Evaluation of Classification Accuracy with Original and Compressed Images

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Abstract*: *The extent of communicated information through internet has augmented speedily over the past few years. Image compression is the preeminent way to lessen the size of the image. JPEG is the one the best technique related to lossy image compression. In this paper a novel JPEG compression algorithm with Fuzzy-Morphology techniques was proposed. The efficacy of the proposed algorithm compared to JPEG is presented with metrics like PSNR, MSE, No of bits transmitted. The proposed approaches lessen the number of encoded bits as a result tumbling the quantity of memory needed. The Planned approaches are best appropriate for the images corrupted with Gaussian, Speckle, Poisson, Salt & Pepper noises. In this paper the effect of compression on classification performance was envisaged, Artificial Neural Network, Support Vector Machine, and, KNN classifiers performance is evaluated with original image data, standard JPEG compressed data and the compressed image data with the proposed method.

***Keywords* : *JPEG, Fuzzy morphology, PNSR, MSE, KNN*.**

I. INTRODUCTION

The specialized lossy compression algorithm for images is Joint Photographic Experts Group JPEG. The lossy compression indicates the image with less number of bits, but JPEG compression not only reduces the size but also uses less memory, the decompressed images with JPEG will looks approximately similar as the original images. The JPEG algorithm eradicates components of high frequency that the human eye can't discriminate. JPEG compression is the excellent observe for the images with smooth color translation[1],[2],[3],[4],[5]. The later part of this paper is planned as follows. Section II evaluates the associated work. Section III accords with the Classification Algorithms. Section IV comprises of Experimental Results. As a final point, the conclusion is obtainable in Section V.

II. INTENDED INNOVATIVE JPEG COMPRESSION ALGORITHMS

The planned JPEG algorithms are executed in two disparate ways.

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- The images are contaminated with Poisson, Speckle, Salt & Pepper noise and Gaussian noise prior to the segregation of the image into 8X8 blocks.
- The image is to be convoluted with Fuzzy C means/ Alpha Trimmed Mean/ Fuzzy –Morphological operator like Dilation/ Erosion earlier than the application of normalized matrix. This paper makes use of MATLAB tools to access the proposed algorithms and the images are downloaded from SIPI image database.

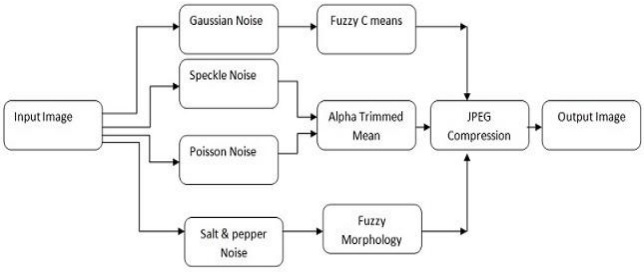

Fig. 1.Structure of Planned JPEG algorithm on images corrupted with various types of noise.

Algorithm1: Fuzzy- Morphology Based JPEG algorithm on noisy images.

Step1: Read the image.

Step 2: Contaminate the images with "speckle / Poisson/ Gaussian/ Salt & Pepper Noise".

Step 3: Apply Fuzzy C means/ Alpha trimmed Mean/ Fuzzy-Morphological Dilation/ Erosion operators on the resultant Image.

Step 4: Alienation of the image into non-overlapped 8x8 pixel blocks.

Step 5: There are 64 samples in each 8x8 pixel block and are level shifted by subtracting the (Gray level resolution) /2 from each pixel.

Step 6: The Discrete Cosine Transforms of each 8x8 block is measured.

Step 7: Standardize the DCT blocks by customary normalization matrix.

Step 8: Now the encode image is being sent to the receiver.

Step 9: The decoding process is done at the receiver.

Step10:"PSNR and MSE" are used to compute the difference between original and compressed image.

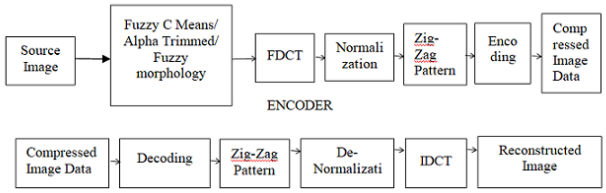

Fig. 2. Architecture of proposed JPEG compression models.

A. Fuzzy C-means Algorithm

Clustering prepare the foundation for the study of any image. The misclassification results of fully damaged and undamaged images after neglecting the partly damaged tissues are provided by considering a good amount of the clustering algorithms Therefore, to overcome these impacts, effective methodologies are to be developed. To identify the above challenges a special clustering algorithm is needed, Fuzzy C-Means algorithm is one such clustering method.

- **Steps Fuzzy C-means algorithm**

Step 1: Select the primary fuzzy pseudo-separation i.e. assign values to all the W_ij(Weight assign to each point x_i in the cluster j).

Step 2: Repeat

Step 3: Estimate the centroid of each cluster using the Fuzzy pseudo-partition, subject to centroid, that minimizes the Fuzzy Sum of Squared Error (SSE).

$$SSE(C_1, C_2, \ldots\ldots, C_k) = \sum_{j=1}^{k} \sum_{i=1}^{m} w_{ij}^{p}\, dist(x_i, c_j)^2$$

Step 4: Recalculate the Fuzzy pseudo-partition i.e. W_ij by equation,

$$W_{ij} = \frac{1/dist(x_i, c_j)^2}{\sum_{q=1}^{k} 1/dist(x_i, c}$$

Step5: Until centriods do not change.

B. Alpha-trimmed mean filter:

It is an amalgam of the mean and median filters. It is a non linear smoothening filter. Removal of Some portion of largest (α) and smallest in the distribution before taking the mean is called as trimming. It is an easy way of ensuring that extreme local values do not influence the output. Alpha-trimmed mean filters are widely used for the restoration of signals and images corrupted by additive non-Gaussian noise. Alpha trimmed mean filter can be used to solve multi type of noise [13].

C. Morphology

Mathematical Morphology is an imaginative mathematical theory that can be used to assess the images. Morphological techniques process an image with a minute silhouette called structuring element. The structuring element is situated at all credible locations in the image. Structuring elements symbolized in the structure of matrices which comprises 0's and 1's. So the structuring element is basically a binary image [6],[7],[8],[9],[10].

- **Fuzzy morphology**

Fuzzy Morphological Dilation/Erosion based JPEG compression the original image is fuzzified with a member function and then the processed image is dilated/ eroded with a 3X 3 matrix with all ones and then the regular JPEG compression is performed [11].

III. Classification Algorithms

A. Artificial Neural Network Humans generally used to learn things by experience, or by practice. Artificial intelligence and neural Networks are used in developing human like behavior in machines. Supervised learning is used to train ANN. The ANN learns the pattern accurately and hastily. After training ANN is used to recognize the patterns for which it is trained. Unsupervised training is used only when dataset is not known. Fault detection, Speech recognition and Character recognition are some of the applications of ANN.

B. Support Vector Machine The SVM belongs to the category of supervised learning .The SVM is a familiar and efficient technique for classification and regression but mainly used for classification. The feature value of object is represented with a point in the n- dimensional space with a coordinate. Then the hyper-plane is used to divided items into clusters.

C. K-NN Classifier The classifier from the class of supervised learning is K-NN. In supervised learning the path to target is identified as the targets are already known. Now to classify the recognized data, K-nearest neighbors is simple and finest algorithm that has a record of all available classes, so the algorithm can absolutely place the new entry into the class on the basis of largest number of vote for k neighbors. In order to identify an unlabelled entry in to a known class the best alternative is the KNN classifier. Selecting k value plays a vital role in determining the efficiency of designed model.

IV. Experimentations and Results

A comparison was made to check the efficiency of Fuzzy C Means, Alpha trimmed mean and Fuzzy Morphological operators. A set of corrupted images were considered with speckle, Gaussian, Poisson and Salt & pepper noise and a resolution of 256 x 256. A detailed comparison is shown in table I-IV

Table- I: Proposed methodologies based JPEG in terms images corrupted with Gaussian noise of size 256X256.

Corrupted images with Gaussian Noise 256 x 256								
Image Number	Moon Surface	Airplane	Clock	Resolution Chart	Moon Surface	Airplane	Clock	Resolution Chart
Operation	*Fuzzy C Means*				*Alpha trimmed Mean*			
No Of Bits Required	57483	59452	63046	70200	38915	35567	40756	48505
Saved bits	466805	464836	461242	454088	485373	488721	483532	475483
RMS Error	2.75	2.26	2.43	2.94	1.99	2.14	2.16	2.95
Compression ratio	9.12	8.81	8.316	7.46	13.47	14.74	12.86	10.8
PSNR	39.38	41.07	40.44	38.81	42.19	41.55	41.48	38.76
MSE	7.56	5.12	5.92	8.61	3.96	4.58	4.66	8.71
Operation	*Fuzzy Dilation*				*Fuzzy Erosion*			
No Of Bits Required	53437	58434	60380	80129	54700	42935	48069	48648
Saved bits	470851	465854	463908	444159	469588	481353	476219	475640
RMS Error	3.37	3.43	3.52	4.19	3.44	2.66	3.12	3.27
Compression ratio	9.81	8.97	8.68	6.54	9.58	12.21	10.90	10.77
SNR	37.60	37.46	37.24	35.73	37.43	39.68	38.28	37.87
MSE	11.38	11.76	12.39	17.52	11.84	7.05	9.74	10.70

Table- II: Proposed methodologies based JPEG in terms images corrupted with Speckle noise of size 256X256

Corrupted images with Speckle Noise 256 x 256								
Image Number	Moon Surface	Airplane	Clock	Resolution Chart	Moon Surface	Airplane	Clock	Resolution Chart
Operation	*Fuzzy C Means*				*Alpha trimmed Mean*			
No Of Bits Required	49323	54978	60509	69268	31807	28385	34746	46210
Saved bits	474965	469310	463779	455020	492481	495903	489543	478078
RMS Error	2.36	2.03	2.23	2.89	1.56	1.86	1.86	2.49
Compression ratio	10.62	9.53	8.66	7.569	16.48	18.47	15.08	11.34
PSNR	40.77	42.00	41.21	38.94	44.28	42.76	42.78	40.22
MSE	5.49	4.13	4.95	8.37	2.44	3.47	3.46	6.22
Operation	*Fuzzy Dilation*				*Fuzzy Erosion*			
No Of Bits Required	40324	23944	35294	64656	43832	34329	38782	72333
Saved bits	489364	500344	488364	459632	480456	491079	485508	451955
RMS Error	2.61	1.31	2.35	3.43	2.71	1.97	2.43	3.9
Compression ratio	13.00	21.89	14.59	10.82	11.96	15.78	13.51	7.24
SNR	39.84	45.81	40.75	39.31	39.50	42.26	40.46	36.34
MSE	6.76	1.72	5.51	11.85	7.35	3.89	5.89	15.22

Table- III: Proposed methodologies based JPEG in terms images corrupted with Poisson noise of size 256X256.

Corrupted images with Poisson Noise 256 x 256								
Image Number	Moon Surface	Airplane	Clock	Resolution Chart	Moon Surface	Airplane	Clock	Resolution Chart
Operation	*Fuzzy C Means*				*Alpha trimmed Mean*			
No Of Bits Required	48821	49567	55593	65483	32309	27980	34650	46407
Saved bits	476267	474721	468695	458805	492249	496308	489638	477681
RMS Error	2.49	1.9	2.05	2.87	1.56	1.82	1.92	2.46
Compression ratio	10.91	10.57	9.43	8.00	16.36	18.75	15.15	11.29
PSNR	40.28	42.61	41.92	39.00	44.33	42.96	42.50	40.35
MSE	6.14	3.6	4.21	8.25	2.42	3.31	3.69	6.04
Operation	*Fuzzy Dilation*				*Fuzzy Erosion*			
No Of Bits Required	52646	71028	70700	91636	58808	44776	47672	51729
Saved bits	469642	453260	453588	435652	465480	465480	476616	472559
RMS Error	3.37	4.38	4.35	5.16	3.56	3.06	3.32	3.30
Compression ratio	9.59	7.38	7.41	5.72	8.91	11.07	10.99	10.13
SNR	37.60	35.34	35.40	33.91	37.15	38.46	37.74	37.80
MSE	11.39	19.16	18.88	26.62	12.64	9.35	11.02	10.88

Table- IV: Proposed methodologies based JPEG in terms images corrupted with Salt & Pepper noise of size 256X256.

Corrupted images with Salt & Pepper Noise 256 x 256								
Image Number	Moon Surface	Airplane	Clock	Resolution Chart	Moon Surface	Airplane	Clock	Resolution Chart
Operation	*Fuzzy C Means*				*Alpha trimmed Mean*			
No Of Bits Required	52347	51910	58464	73712	33233	32896	37968	52879
Saved bits	471941	472378	465824	450576	491055	491192	486320	471409
RMS Error	2.62	2.54	2.63	3.55	1.62	2.21	1.96	2.66
Compression ratio	10.01	10.099	8.96	7.11	15.77	16.33	13.80	8.91
PSNR	39.80	40.07	39.77	37.15	43.95	41.28	42.30	39.67
MSE	6.87	6.48	6.91	12.62	2.64	4.88	3.86	7.07
Operation	*Fuzzy Dilation*				*Fuzzy Erosion*			
No Of Bits Required	120798	60176	82911	88564	128077	182326	161017	198096
Saved bits	403490	464112	441377	436324	396211	341932	363271	326192
RMS Error	6.94	4.15	5.1	8.86	6.6	7.11	6.71	6.78
Compression ratio	4.34	8.71	6.32	7.46	4.09	2.87	3.25	2.64
SNR	31.34	35.81	34.02	35.6	31.77	31.13	31.63	31.54
MSE	48.13	17.20	25.99	16.94	43.56	50.55	45.04	45.96

Tables five to sixteen show the confusion matrices for the images of size 256 X256 by above classifiers. Overall accuracies and Kappa coefficients for all the confusion matrices are displayed.

Spectral class-Sp, Correct classification- CC, Number of samples used-Ns and Classified as group- Cg

Table- V: Confusion matrix for images corrupted with Gaussian Noise by KNN classifier

Sp	CC (%)	Ns	Cg			
			1	2	3	4
Moon Surface	99.6	100	98	0	0	2
Airplane	91.4	100	1	96	1	2
Clock	98.8	100	2	1	96	1
Resolution Chart	98.2	100	2	2	0	96
Misclassification= 2.2% Overall accuracy= 98.8% Kappa Coefficient=0.9886						

Table- VI: Confusion matrix for images corrupted with Speckle Noise by KNN classifier.

Sp	CC (%)	Ns	Cg			
			1	2	3	4
Moon Surface	99.6	100	98	0	0	2
Airplane	92.4	100	3	92	3	2
Clock	99.2	100	2	1	96	1
Resolution Chart	98.2	100	2	2	5	91
Misclassification= 2.65% Overall accuracy= 97.35% Kappa coefficient=0.9667						

Table-VII: Confusion matrix for images corrupted with Poisson Noise by KNN classifier.

Sp	CC (%)	Ns	Cg			
			1	2	3	4
Moon Surface	99.6	100	98	0	0	2
Airplane	91.4	100	1	91	5	3
Clock	98.8	100	2	1	94	3
Resolution Chart	98.2	100	2	2	5	91
Misclassification= 3.11% Overall accuracy= 96.89% Kappa coefficient=0.9763						

Table-VIII: Confusion matrix for images corrupted with Salt & pepper Noise by KNN classifier.

Sp	CC (%)	Ns	Cg			
			1	2	3	4
Moon Surface	99.4	100	97	0	1	2
Airplane	91.8	100	1	92	5	2
Clock	98.4	100	3	2	92	3
Resolution Chart	98.0	100	2	3	5	90
Misclassification= 3.07% Overall accuracy= 96.93% Kappa coefficient=0.9678						

Table- IX: Confusion matrix for images corrupted with Gaussian by Support Vector machine classifier.

Sp	CC (%)	Ns	Cg			
			1	2	3	4
Moon Surface	99.6	100	98	0	1	1
Airplane	93.2	100	1	92	4	3
Clock	98.2	100	4	1	91	4
Resolution Chart	98.0	100	2	3	5	90
Misclassification= 2.75% Overall accuracy= 97.25% Kappa coefficient=0.966						

Table- X: Confusion matrix for images corrupted with Speckle Noise by Support Vector machine classifier.

Sp	CC (%)	Ns	Cg			
			1	2	3	4
Moon Surface	99.6	100	98	0	0	2
Airplane	92.0	100	1	91	5	3
Clock	99.6	100	2	0	98	0
Resolution Chart	98.0	100	2	2	6	90
Misclassification= 2.7% Overall accuracy= 97.3% Kappa coefficient=0.9664						

Table- XI: Confusion matrix for images corrupted with Poisson Noise by Support Vector machine classifier.

Sp	CC (%)	Ns	Cg			
			1	2	3	4
Moon Surface	99.6	100	98	0	0	2
Airplane	91.4	100	1	91	5	3
Clock	98.8	100	2	1	94	3
Resolution Chart	98.2	100	2	2	5	91
Misclassification= 3% Overall accuracy= 97% Kappa coefficient=0.9686						

Table- XII: Confusion matrix for images corrupted with Salt & Pepper Noise by Support Vector machine classifier.

Sp	CC (%)	Ns	Cg			
			1	2	3	4
Moon Surface	100	100	100	0	0	0
Airplane	92.4	100	0	91	3	6
Clock	97.2	100	1	1	96	2
Resolution Chart	94.6	100	2	2	2	94
Misclassification= 3.95% Overall accuracy= 96.05% Kappa coefficient=0.9428						

Table- XIII: Confusion matrix for images corrupted with Gaussian Noise by ANN classifier.

Sp	CC (%)	Ns	Cg			
			1	2	3	4
Moon Surface	99.6	100	98	0	0	2
Airplane	91.4	100	1	90	6	3
Clock	98.8	100	2	1	94	3
Resolution Chart	98.2	100	2	2	5	491
Misclassification= 3.3% Overall accuracy= 96.7% Kappa coefficient=0.966						

Table- XIV: Confusion matrix for images corrupted with Speckle Noise by ANN classifier.

Sp	CC (%)	Ns	Cg			
			1	2	3	4
Moon Surface	99.4	100	97	0	1	2
Airplane	91.8	100	1	90	7	2
Clock	98.4	100	3	2	92	3
Resolution Chart	98.0	100	2	3	5	90
Misclassification= 3.22% Overall accuracy= 96.78% Kappa coefficient=0.968						

Table- XV: Confusion matrix for images corrupted with Poisson Noise by ANN classifier.

Sp	CC (%)	Ns	Cg			
			1	2	3	4
1. Barren land	99.6	100	98	0	0	2
2. Shrub	91.4	100	1	90	6	3
3. Water Body	98.8	100	2	1	94	3
4. Forest	98.2	100	2	2	5	491
Misclassification= 3.11% Overall accuracy= 96.89% Kappa coefficient=0.9763						

Table- XVI: Confusion matrix for images corrupted with Salt & Pepper Noise by ANN classifier.

Sp	CC (%)	Ns	Cg			
			1	2	3	4
1. Barren land	99.4	100	97	0	1	2
2. Shrub	91.8	100	1	91	6	2
3. Water Body	98.4	100	3	2	92	3
4. Forest	98.0	100	2	3	5	90
Misclassification= 3.07% Overall accuracy= 96.93% Kappa coefficient=0.9678						

V. CONCLUSION

In this work, we assessed the classification concert of an assortment of parametric and non parametric image classifiers such as Artificial Neural Networks, Support vector machine and K-Nearest Neighbors classifiers with original and compressed images. ANN Classifier performs better than the other two classifiers. From experimental examinations it is clear that classification performance of original images, Conventional compressed images and compressed images through proposed methods almost the same.

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