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Fuzzy Morphology Based JPEG compression for Image Quality Enhancement of Noisy 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.

Keywords—Compression, Morphology, PSNR, MSE, RMS

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 Mathematical morphology techniques. Section IV comprises of Fuzzy Morphology. The section V presents the experimental results. As a final point, the conclusion is obtainable in SectionVI.

II. INTENDED INNOVATIVE JPEG COMPRESSION ALGORITHMS

The planned JPEG algorithms are executed in two disparate ways.

1) The images are contaminated with Poisson, Speckle, Salt & Pepper noise and Gaussian noise prior to the segregation of the image into 8X8 blocks.
2) The image is to be convoluted with Fuzzy – Morphological operator like Dilation/ Erosion earlier than the application of normalized matrix.

This paper studies the assessment of the proposed fuzzy-morphology based approaches with the standard JPEG compression. The planned approaches exemplify improved results compared to the JPEG in terms number of bits to be transmitted. This paper makes use of MATLAB tools to access the proposed algorithms and the images are downloaded from SIPI image database.

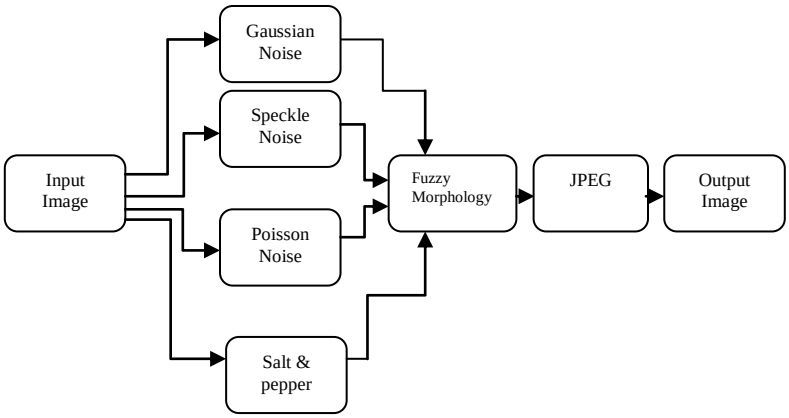

Figure 1: *Structure of Planned JPEG algorithm on images corrupted with various types of noise.*

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-Morphological Dilation 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.

Step 10: "Peak Signal to Noise Ratio and Mean Square Error" are used to compute the difference between original and compressed image.

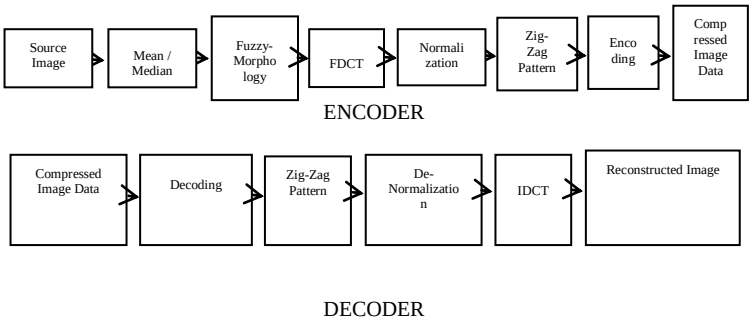

Figure 2: Architecture of Fuzzy Morphology based JPEG compression.

III. 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].

i) DILATION

The *Dilation* process is similar convolution and is performed by sliding the structuring element **B** on the image **A**

Dilation is represented as: $\mathbf{A \oplus B}$

ii) EROSION

The *Erosion* procedure is analogous to dilation.

Erosion is represented as: $\mathbf{A \Theta B}$

iii) OPENING and CLOSING

Opening and closing are the complex sequences which are the combination of basic operations, dilation and erosion. *Opening* is a procedure where erosion followed by dilation and can be used to remove all pixels in regions that are too small to. *Closing is used to fill the holes and is an operation where* dilation followed by erosion.

The Opening is represented as below: $A \circ B = (A \Theta B) \oplus B$

The Closing is represented as below: $A \bullet B = (A \oplus B) \Theta B$

Dilation and Erosion are used to filter the inner part and outer part of the image. Opening is process used to smoothen the breaks, narrowed gaps and Closing is used to merge tapered breaks and exterminate small holes.

IV. 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].

A. Fuzzy Morphology based JPEG Compression Algorithm

Step 1: Read the image.

Step 2: Apply "speckle / Poisson/ Gaussian/ Salt & Pepper Noise".

Step 3: The membership function is applied on the noisy image.

Step 4: After the application of member function the noisy images are processed with morphological dilation/ erosion [11].

Step 5: Standard Jpeg Compression.

V. RESULTS

Investigational Results and Discussion In the present section, fuzzy membership functions are used to perform the fuzzy morphology operations. Initially original image is fuzzified with the fuzzy membership function [10]. Then a structuring element of 3X3 matrix is navigated on the whole image to process "dilation, erosion, opening and closing operations". Now the image is convoluted with a constituent of 3x3 mask size. The competence of the

proposed system is evaluated with mathematical morphological operations on the same images. The results produced are shown in Tables 1-12. The results presented in this section are generated on the images corrupted with "Speckle, Gaussian, Poisson, and Salt & Pepper noises". The experimental results shows that images processed with Fuzzy Morphological operators are resulted with better PSNR compared to images processed with Mathematical operations as shown Tables 1-12. As a result the images attained with Fuzzy Morphological operations are enhanced.

In this paper the performance of Fuzzy morphology based Jpeg compression on images corrupted with dissimilar types of noises and of disparate sizes is observed. Reflection of results concludes that the newly planned compression techniques are extremely an imperative alternate since they are proved to be better in terms of image quality metrics like Peak Signal to Noise Ratio, Mean Square Error, Compression ratio, and RMS error.

The decompressed images are indistinguishable to the source image with lossless compression algorithms as they not only wipe out redundancy but also eradicate the redundancy in the image data. But in case of lossy compression the decompressed images are not similar to the original images. There are two types of criteria's to find out the difference between original and decompressed image. The image quality metrics comes under the category of objective fidelity.

A comparison was made to check the efficiency of fuzzy morphological operations and morphological operations with respect to Dilation and Erosion. A set of corrupted images were considered with speckle noise and a resolution of 256 x 256, 512 x 512. A detailed comparison is shown in table 1 and table 2. Corrupted images with poisson noise and a resolutions same as the above comparison were considered. Operations, Dilation and Erosion were chosen for the comparison shown in table 3 and table 4. Table 5 and table 6 show the comparison of Morphological and fuzzy morphological dilation and erosion operations on corrupted images with Salt and pepper noise with two different resolutions of 256 x 256 and 512 x 512.

Corrupted images with Speckle Noise 256 x 256								
Image Number	**5.1.09**	**5.1.11**	**5.1.12**	**5.1.13**	**5.1.09**	**5.1.11**	**5.1.12**	**5.1.13**
Operation	***Dilation***				***Erosion***			
No Of Bits Required	40234	23944	45218	63562	43324	43261	48347	80417
Saved bits	483964	500344	479070	460726	480964	481027	475941	443871
RMS Error	2.61	1.31	3.05	3.60	2.64	2.68	2.92	4.07
Compression ratio	13.00	21.89	11.59	8.2485	12.10	12.11	10.8443	6.519
PSNR	39.84	45.81	38.48	37.03	39.75	39.62	38.85	35.96
MSE	6.79	5.15	9.30	12.97	6.95	7.16	8.53	16.60
Operation	***Fuzzy Dilation***				***Fuzzy Erosion***			
No Of Bits Required	48118	393301	35924	63562	43832	33209	98782	72333
Saved bits	476170	484987	488364	460726	480456	491079	485506	451955
RMS Error	2.29	2.25	2.35	3.60	2.71	1.97	2.43	3.90
Compression ratio	10.89	13.34	14.59	8.2485	11.96	15.78	13.51	7.24
PSNR	38.65	41.14	40.75	37.03	39.50	42.26	40.46	36.34
MSE	8.94	5.04	5.51	12.97	7.35	3.89	5.89	15.22

Table 1 Morphology and Fuzzy Morphology based Dilation and Erosion based JPEG in terms images corrupted with speckle noise of size 256X256.

	Corrupted images with Speckle Noise 512 x 512							
Image Number	5.2.08	5.2.10	7.1.03	7.1.05	5.2.08	5.2.10	7.1.03	7.1.05
Operation	***Dilation***				***Erosion***			
No Of Bits Required	197912	257585	178699	212802	181982	227575	164221	201422
Saved bits	1899240	1839567	1918453	1884350	1915170	186977	1932931	1895730
RMS Error	3.01	3.88	2.61	3.28	2.70	3.20	2.69	2.80
Compression ratio	10.59	8.14	11.73	9.85	11.52	9.21	12.77	10.41
PSNR	44.63	42.41	45.87	43.86	45.55	44.08	45.59	45.25
MSE	9.03	15.04	6.79	10.77	7.31	10.25	7.23	7.83
Operation	***Fuzzy Dilation***				***Fuzzy Erosion***			
No Of Bits Required	48118	393301	35924	63562	43832	33209	98782	72333
Saved bits	476170	484987	488364	460726	480456	491079	485506	451955
RMS Error	2.29	2.25	2.35	3.60	2.71	1.97	2.43	3.90
Compression ratio	10.89	13.34	14.59	8.2485	11.96	15.78	13.51	7.24
PSNR	38.65	41.14	40.75	37.03	39.50	42.26	40.46	36.34
MSE	8.94	5.04	5.51	12.97	7.35	3.89	5.89	15.22

Table 2 Morphology and Fuzzy Morphology based Dilation and Erosion based JPEG in terms images corrupted with speckle noise of size 512X512.

Corrupted images with Poisson Noise 256 x 256								
Image Number	5.1.09	5.1.11	5.1.12	5.1.13	5.1.09	5.1.11	5.1.12	5.1.13
Operation	***Dilation***				***Erosion***			
No Of Bits Required	49457	47141	52730	63332	48076	51623	55453	86268
Saved bits	474831	477147	471558	461556	476212	472665	468835	437460
RMS Error	3.07	2.63	3.14	3.12	2.98	3.04	3.17	4.26
Compression ratio	10.6	11.21	9.94	9.89	10.9	10.15	9.45	6.03
PSNR	38.43	39.75	38.23	38.24	38.69	38.51	38.15	35.58
MSE	9.41	6.94	9.85	10.92	8.86	9.24	10.04	18.15
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	485506	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
PSNR	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 3 Morphology and Fuzzy Morphology based Dilation and Erosion based JPEG in terms images corrupted with poisson noise of size 256X256.

Corrupted images with Poisson Noise 512x 512								
Image Number	5.2.08	5.2.10	7.1.03	7.1.05	5.2.08	5.2.10	7.1.03	7.1.05
Operation	***Dilation***				***Erosion***			
No Of Bits Required	208279	257817	189274	214430	204935	238596	185108	214397
Saved bits	1888873	1839335	1907878	1882722	1892217	1858556	1912044	1882755
RMS Error	3.15	3.84	2.79	3.25	3.01	3.39	3.14	3.06
Compression ratio	10.069	8.19	11.08	9.78	10.23	8.78	11.32	9.78
PSNR	44.22	42.49	45.27	43.94	44.61	43.59	44.26	44.48
MSE	9.93	14.76	7.79	10.59	9.07	11.48	9.84	9.33
Operation	***Fuzzy Dilation***				***Fuzzy Erosion***			
No Of Bits Required	198574	258326	199422	219258	182114	227689	182851	209794
Saved bits	1898578	1838826	1897730	1877894	1915038	1869463	1914301	1887358
RMS Error	2.95	3.89	2.88	3.35	2.69	3.21	2.98	2.94
Compression ratio	10.56	8.11	10.51	9.56	11.51	9.21	11.46	9.99
PSNR	44.80	42.38	45.01	43.69	45.60	44.07	44.70	44.83
MSE	8.69	15.17	8.27	11.21	7.22	10.27	8.88	8.63

Table 4 Morphology and Fuzzy Morphology based Dilation and Erosion based JPEG in terms images corrupted with poisson noise of size 512X512.

Corrupted images with Salt & Pepper Noise 256x256								
Images	5.1.09	5.1.11	5.1.12	5.1.13	5.1.09	5.1.11	5.1.12	5.1.13
Operation	***Dilation***				***Erosion***			
No Of Bits Required	124806	78421	81065	43694	123002	168586	165639	198986
Saved bits	399482	445867	443233	480594	401286	355702	358649	325302
RMS Error	7.10	5.2	5.14	3.01	6.42	7.05	6.86	6.76
Compression ratio	4.2	6.68	6.46	11.99	4.62	3.09	3.16	2.63
PSNR	31.14	33.84	33.95	38.58	32.01	31.20	31.44	31.56
MSE	50.44	27.07	26.41	9.09	41.22	49.67	47.09	45.75
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	4.86	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
PSNR	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

Table 5 Morphology and Fuzzy Morphology based Dilation and Erosion based JPEG in terms images corrupted with Salt & Pepper noise of size 256X256.

Corrupted images with Salt & Pepper Noise 512X512								
Images	5.2.08	5.2.10	7.1.03	7.1.05	5.2.08	5.2.10	7.1.03	7.1.05
Operation	***Dilation***				***Erosion***			
No Of Bits Required	512950	523482	487720	543943	494922	445398	516181	434962
Saved bits	1584202	1573670	1609432	1553209	1602230	1651754	1580971	1662190
RMS Error	7.05	7.03	7.00	7.30	6.35	5.90	6.65	5.99
Compression ratio	4.08	4.00	4.29	3.85	4.23	4.70	4.06	4.82
PSNR	37.22	37.25	37.29	36.91	38.13	38.77	37.73	38.64
MSE	49.67	49.41	48.94	53.35	40.32	34.81	44.20	35.82
Operation	***Fuzzy Dilation***				***Fuzzy Erosion***			
No Of Bits Required	519758	518797	446377	560254	499986	444220	550530	415640
Saved bits	1577384	1578355	1650775	1536898	1597166	1652932	1546622	1681512
RMS Error	7.09	7.01	6.62	7.39	6.37	5.86	6.74	5.77
Compression ratio	4.03	4.04	4.69	3.74	4.19	4.72	3.80	5.04
PSNR	37.17	37.27	37.77	36.81	38.10	38.83	37.61	38.96
MSE	50.28	49.15	43.80	54.62	40.60	34.32	45.40	33.34

Table 6 Morphology and Fuzzy Morphology based Dilation and Erosion based JPEG in terms images corrupted with poisson noise of size 512X512.

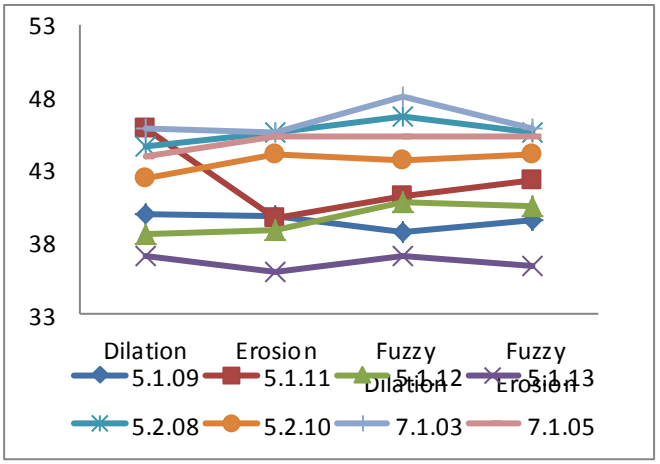

Figure 3: Comparison between Proposed and Morphology based JPEG in terms PSNR on images corrupted with "Speckle noise".

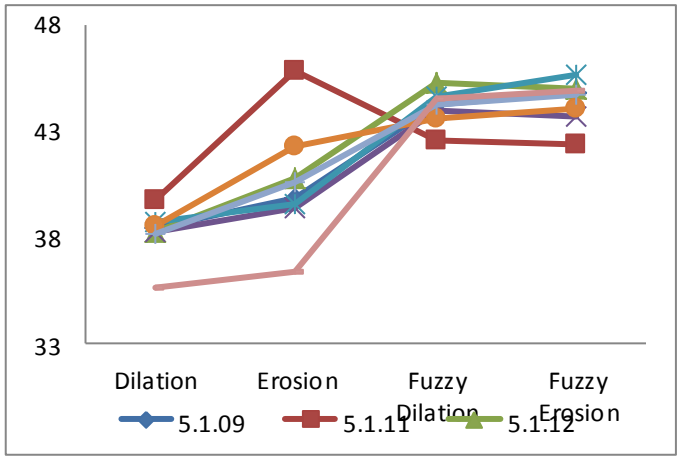

Figure 4: Comparison between Proposed and Morphology based JPEG in terms PSNR on images corrupted with "Poisson noise".

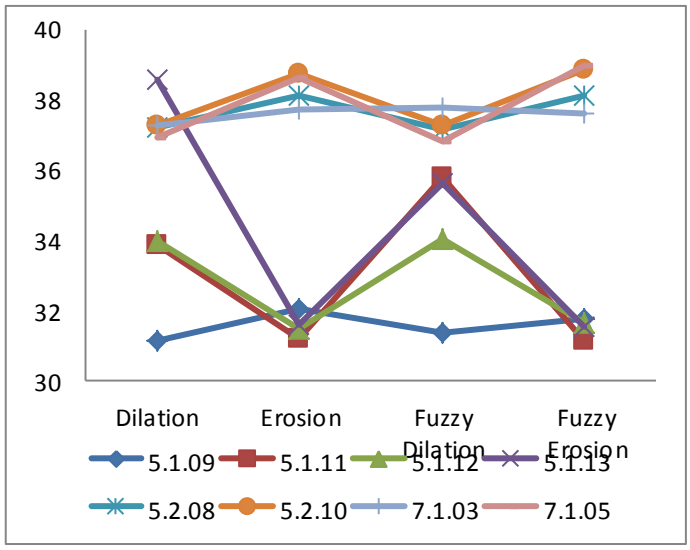

Figure 5: Comparison between Proposed and Morphology based JPEG in terms PSNR on images corrupted with "Salt & Pepper" noise.

VI. CONCLUSION

In this paper Fuzzy morphology based JPEG compression algorithm is projected, and this algorithm is assessed with Mathematical Morphological operator based jpeg algorithm on images corrupted with Gaussian, Speckle, Poisson and Salt & Pepper noise. The efficiency of the proposed approach is compared in terms of PSNR, RMS error, MSE and Compression ratio. The Proposed approach eliminates Speckle and Poisson noise effectively than Salt & Pepper noise. The PSNR value of proposed approach is more for the images corrupted with Speckle and Poisson is more as result MSE value is less. The more value of PSNR results high quality image.

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