Comparative Analysis of MSE AND PSNR Q-Factor with Cameraman, Lena and Pentagon images & Removal of Artifacts

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Abstract - *During Image communication the source image is compressed in order to reduce the transmission cost and memory space requirement respectively. In this paper the various source images such as Cameraman, Lena and Pentagon are compressed at the input but at the receiver end the reconstructed image suffers from artifacts such as blocking artifacts. In order to reduce these artifacts MSE and PSNR indices and performance evaluation is done. The final results depict that MSE increases whereas PSNR decreases as the compression increases.*

Key Words: MSE, PSNR, Q- factor, JPEG

1. INTRODUCTION

Due to the increasing amounts of data transferred and stored, image compression is now plays a very vital role than ever. Image compression is minimizing the size in bytes of a graphics file without degrading the quality of the image to an unacceptable level. The prominent goal of data compression is to decrease the transmission cost by reducing the storage space. Image Compression techniques are used to exploit inherent redundancies by changing a big data file into a smaller file from which the original file which can be reconstructed later is exactly or approximately same. In the image compression, we have to maintain the visual quality of the image. Image compression is very significant factor for various utilizations in the area of interactive media communications. There are lots of techniques used for image compression in various utilizations. Transform quantization and entropy coding are the main steps involved in the image coding. These steps are applied on image or frame blocks independently. As the compression ratio increases, the correlation of the adjoining pixels decreases that falls in distinct blocks. It happens because in an independent way, the reconstruction of the pixels deceases or become poor. Visual distortion such as blurring images, change in texture pattern, false edges at boundaries and exaggeration in picture etc. occurs because of the increase in the compression ratio.

2. ARTIFACTS

Many techniques have already been deployed to reduce the blocking artifacts in the recent decades. When the techniques such as lossy data compression techniques have been applied, noticeable distortion of data occurs which is called artifacts. These artifacts should be removed for better image quality. If the artifacts effects are significantly reduced, a higher compression ratio can be achieved.

2.1 Types of Artifacts

There are various types of artifacts which effects image quality. Two of them such as Blocking Artifacts and Ringing Artifacts are discussed below:

2.1.1 Blocking Artifacts

Blocking artifacts is generally occurring in a re-constructed picture due to the discontinuity found at the boundary of the adjacent blocks. These artifacts can be reduced by using the de-blocking filter.

2.1.2 Ringing Artifacts

Due to the loss of high frequency, noise like variation occurs in the boundary of edges. DCT coefficient quantization is the source of the ringing artifacts.

3. ADAPTIVE FILTER METHOD

Adaptive filter are used to process the signals. An adaptive is used where exact frequency response of the signal is not known. An adaptive filter has self adjusting characteristics such as it adapt automatically changes in its input signals. It minimizes the error and provides desired output.

Different algorithms are used in adaptive filter for noise cancellation such as least mean square (LMS) algorithm, the normalized least mean square (NLMS) algorithms, Recursive least square (RLS) algorithms and affine projection algorithms (APA).LMS converges at the slow rate but it is very easy to implement. NLMS converges faster than the LMS as it has normalized step size. But it also increases the complexity. RLS and APA is the improved version of the NLMS and provide better convergence rate.

4. MEAN SQUARE ERROR

MSE is signal fidelity measure which compares two signals. It is used to calculate the difference estimator such as predicted outcome and what it is estimated such as expected outcome. Image degradation increases if the MSE increases and if image become perfect if the value of the MSE is zero. MSE is simple and economical methods to compute. The formula to calculate the MSE is shown below.

$$MSE = \frac{1}{MN}\sum_{i=1}^{M}\sum_{j=1}^{N}((x(i,j)-y(i,j))^2$$

Where **M** and **N** are the number of pixels in the horizontal and vertical directions whereas **x (i,j)** and **y(i,j)** is the filtered and noisy image at i and j co-ordinates respectively.

4. PEAK SIGNAL TO NOISE RATIO

Peak signal-to-noise ratio (PSNR) is the ratio between the maximum possible value power of a signal and the power of distorting noise which affects the image quality representation. The higher the value of PSNR reflects better quality of the compressed image or reconstructed image respectively. The PSNR is expressed in logarithmic decibel scale and the formula to calculate the PSNR is given below

$$PSNR = 10\log_{10}\frac{MaxI^2}{MSE}$$

5. EXPERIMENT AND RESULTS

In this part, different images such as Cameraman, Lena and Pentagon with different quality factor on JPEG Standard and median filtering are compared using MSE and PSNR respectively.

5.1 Results with Cameraman image

In the first experiment Cameraman image with different Q-Factor 7,9,11 and 13 are compared between JPEG Standard image and proposed method with median filtering using MSE and PSNR are represents in the Chart 1 and Chart 2 and its values are shown in Table 1 and Table 2 respectively.

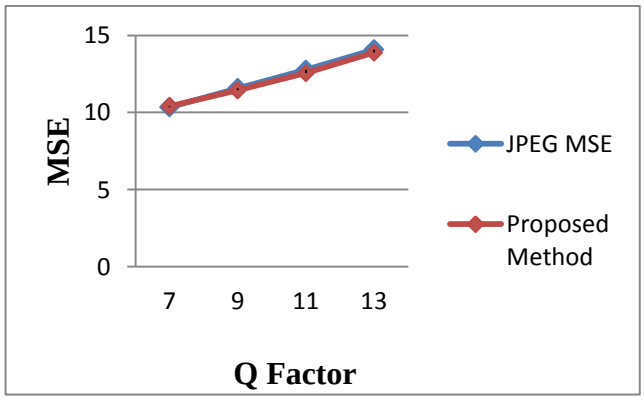

Chart -1: Comparison of MSE for Cameraman using JPEG Standard and Median Filtering at different values of Quality Factor.

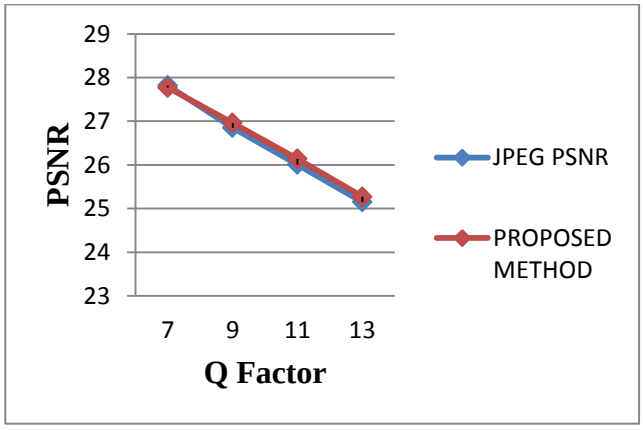

Chart -2: Comparison of PSNR for Cameraman using JPEG Standard and Median Filtering at different values of Quality Factor.

Table-1: Comparison of MSE values for Cameraman using JPEG Standard and Median Filtering at different values of Quality Factor.

S. No.	Q FACTOR	JPEG STANDARD MSE	Proposed method with median filtering
1	7	10.35	10.41
2	9	11.57	11.44
3	11	12.76	12.56
4	13	14.08	13.89

Table-2: Comparison of PSNR values for Cameraman using JPEG Standard and Median Filtering at different values of Quality Factor.

S. No.	Q FACTOR	JPEG STANDARD	Proposed method with median filtering
1	7	27.82	27.77
2	9	26.85	26.96
3	11	26.01	26.14
4	13	25.15	25.27

5.2 Results with Lena image

In the second experiment Lena image with different Q-Factor 7,9,11 and 13 are compared between JPEG Standard image and proposed method with median filtering using MSE and PSNR are represents in the Chart 3 and Chart 4 and values are shown in Table 3 and Table 4 respectively.

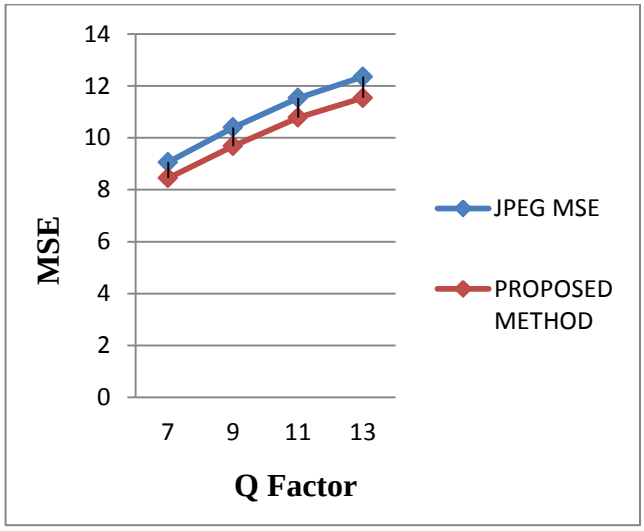

Chart -3: Comparison of MSE for Lena using JPEG Standard and Median Filtering at different values of Quality Factor.

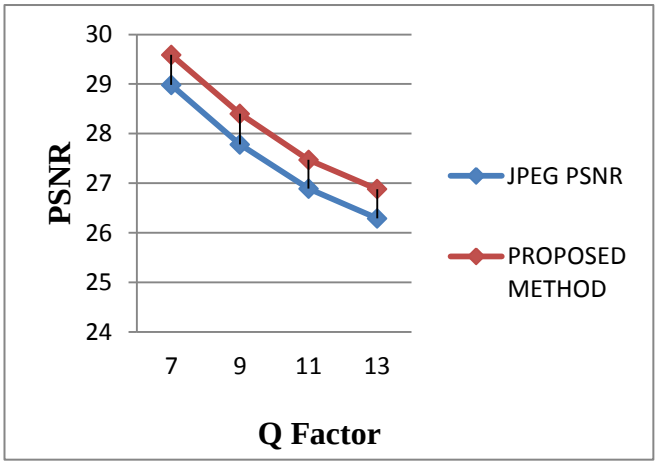

Chart -4: Comparison of PSNR for Lena using JPEG Standard and Median Filtering at different values of Quality Factor.

Table-3: Comparison of MSE values for Lena using JPEG Standard and Median Filtering at different values of Quality Factor.

S. No.	Q FACTOR	JPEG STANDARD MSE	Proposed method with median filtering
1	7	9.0605	8.4513
2	9	10.4081	9.6844
3	11	11.53	10.78
4	13	12.35	11.54

Table-4: Comparison of PSNR values for Lena using JPEG Standard and Median Filtering at different values of Quality Factor.

S. No.	Q FACTOR	JPEG STANDARD	Proposed method with median filtering
1	7	28.98	29.59
2	9	27.78	28.40
3	11	26.89	27.47
4	13	26.29	26.88

5.3 Results with Pentagon image

In the third experiment Lena image with different Q-Factor 7,9,11 and 13 are compared between JPEG Standard image and proposed method with median filtering using MSE and PSNR are represents in the Chart 5 and Chart 6 and values are shown in Table 5 and Table 4 respectively.

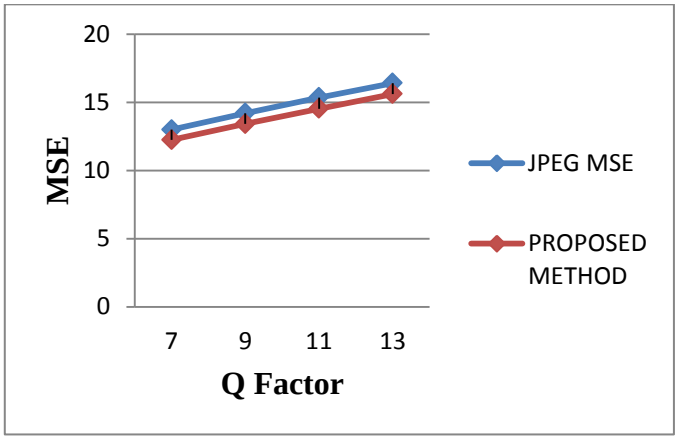

Chart -5: Comparison of MSE for Pentagon using JPEG Standard and Median Filtering at different values of Quality Factor.

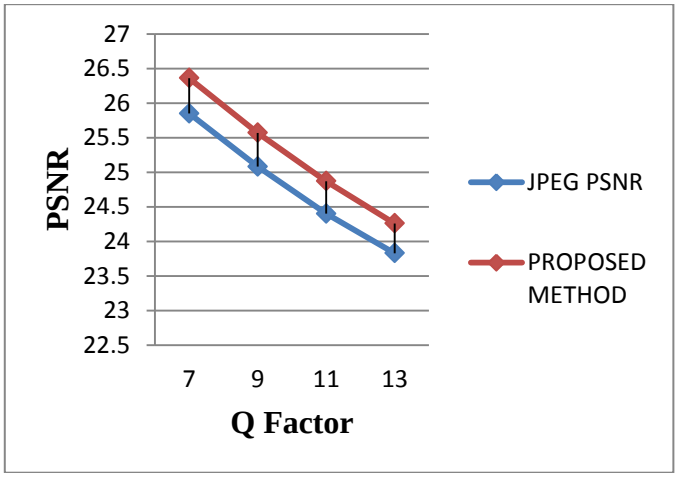

Chart -6: Comparison of PSNR for Pentagon using JPEG Standard and Median Filtering at different values of Quality Factor.

Table-5: Comparison of MSE values for Pentagon using JPEG Standard and Median Filtering at different values of Quality Factor.

S. No.	Q FACTOR	JPEG STANDARD MSE	Proposed method with median filtering
1	7	12.99	12.24
2	9	14.20	13.41
3	11	15.35	14.53
4	13	16.40	15.61

Table-6: Comparison of PSNR values for Pentagon using JPEG Standard and Median Filtering at different values of Quality Factor.

S. No.	Q FACTOR	JPEG STANDARD	Proposed method with median filtering
1	7	25.85	26.36
2	9	25.08	25.57
3	11	24.40	24.87
4	13	23.83	24.26

6. CONCLUSION

In this paper we concluded that after the removal of the Blocking Artifacts by proposed method from Cameraman, Lena and Pentagon images, the perceived quality of the image is enhanced respectively. In this proposed work we compared the Q-factor values of the MSE and PSNR on Cameraman, Lena and Pentagon images and we found that the propose work with median filtering give better result respectively. In the future, the reduction of blocking artifacts can be increased to great extent by recovering the information loss by using artificial intelligence or fuzzy logic.

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BIOGRAPHIES

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