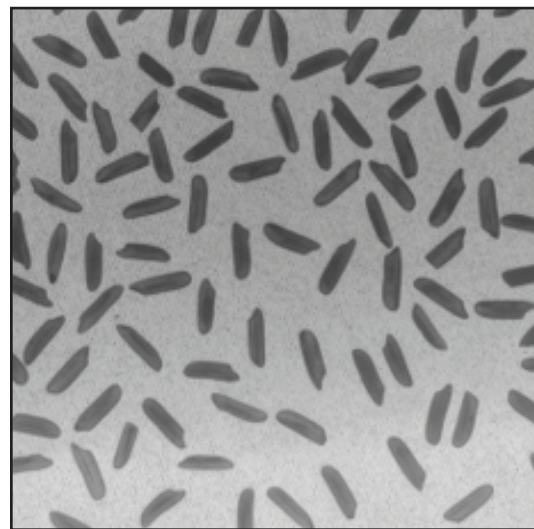


Fig. 7: Inversion Image

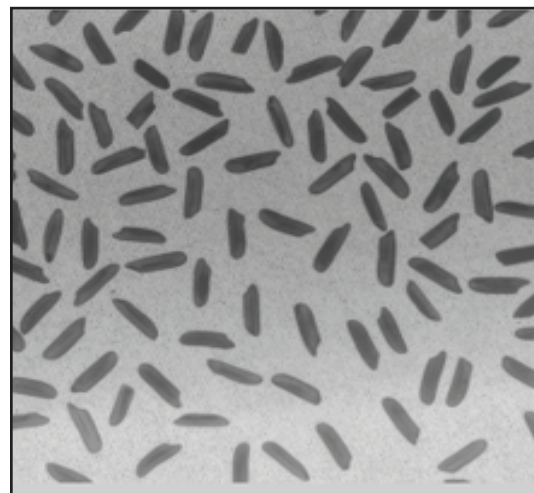


Fig. 8: Gamma Corrected Graph



Fig. 9: Thresholded Image

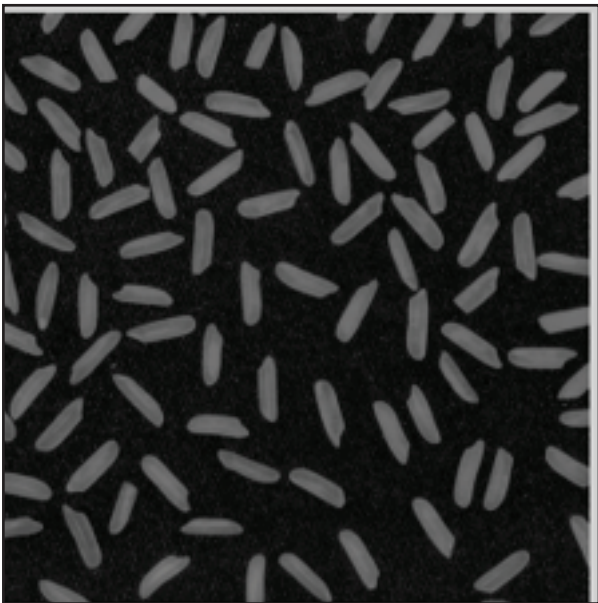


Fig. 10: Subtracted Image



Fig. 11: Contrasted Image

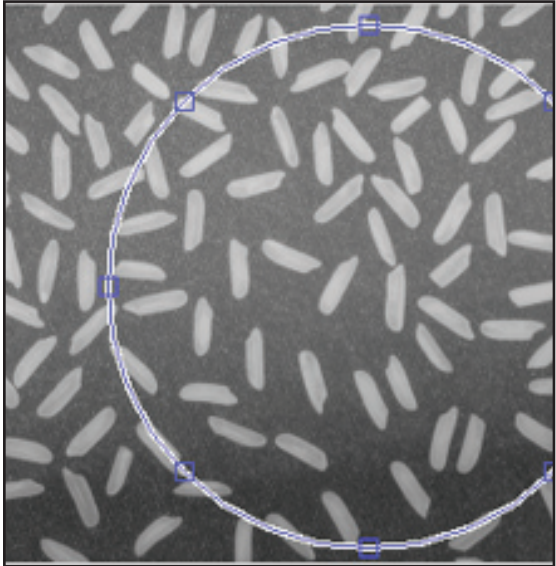


Fig. 12: Masked Image

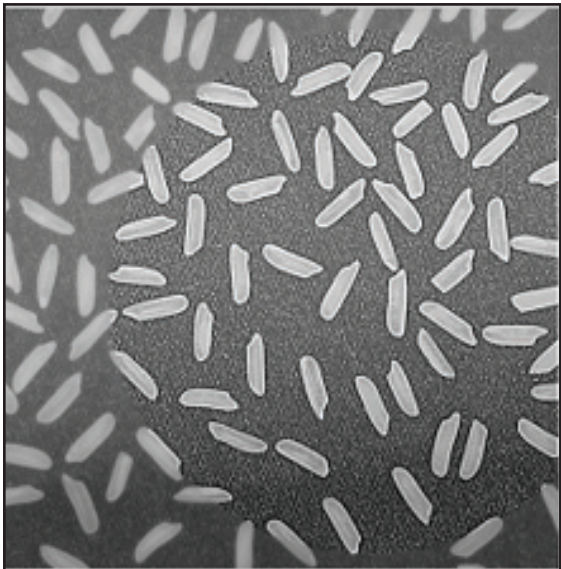


Fig. 13: Eroded Image

Table 1: MSE and PSNR of Various Image Enhancement Techniques

Enhancement using INVERSION technique			
S.No.	Parameters	Parametric Value	Comments
1	PSNR	57.6745	Results could be more better
2	MSE	0.1120	
Enhancement using GAMMA CORRECTION method			
S.No.	Parameters	Parametric Value	Comments
1	PSNR	57.6745	Same as previous technique , no improvement is shown
2	MSE	0.1120	
Enhancement using THRESHOLD technique			
S.No	Parameters	Parametric Value	Comments
1.	PSNR	57.1692	low PSNR , results slightly poor than previous results
2	MSE	0.1258	

Enhancement using SUBTRACTION technique			
S.No	Parameters	Parametric value	Comments
1	PSNR	58.6219	Results are better than previous case , but could be made more better
2	MSE	0.0900	
Enhancement using CONTRAST ADJUSTMENT technique			
S.No.	Parameters	Parametric value	Comments
1	PSNR	63.3044	Substantial growth in PSNR and degradation in MSE value
2	MSE	0.0306	
Enhancement using EROSION Technique			
S.No	Parameters	Parametric value	Comments
1	PSNR	69.3654	Max value of PSNR and min value of M,SE so results are best among all
2	MSE	0.0076	

IX. Conclusion

The aim of image enhancement is to improve the information in images for human viewers, or to provide 'better' input for other image enhancing devices. There is no general theory for defining a 'good' image so image enhancement technique is also can't be determined as per human perception. As it is evident from the results, the all ways for enhancement (frequency and spatial) domain are more or less the same. When needed to image enhancement with a small kernel, it is advised to use the spatial domain instead of the frequency domain, since the Fourier transformation is time consuming. As we know that spatial domain is fast and less complex than Fourier filtering. Furthermore, choice of technique also depends upon application, and choice whether clarity is required or there is a need of high PSNR value or least MSE value. So, it can vary but both techniques are quite reliable, simple and easy to use technique. Moreover, proposed technique is enhancing the original image and obtained PSNR and MSE value are quite good and they marks the reliability of proposed technique. The above discussion and results, concludes that erosion technique is helpful to a great extent to provide an enhanced image and value of PSNR, MSE which is better than results of all other techniques. So, overall it is a nice technique to be used for image enhancement.

References

- [1] Knee Manish, "A single-ended picture quality measure for MPEG-2," In Proc. Int. Broad., Convention (IBC 2000), Vol. 34, Sep. 2015, pp. 95–100.
- [2] AmiriS. Asadi, "Image quality enhancement using pixel-wise gamma correction via svm classifier", IJE Transactions B: Applications Vol. 24, No. 4, December 2011, pp. 45-52.
- [3] Goo Choi Min, Jung Hoon, "Image Quality Assessment Using Blur & Noise", World Academy of Science Engineering & Vol. 28 No.12, pp. 56-63, January 2009, pp. 56-63.
- [4] Hassanpour H., S. Asadi Amiri, "Image quality enhancement using pixel-wise gamma correction via svm classifier", Vol. 24, No. 4, IJE, December 2011, pp. 67-72.
- [5] Bhattacharya Saumik, Sumana Gupta, Subramanian Venkatesh K., "Localized image enhancement" in Communications (NCC), 2014 Twentieth National Conference, Vol. 5, pp. 1-6, IEEE, 2014, pp. 1-6.
- [6] Khan Farhan, Ekram, Z. A. Abbasi, "Multi segment histogram equalization for brightness preserving contrast enhancement", In Advances in Computer Science, Engineering & Applications, Springer Berlin Heidelberg, Vol. 11, 2015, pp. 193-202.
- [7] Turaga D.S, Y. Chen, J. Caviedes, "PSNR estimation for compressed pictures," In Signal Process. Image Communication conference, Vol. 19, 2004, pp. 173–184.
- [8] Maini Raman, Aggarwal Himanshu, "A Comprehensive Review of Image Enhancement Techniques", In journal of computing, Vol 2, March 2010, pp. 2151-9617.
- [9] Chopra Henan, Wu, Yang Guang, XuZhonglin, Li Dejun, Yuan Yuwei, "Remote sensing image enhancement method based on multi-scale Retinex", In Information Technology, International Conference on Computer Engineering and Management Sciences (ICM), Vol. 3, 2011, pp. 15-18. IEEE.
- [10] Sharma, Juliastuti, E.; L. Epsilawati, "Image contrast enhancement for film-based dental panoramic radiography", In System Engineering and Technology (ICSET), 2012 International Conference, Vol 8, pp. 1-5, IEEE, 2012.
- [11] Khan Mohd; Manish, Vohra; Rana K.; Vineet Kumar, "A virtual instrumentation based scheme for automatic gas burner drilling mechanism using lab view", Journal of Information Systems and Communication, Vol. 3, Issue 1, pp. 35-37, 2012,
- [12] Khan Hasikin; Khairunnisa; Ashidi Mat Isa, "Enhancement of the low contrast image using fuzzy set theory". Computer Modelling and Simulation (UKSim), UKSim 14th International Conference, Vol. 7, pp. 371-376. IEEE, 2012.
- [13] Wang, Lung-Jen, Ya-Chun Huang, "Combined opportunity cost and image classification for non-linear image enhancement". Complex, Intelligent and Software Intensive Systems (CISIS), 2012 Sixth International Conference, Vol. 98, 2012, pp. 135-140. IEEE.
- [14] Kaushik Pooja, Yuvraj Sharma, "Comparison of Different Image Enhancement Techniques Based Upon Psnr & Mse", International Journal of Applied Engineering Research, Vol. 7, No. 11, 2012, pp. 28-32.
- [15] Khandelwal, Rati, "Various Image Enhancement Techniques-A Critical Review", In International Journal of Advanced Research in Computer and Communication Engineering Vol. 2, IEEE, March 2013, pp. 45-50.
- [16] GrewalRaju, G., Madhu S. Nair, "A fast and efficient color image enhancement method based on fuzzy-logic and histogram". AEU-International Journal of electronics and communications, Vol. 68, No. 3, pp. 237-243, IEEE, 2014.
- [17] Varnan, C.S; jagan, A.; Jaspreet, Rao, D.S, "Image Quality Assessment Techniques", International journal science & technology, Vol. 2, No. 3, Sep. 2015, pp. 2108-2113, IEEE.
- [18] Sawant, H.K; Deore, Mahentra, "A Comprehensive Review of Image Enhancement Techniques". International Journal of Computer Technology and Electronics Engineering (IJCTEE) Vol. 1, Issue 2, 2015, pp. 39.
- [19] Karunya, Praiseline, "Image Enhancement Techniques: A Review", International Journal of Research in Engineering and Technology, Vol. 12, 2016, pp. 567- 572.



Palak Khandelwal is currently pursuing her M.Tech degree in electronics and communication from Manav Rachna International University, Faridabad, Haryana, India. She has completed B.Tech. in 2013 in Electronics & Communication Engineering, from M.D.U, Rohtak. Her research interest includes Image Processing.



Gagandeep Kaur is currently working as an Assistant Professor in ECE Department of FET, Manav Rachna International University, Faridabad. She has completed B.E. in 2009 in Electronics & Communication Engineering, from M.D.U, Rohtak and M.Tech in 2011 from D.C.R.U.S.T, Murthal. She did her thesis under the guidance of Mr. Rajeshwar Dass, Assistant Professor in D.C.R.U.S.T, Murthal. She is pursuing Ph.D from Manav Rachna International University, Faridabad under the Guidance of Dr. Shruti Vashisht, Associate Professor in ECE Department of FET, Manav Rachna International University, Faridabad. Her interest includes Medical Image Processing, and Quantum Computing. She is a life member of ISTE & Associate Member of Universal Association of Computer and Electronics Engineers.