Comparative Analysis of Image Quality Assessment Using HVS Model

Er. Mandeep Kaur[1], Er. Nancy Jindal[1]
Department of CS & IT, Kurukshetra Institute of Technology & Management, Kurukshetra University, Haryana

Abstract- Image Quality Assessment (IQA) plays an important role in various image processing applications. Most Full Reference (FR) technique were derived based on pixel to pixel error such as Mean Square Error (MSE) or Peak Signal to Noise Ratio (PSNR), etc. unfortunately, these metrics cannot correlate well with perceived quality measurement and the assessment of quality by these methods is highly complex and time consuming. Moreover they are highly sensitive to error. Therefore, a measurement of structural distortion should be a good approximation of perceived image distortion. For this the Mean Structural Similarity based Image Quality Assessment metric was proposed. It is easy to implement and less sensitive to distortions. A comparative analysis of image quality assessment using Human Visual System (HVS) model based metric & Statistical Metrics presented here for different type of images. Experimental results reveal that the MSSIM technique is well consistent when compared to the PSNR and SNR.

Keywords: *MSE, PSNR, MSSIM*

I. INTRODUCTION

Simple statistics error metrics and Human Visual System (HVS) feature based metrics defined as:

A. Simple statistics error metrics

(i) MSE

It stands for the mean squared difference between the original image and distorted image. MSE (mean square error) is the Euclidian distance between the original and the degraded images. The mathematical definition for MSE [1] is:

$$MSE = \left(1 / M \times N\right) \sum_{i=1}^{M} \sum_{j=1}^{N} (a_{ij} - b_{ij})^2$$

In Equation (1.1), a_{ij} means the pixel value at Position (i, j) in the original image and b_{ij} means the pixel value at the same position in the corresponding distorted image.

(ii) PSNR

PSNR is a classical index defined as the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation [2]. It is given by:

$$PSNR = 10 \log_{10} 255^2 / MSE$$

Where 255 is the maximal possible value the image pixels when pixels are represented using 8 bits per sample. There are also some other metrics like: Average Difference (AD), Maximum Difference (MD), Mean Absolute Error (MAE), Peak Mean Square Error (PMSE)

B. Human Visual System (HVS) feature based metric

(i) SSIM

The structural similarity index is a method for measuring the similarity between two images [3].

$$SSIM(x, y) = \frac{\{(2\mu_x\mu_y + C_1)(2\sigma_{xy} + C_2)\}}{\{(\mu_x{}^2 + \mu_y{}^2 + C_1)(\sigma_x{}^2 + \sigma_y{}^2 + C_2)\}}$$

Where μ_x *is* average of x, μ_y is average of y, σ_x, σ_y are standard deviation between the original and processed images pixels, respectively.C_1, C_2 are positive constant chosen empirically to avoid the instability of measure. The mean of SSIM is known as mean structural similarity index metric (MSSIM) [4] and it is given as:

$$MSSIM(X,Y) = \frac{1}{M} \sum_{l=1}^{M} SSIM(xl, yl)$$

II. METHODOLOGY USED

Image quality assessment consists in modeling the metric between an original (ideal) image and a distorted version of it. The goal is to evaluate and compare the performance of image processing algorithms. For Quality Analysis of Images, step by step operations performed as shown in flow chart.

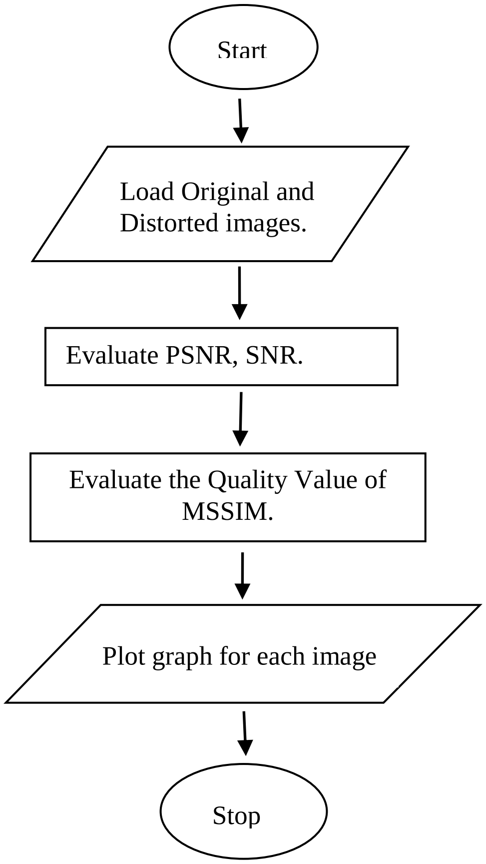

Fig.1 Flowchart of the Methodology Adopted

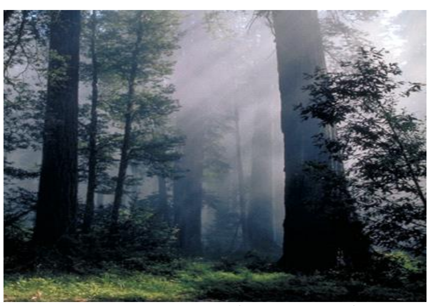

Fig.2: Orignal images used for analysis of redwood

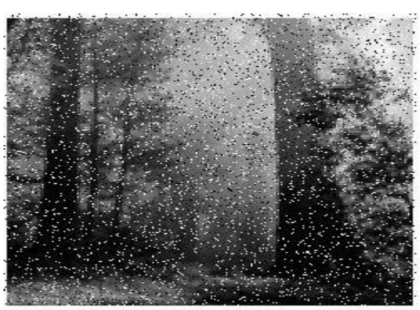

Fig.3: Noise Density 0.1

Fig.4: Noise density 0.2

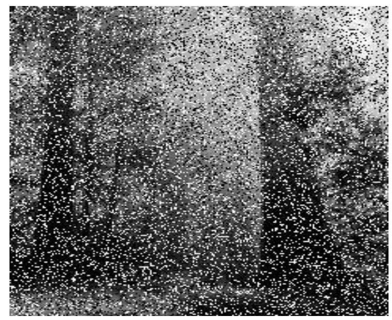

Fig.5: Noise density 0.3

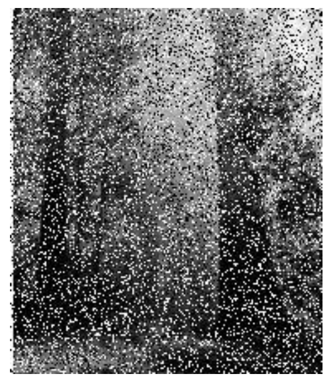

Fig.6: Noise density 0.4

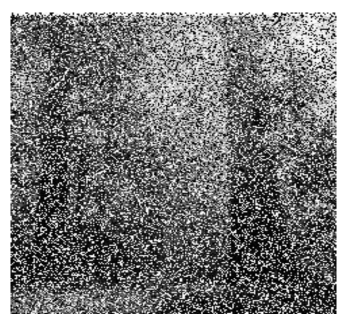

Fig.7: Noise density 0.5

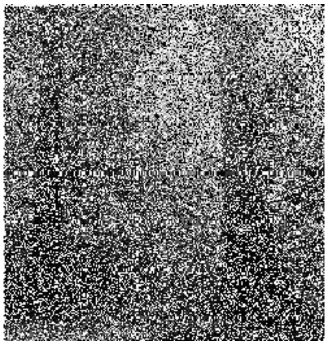

Fig.8: Noise density 0.6

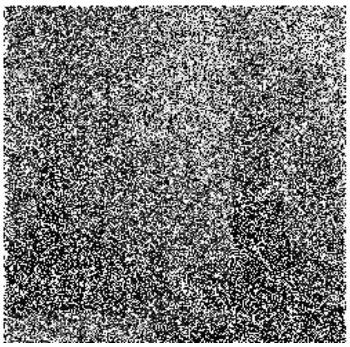

Fig.9: Noise density 0.7

III. SIMULATION AND ANALYSIS

In this section, we compare the performance of MSSIM with the statistical methods that are PSNR, SNR. The specific contents of the type of noise we have used is salt & pepper noise. The algorithms were implemented on MATLAB Software. Each Simulation was run on an Intel core i3-330M processor at 2.13 GHz.

TABLE 1: RESULTS FOR REDWOOD IMAGE

Noise	SNR	PSNR	MSSIM
0.1	-2.069	5.095	0.179
0.2	-2.090	5.074	0.155
0.3	-2.124	5.041	0.142
0.4	-2.153	5.012	0.135
0.5	-2.210	4.954	0.130
0.6	-2.254	4.919	0.126
0.7	-2.312	4.852	0.124

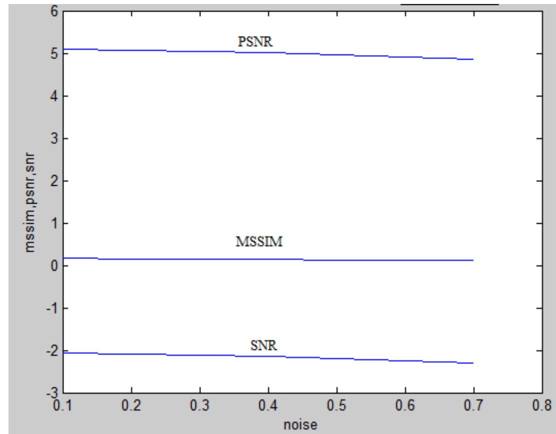

Fig.10: Plot for red wood image

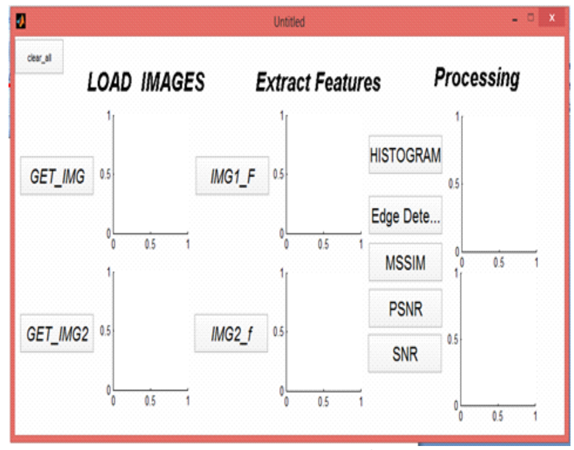

Fig.11: Simulation with METLAB before loading images

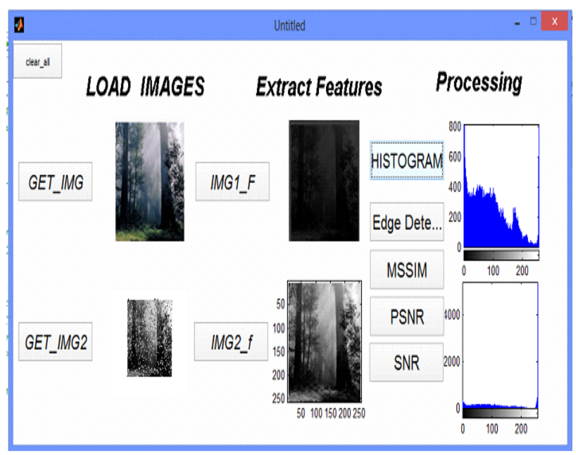

Fig.11: Feature Extraction and Histogram

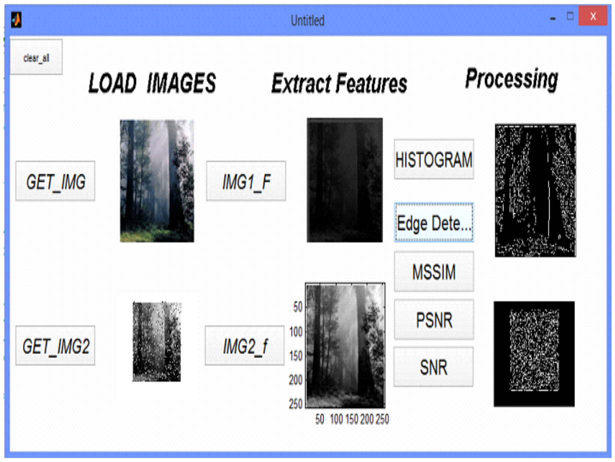

Fig.12: Edge detection

IV. CONCLUSION AND FUTURE SCOPE

A. Conclusion

In the field of image processing, image quality assessment is a fundamental and challenging problem with many interests in a variety of applications, such as dynamic monitoring and adjusting image quality, optimizing algorithms and parameter settings of image processing systems, and benchmarking image processing system and algorithms. Earlier techniques were based on mathematical metrics like PSNR, MSE but they do not correlate well with subjective perception values. MSSIM is a human visual system based metric which uses the luminance, structural and contrast information present in the given image as like in HVS model. These validation results show the robustness, feasibility of the MSSIM and it can perform better than PSNR and SNR. Plot for redwood image in fig 10 is drawn according to the table1 this shows the variation of the various assessing parameters with respect to noise density variation. The plot clearly shows that curve for MSSIM is almost a straight line parallel to the axis which is used to show the noise density variations. And the variation of this (MSSIM) parameter with respect to noise density is greater than the other two parameters i.e. SNR and PSNR. So the image quality can be calculated more precisely by HVS based metric.

B. Future Scope

Although this HVS based metric has good consistency with subjective perception values, there are still some issues to be investigated in the future. For example, we can investigate the new image representation method to reduce the number of feature parameters needed for IQA metrics. Also we can introduce the methods which can estimate the quality of the image without any reference.

V. REFERENCE

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