www.ijecs.in
International Journal Of Engineering And Computer Science ISSN: 2319-7242
Volume 5 Issues 7 July 2016, Page No. 17291-17296

Estimation of the Image Quality under Different Distortions

[1]Pinki, [2]Rajesh Mehra
[1]Student, M.E. Scholar, [2]Associate Professor
[1.2]Department of Electronics & Communication Engineering
National Institute of Technical Teachers Training & Research, Chandigarh
pinki.dabas.24@gmail.com

ABSTRACT
The evaluation of the image quality is very important. The best subjective evaluation of the image is done by the human eyes as they are the good receivers. Objective analysis of the image is done by using full reference metric. The results of the objective measurements are validated by the subjective measurements. The objective evaluation of image in this paper has been done using PSNR (Peak Signal to Noise Ratio), MSE (Mean Squared Error) and SSIM (Structural Similarity Index Metric). These algorithms are applied on the different images. If the value of PSNR increases, the corresponding value of SSIM also increases and the value of MSE decreases. In the proposed wok, if the value of MSE increases by 8%, then the corresponding PSNR decreases by 10%. This is not applicable on all images because the MSE, PSNR and SSIM changes according to the complexity of the image. Every image has different coefficient of complexity. More complex image gets distorted first than the less complex image.
Keywords: MSE, PSNR, SSIM, Quality, Coefficient of complexity.

INTRODUCTION

Every time the technologies are revolving around the path of technology. New advancements are going on every step of the science innovation. Whenever we see the world with our eyes, it should be smooth and pleasant to the eyes but sometimes it looks annoying to the eyes when we saw the captured or transmitted images [1, 2]. This is due to the distortion occurred in the image during the transmission or capturing of the image. To measure or analyze this distortion there are some algorithms and techniques. SSIM, PSNR, JND, MSE which notices the difference between the distorted image and the original or the reference image [3]. The analysis of these parameters gives the details about the extent of the similarity to the reference image or the original. There are large files which uses the large space to store the image. This capacity of the storing can be minimized by using the compression algorithm. This compression is done at the transmitting end, vice versa decompression is done at the receiving end. During this transmission of the image there occurs a distortion in the image. This distortion is measured using different terms in this paper and the analysis of the image quality has been done. To evaluate the image quality the quality analysis should be done systematically analysis can be used to systematically. Using this paper work the human visual system will be able to determine the difference between the original image and the distorted image.

The image quality assessment has been done using the SSIM index, PSNR, MSE, JND [4]. The structural similarity is measured by SSIM index. If the perfect quality is regarded by the one image then other image signal quality is compared and then the similarity index is determined. Global computation is much useful than the local computation because of manifold. The prediction of the perceived quality of cinematic pictures and digital television pictures is done by using structural similarity index. The similarity of two images is measured by SSIM [5]. The full reference matrix is used in the calculation of the SSIM index means every pixel of the output image is compared with the every pixel of the input image. By means of using the no reference matric or partial reference matric the value of SSIM index cannot be calculated. The PSNR & MSE are inconsistent with the human visual perception. The values of the PSNR and MSE can be improved by using the SSIM index [6].

To give the brighter and the better results there is a need to adjust the value of SSIM index and absolute error. Perceived change in the structural information as image degradation can be determined by SSIM perception based model. When the pixels are spatially close, there is a strong interdependency between the pixels which gives the idea about the structural information.In the visual scene the important information about the structure of the object is carried out by these dependencies. In bright regions the image distortion is less visible, while if there is significant activity in the image, this type of phenomena is less visible in the contrast masking. The important loss of the information occurs due to any processing on the image [7]-[9]. There are two methods of the image quality evaluation. (1) Objective method. (2) Subjective method. Human judgment method which is not based on the reference image is called the subjective method wherease in objective method the numerical comparisons are done between the reference image and the distorted image. Statistical parameters and tests can be formulated by using several references as the ground truth or prior knowledge [10].

SSIM index value calculation for a particular window between x and y of size N × N can be done in the following way

$$SSIM(x, y) = \frac{(2\,\mu x\,\mu y + c1)\,(2\sigma xy + c2)}{(\mu x2 + \mu y2 + c1)\,(\sigma x2 + \sigma y2 + c2)} \qquad (1)$$

μx => Average of x.
μy => Average of y.
σx^2 => Variance of x.
σy^2 => Variance of y.
σxy the covariance of x and y.
$C_1 = (k_1 L)^2$ $C_2 = (k_2 L)^2$

C_1 and C_2 are the variables to stabilize the weak denominator [1, 11].

L is the dynamic range. The default values of $k_1 = 0.01$, $k_2 = 0.03$.

This formula is applicable on luma, color RGB images and chromatic YCbCr values to evaluate the image quality. The resulting values of the SSIM lies between -1 and +1, if there are two identical sets of the data gives the value as 1 [12]. Generally the window size is taken as 8×8. The calculation can be done by placing the whole window but to reduce the complexity of calculation use only a subgroup of the window. During the evaluation of the image quality the values of the SSIM and PSNR varies, there is no any prescribed rule for selecting these values. Some theories revealed that the value of PSNR and MSE does not give the accurate idea about the structural similarity of the image [13, 14]. On the other hand some author's paper revealed that these parameters are highly related to each other. This paper proposed the relationship between the SSIM and PSNR under different distortions like Gaussian blur, additive Gaussian, salt and pepper noise, and jpeg2000 and jpeg compression [2, 15].

PSNR is defined as the ratio of the possible maximum power of the signal to the possible maximum power of the noise. Logarithmic decibel scale is used for the PSNR value representation. PSNR value calculation is done as follows.

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

$$= 20 \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right)$$

$$= 20 \log_{10}(MAX_I) - 10 \log_{10}(MSE) \qquad (2)$$

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - k(i,j)]^2 \qquad (3)$$

Image quality measurement has been done using different algorithms. Out of them some are Mean Squared Error (MSE), Peak Signal to Noise Ratio (PSNR), Average Difference (AD), Maximum Difference, Universal Image Quality Index (UIQI) and Structural Similarity Index Matric (SSIM). Therefore in the first step the metric is to be studied which results in the analysis of their significance. After this the simulation of the method is done by applying on standard images [2, 16, 17].

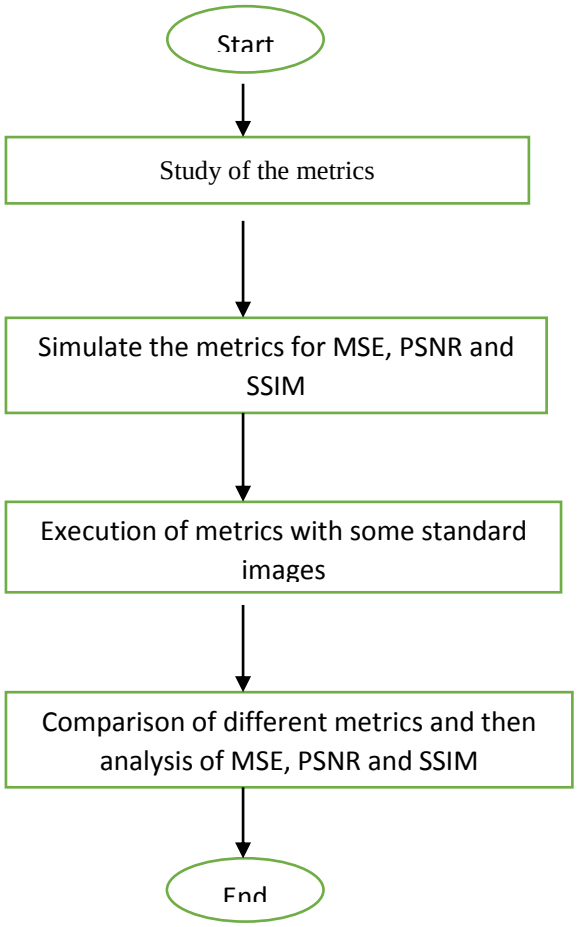


Figure 1. Flowchart for objective image quality estimation.

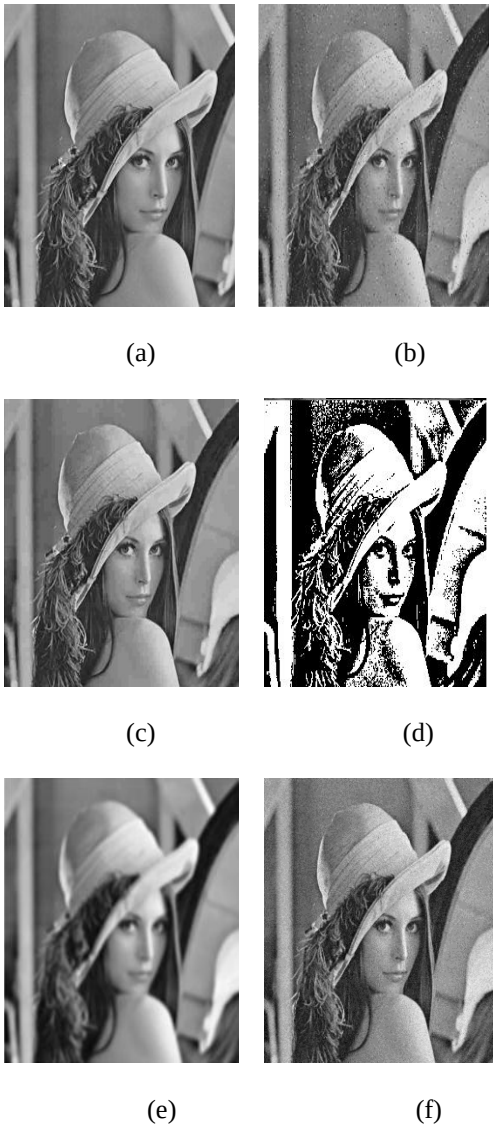
There is a fundamental importance of measurement of visual quality in different image processing applications. The image quality gets degraded right from the point when they are captured to the point when they are viewed by the viewer. Firstly, we have to find those points which are more sensitive to the distortions [18]. On keeping those points in the mind we have to opt that method of distortion which is more rigorous. Because our aim is to satisfy the customer. In response he needs the higher image quality in low cost. There is always tradeoff between the image of quality and the cost. It becomes very crucial for a designer to fulfill both the criteria up to the mark of consumer satisfaction.

During signal acquisition, storage, processing, transmission and reproduction a number of distortions takes place. By means of which the image quality get distorted. Improved quality image can be obtained by using the quality metric to adjust itself automatically. Image processing systems can be compared or evaluated by using image quality metrics. Subjective testing sessions and objective computational metrics determine the quality of the image. Quantification of visual image quality can be done correctly through subjective evaluation. There are number of evaluators in subjective evaluation. The number of scores is listed in reference to the quality of the image from different observers. Subjective evaluation takes more time, usually inconvenient and expensive. The automatic evaluation of the quality of the image is done by objective algorithm. In this method there is no human involvement which leads to the

cost effective algorithm [19, 20]. Therefore objective algorithm fulfill both the conditions namely, cost and effective image quality estimation.

MATLAB SIMULATIONS & RESULTS

The MATLAB is used for the design of the image quality metric and their analysis. Mathematical software package is provided by the MATLAB. Excellent graphics and matrix handling properties are provided by the MATLAB. Technical computing is done in the flexible environment with the help of MATLAB. There is a wide list of inbuilt mathematical tools and graphical functions. Using MATLAB codes the software provides the option for generating the VHDL code, C program etc. In this paper the analysis of different images has been done in the MATLAB to find the values of the PSNR, MSE and SSIM. The subjective analysis can also be done on seeing the images given in the figure 2, 4, 6. Objective analyses results have been presented in the table 1, 2, and 3. These values have been calculated by using the different commands of the MATLAB. The image quality metric has been designed by MATLAB. These codes are very easy to understand and learn. MATLAB provides the user friendly environment.



(a) (b)

(c) (d)

(e) (f)

Figure 2. (a). Original image of Lena. (b). Salt & pepper noised image. (c). Compressed image. (d). Contrast image. (e). Blurred image. (f) Gaussian noise

Table 1. Analysis of PSNR, MSE and SSIM for figure 2.

Original image		
Sr. No.	Parameter of quality estimation	Value of quality
1	PSNR	∞
2	MSE	0
3	SSIM	1
Effect of Salt & pepper noise on image		
1	PSNR	32.9799
2	MSE	32.7404
3	SSIM	0.6783
Effect of Compression on image		
1	PSNR	33.3421
2	MSE	30.1209
3	SSIM	0.8146
Effect of Contrast on image		
1	PSNR	31.8423
2	MSE	42.5449
3	SSIM	0.4189
Effect of blurring on image		
1	PSNR	32.6303
2	MSE	35.4387
3	SSIM	0.6188
Effect of Gaussian noise on image		
1	PSNR	33.2935
2	MSE	30.4598
3	SSIM	0.8711

There are two types of the assessment subjective assessment and the objective assessment. In the previous page we have used the image of Lena as a standard image. There are various types of changes on applying the different types of the distortions. The conclusions can be drawn through the table.

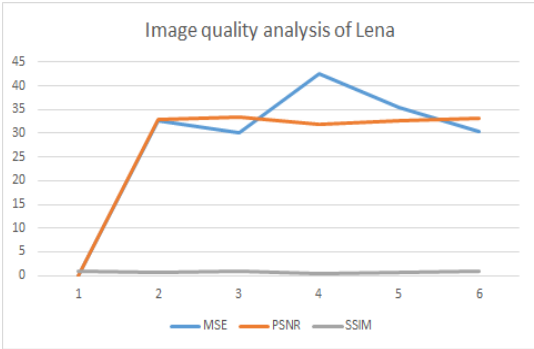


Figure 3. Graphical illustration of PSNR, MSE, SSIM

As the value of PSNR decreases the corresponding value of MSE increases and vice versa. When the value of the peak signal to noise ratio increases the resulting image is very smooth to the eye perception. If the value of structural similarity index increases, that image approaches to its original image. Highly distorted images gives high value of

mean square error, less value of peak signal to noise ratio and worst values for the structural similarity index. If the value of peak signal to noise ratio is ∞, corresponding value of mean square error becomes zero and the resulting value of structural similarity becomes highest.

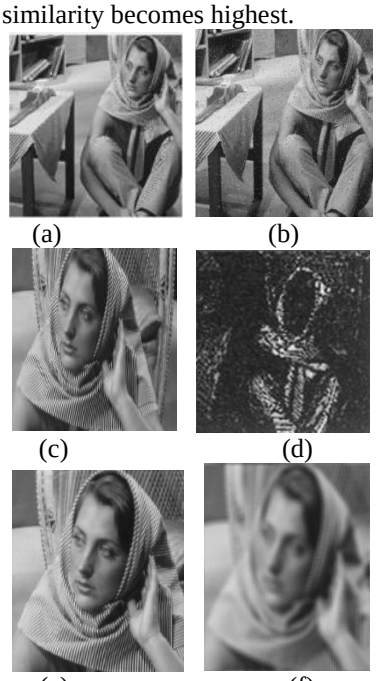


Figure 4 (a). Original image of Lena. (b). Salt & pepper noised image. (c). Compressed image. (d). Contrast image. (e). Blurred image. (f) Gaussian noise

Table 2. Analysis of PSNR, MSE and SSIM for figure 4.

Original image		
Sr. No.	Parameter of quality estimation	Value of quality
1	PSNR	∞
2	MSE	0
3	SSIM	1
Effect of Salt & pepper noise on image		
1	PSNR	31.9082
2	MSE	41.9044
3	SSIM	0.6249
Effect of Compression on image		
1	PSNR	32.9853
2	MSE	32.7003
3	SSIM	0.8053
Effect of Contrast on image		
1	PSNR	31.2264
2	MSE	49.0276
3	SSIM	0.5908
Effect of blurring on image		
1	PSNR	32.3714
2	MSE	37.6654
3	SSIM	0.7643
Effect of Gaussian noise on image		
1	PSNR	31.6018
2	MSE	44.9675
3	SSIM	0.6132

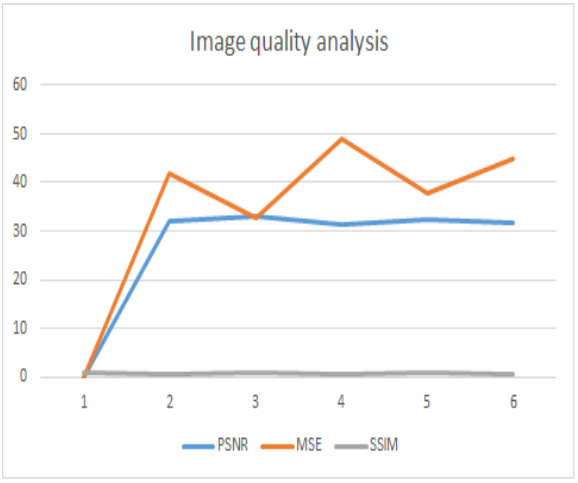


Figure 5. Graphical illustration of PSNR, MSE, SSIM

Conclusion can be derived from the above graph and table is PSNR and SSIM are directly proportional to each other, PSNR and MSE are inversely proportional to each other.

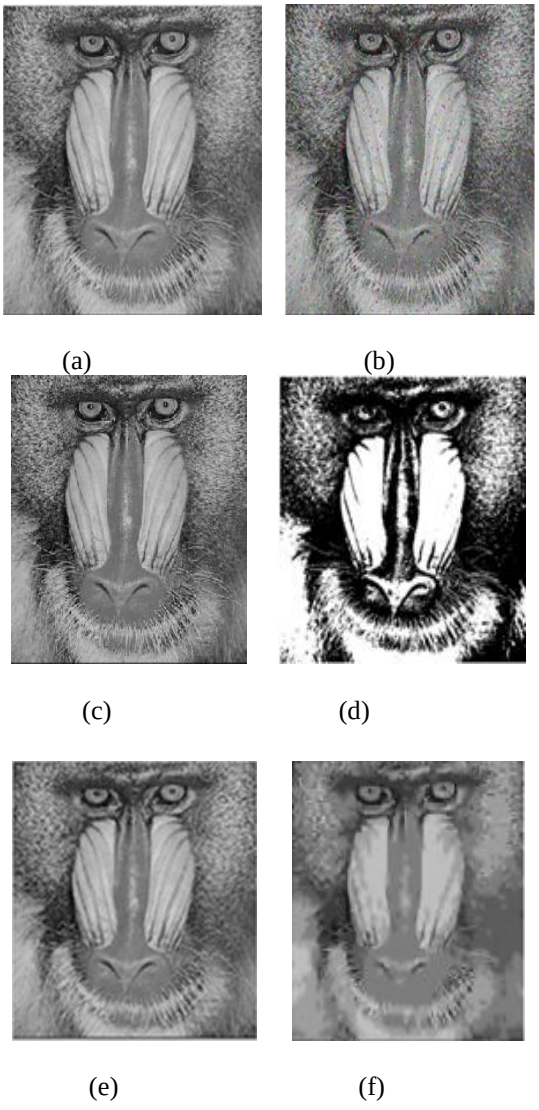


Figure 6 (a). Original image of Lena. (b). Salt & pepper noised image. (c). Compressed image. (d). Contrast image. (e). Blurred image. (f) Gaussian noise

Table 3. Analysis of PSNR, MSE and SSIM for figure 6.

Original image		
Sr. No.	Parameter of quality estimation	Value of quality
1	PSNR	∞
2	MSE	0
3	SSIM	1
Effect of Salt & pepper noise on image		
1	PSNR	32.0176
2	MSE	40.8619
3	SSIM	0.7189
Effect of Compression on image		
1	PSNR	31.7561
2	MSE	43.3981
3	SSIM	0.6488
Effect of Contrast on image		
1	PSNR	31.4298
2	MSE	46.7841
3	SSIM	0.5238
Effect of blurring on image		
1	PSNR	32.2298
2	MSE	38.9134
3	SSIM	0.8341
Effect of Gaussian noise on image		
1	PSNR	31.8048
2	MSE	42.9138
3	SSIM	0.6813

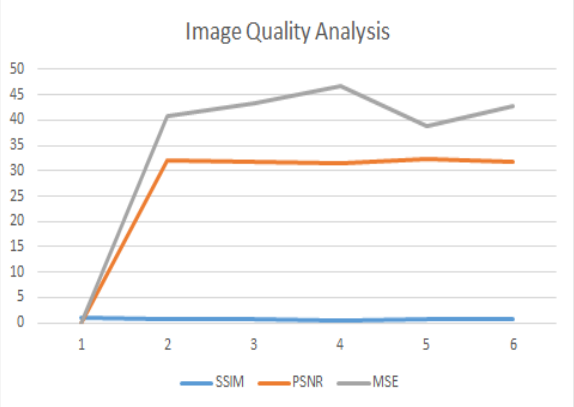


Figure 7. Graphical illustration of PSNR, MSE, SSIM

CONCLUSION

In the proposed work, we have discussed about the estimation of image quality under different distortions. We have illustrated the corresponding graph and the table in reference of the standard original image to estimate the quality by objective method. If the image quality increases it results in increased value of structural similarity and peak signal to noise ratio, but the value of mean square error get reduced. The criteria of relation between peak signal to noise ratio and structural similarity remains the same, but the values get changed because of the variation in the complexity of image. The measurement of structural similarity gives the better results for image quality estimation but it fails in highly blurred images.

ACKNOWLEDGEMENT

I am highly grateful to the Director NITTTR Chandigarh for providing me the opportunity to carry out my research.
I express my deep sense of gratitude to my research supervisor Dr. Rajesh Mehra for his expert guidance, discussions as well as continued impetus throughout the period of this work.
Finally, I am thankful to all those people who are directly or indirectly involved in this work.

REFERENCES

[1]. C. Sasi Varnan, A. Jagan, Jaspreet Kaur, Divya Jyoti, Dr.D.S.Rao, "Image Quality Assessment Technique pn Spatial Domain," International Journal of Computer Science & Technology, Vol. 2, pp. , 2011.

[2]. Prateek Gupta, Priyanka Sarivastava, Satyam Bhardwaj, Vikrant Bhateja, "A HVS Based Perceptual Quality Estimation Measure for Color Images," ACEEE International Journal on Signal & Image Processing, Vol. 03, pp. 63-69, 2012.

[3]. P Aggarwal, R Mehra, "High Speed CT Image Reconstruction Using FPGA," International Journal of Computer Applications, Vol. 22, pp. 7-10, 2011.

[4]. S Sharma, S Sharma, R Mehra, "Image Restoration Using Modified Lucy Richardson Algorithm in the Presence of Gaussian and Motion Blur," International Journal of Advance in Electronic and Electric Engineering, Vol. 3, pp. 1063-1070, 2013.

[5]. Alaine Hore, Djemel Ziou, "Image quality Metrics: PSNR Vs. SSIM," IEEE International Conference on Pattern Recognition, DOI: 10.1109/ICPR.2010.579, pp. 2366-2369, 2010.

[6]. A. Murat Demirtas, Amy R. Reibman, Hamid Jafarkhani, "Image Quality Estimation for Different Spatial Resolutions," IEEE International Conference on Image Processing. DOI: 10.1109/ICIP.2013.6738078, pp. 379-382, 2013.

[7]. S Kaur, R Mehra, "High speed and Area Efficient 2D DWT Processor Based Image Compression," International Journal of Signal & Image Processing, Vol. 1, pp. 22-31, 2010.

[8]. A. Murat Demirtas, Amy R. Reibman, Hamid Jafarkhani, "Full References Quality Estimation for Images with Different Spatial Resolutions," IEEE Transactions on Image Processing, Vol. 23, pp. 2069-2080, 2014.

[9]. Dragon Kukolj, Dragana Dordevic, David Okolisan. Ivana Ostojic, Dragana Sandic-Stankovic, Chaminda Hewage, "3D Image Quality Estimation Based on Depth/Disparity and 2D Metrics," IEEE International Conference on Computational Intelligence and Informatics, DOI: 10.1109/CINTI.2013.6705177, pp. 125-130, 2013.

[10]. R Mehra, R Verma, "Area Efficient FPGA Implementation of Sobel Edge Detector for Image Processing Applications," Vol. 56, pp. 7-11, 2012.

[11]. Aladine Chetouani, Azeddine Beghdadi, "A New Image Quality Estimation Approach for JPEG 2000 Compressed Images," IEEE International Symposium on Signal Processing and Information Technology, DOI: 10.1109/ISSPIT.2011.6151627, pp. 581-584, 2011.

[12]. Zhengyou Wang, Wan Wang, Zhenxing Li, Jin Wang, Weisi Lin, "No Reference Image Quality Assessment for Compressed Image Based on DCT Coefficient Distribution and PSNR Estimation," IEEE International Conference on Signal & Image Processing Association Annual Summit and Conference, Print ISBN: 978-1-4673-4863-8, pp. 1-4, 2012.

[13]. Abdul Rehman, Zhou Wang, "Reduced-Reference Image Quality Assessment by Structural Similarity Estimation," IEEE Transactions on Image Processing, Vol. 21, pp. 3378-3389, 2012.

[14]. Ke Gu, Guangtao Zhai, Xiaokang Yang, Wenjun Zhang, "A New Reduced Reference Image Quality Assessment using Structural Degradation Model," IEEE International Symposium on Circuits & Systems, DOI: 10.1109/ISCAS.2013.6572041, pp. 1095-1098, 2013.

[15]. Prateek Gupta, Priyanka Sarivastava, Satyam Bhardwaj, Vikrant Bhateja, "A Modified PSNR Metric Based on HVS for Quality Assessment of Color Images," IEEE International Conference on Communication and Industrial Application, DOI: 10.1109/ICCIndA.2011.6146669, pp. 1-4, 2011.

[16]. Dr. P. Sumitra, "Objective Performance of Picture Quality Measures Based on Set Partitioning in Hierarchical Trees (SPIHT)," International Journal of Scientific & Engineering Research, Vol. 5, pp. 1391-1395, 2014.

[15]. Qia Wang, Wenjun Zeng, Jun Tian, "A Compressive Sensing Based Secure Watermark Detection and Privacy Preserving Storage Framework," IEEE Transactions on Image Processing, Vol. 23, pp. 1317-1328, 2014.

[16]. Hong Cao, Kot A.C., "On Establishing Edge Adaptive Grid for Bilevel Image Data Hiding," IEEE Transactions on Information Forensics and Securiy, Vol. 8, pp. 1508-1518, 2013.

[17]. Jen-Sheng Trai, Win-Bin Huang, Yau-Hwang Kuo, "On the Selection of Optimal Feature Region Set for Robust Digital Image Watermarking," IEEE Transactions on Image Processing, Vol. 20, pp. 735-743, 2010.

[18]. Kalantari N.K., Ahadi S.M., "A Logarithmic Quantization Index Modulation for Perceptually Better Data Hiding," IEEE Transactions on Image Processing, Vol. 19, pp.1504-1517, 2010.

[19]. Weiming Zhang, Biao Chen, Nenghai Yu, "Improving various Reversible Data Hiding Schemes Via Optimal Codes for Binary Covers," IEEE Transactions on Image Processing, Vol. 21, pp. 2991-3003, 2012.

[20]. Korus P., Dziech A., "Efficient Method for Content Reconstruction With Self- Embedding," IEEE Transactions on Image Processing, Vol. 22, pp. 1134-1147, 2012.

[21]. Shan Wang, Dong Zheng, Jiying Zhao, "Adaptive Watermarking and Tree Structure Based Image Quality Estimation," IEEE Transaction on Multimedia, Vol. 16, no.2, pp. 311-325, 2014.

AUTHORS

Pinki has done the Bachelors of Technology degree in Electronics and Communication Engineering fro
from Chaudhari Devi Lal Memorial Engineering College, Panniwala Mota, Sirsa, Haryana.
Presently she is working as a Lecture in Govt. Polytechnic, Jhajjar, Haryana, since 2009.

Dr. **Rajesh Mehra** is currentlyassociated with Electronics and Communication Engineering Department of National Institute of Technical Teacher's Training & Research, Chandigarh, India since 1996. He has earned his Doctor of Philosophy in Engineering & Technology and Master of Engineering from Panjab University, Chandigarh, India. He has completed his Bachelor of Technology from NIT, Jalandhar, India. Dr. Mehra has 20 years of academic and research experience. He has more than 350 papers to his credit which are published in referred International Journals and Conferences. Dr. Mehra has guided 80 ME thesis and he is also guiding 02 PhD scholars. He has also authored one book on PLC & SCADA and developed 06video films in VLSI area. His research areas are Advanced Digital Signal Processing, VLSI Design, FPGA System Design, Embedded System Design, and Wireless & Mobile Communication. Dr. Mehra is member of IEEE and ISTE