An Analysis of Quality of Image compression with Disturbances

Dr.T.Rammohan
Professor,
Department of Electrical and Electronics Engineering
Karpagam college of Engineering
Coimbatore ,Tamil Nadu, India

Dr.E.Kaliappan
Professor,
Department of Electrical and Electronics Engineering
Easwari Engineering College
Chennai, Tamil Nadu, India

Abstract— **In technological development, in applications like storage of images in a data base, picture archiving and communication, television,** multimedia, internet, satellite imaging and remote sensing **etc., uses Image compression. Real time image may consist of noise. Sometimes an image need to be compressed with noise. It has been proved that Transform technique may be used for compression effectively. The performance and quality of image compression with Dc shift, Gaussian blur and Gaussian noise were analyzed. For compression purpose wavelet, Curvelet and non-subsampled contourlet transforms are used. For encoding SPHIT,MSPHIT and Hybrid MSPIHT are used . With three transforms and three encoding techniques, the performance of image compression with noise is analyzed. In this paper three image compression techniques namely curvelet transform, wavelet based contourlet transform, and non-subsampled contourlet transform have been used and the evaluation of these techniques is done by comparing the nonlinear approximation experiments in each technique with SPHIT,MSPHIT and Hybrid MSPIHT encoding techniques. The performance analysis of each transform was done using MATLAB.**

Keywords—

I. INTRODUCTION

The storage and processing of digital information has become popular, due the increased technological advancement in the field of multimedia. Images need to be processed with noise. It is very challenging to deal with the large amount of data. There are so many image processing and compression techniques. Three compression techniques with transform are chosen for analysis. [1].

The image compression plays an important role in the terms of storage in internal and external devices and in transmission of images. In a medical field, image compression plays an important position in hospitals as a move towards filmless imaging and totally digital. The image compression is done in various fields like storage of images in a data base, picture archiving and communication, television, multimedia, internet, satellite imaging and remote sensing and in many other applications.[2-3].

This paper mainly focuses on comparison of performance analysis of image compression based on different transformation techniques and encoding techniques with various noise levels. Section II explains how the transformation techniques are used in combination with various disturbances and section III discusses about the image quality matrices and section IV discusses about the experimental result analysis of the work and section V focuses on the conclusion and future improvement of the work.

II. TRANSFORMATION TECHNIQUES

Image data compression may be done with
1. Pixel Coding
2. Predictive Coding .
3.Transform Coding
As it is found advantages in Transform based compression , Transforms were used. a mathematical tool that takes a function and maps it into another function. It has many advantages. The transform of a function gives more information in other domain and easier to solve expressions and takes less space to store. In image based transform, a discrete set of unitary matrices used for representing images called basis images.

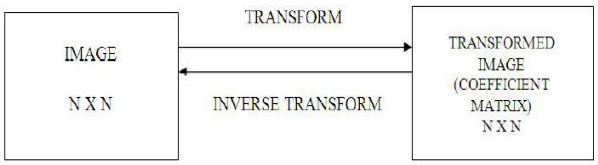

Fig. 1. Simulation results of PROTEUS

The transforms used for image compression techniques are

1. Curvelet transform
2. Wavelet-based contourlet transform
3. Non-subsampled contourlet transform.

In the first proposed approach, the curvelet transform is used for transformation. The image is analyzed with DC shift, Gaussian blur and Gaussian noise. Set Partitioning in Hierarchical Trees (SPIHT), Modified Set Partitioning in Hierarchical Trees (MSPIHT) [15-16] and Hybrid coding of MSPIHT with Huffman entropy encoder are used to compress the image. To reconstruct the compressed image, the operations are reversed.[8-10]

The second work focuses on presenting a non-linear image compression technique that compresses image both radically and angularly. Wavelet-based Contourlet Transformation (WBCT) has been used with DC shift, Gaussian blur and Gaussian noise. Set Partitioning in Hierarchical Trees (SPIHT), Modified Set Partitioning in Hierarchical Trees (MSPIHT) [15-16] and Hybrid coding of MSPIHT with Huffman entropy encoder are used to compress the image. [4-7]

In third work, a Non-sub sampled Contourlet Transformation (NSCT) is used with proposed. In addition to this transformation it is used with DC shift, Gaussian blur and Gaussian noise. Set Partitioning in Hierarchical Trees (SPIHT), Modified Set Partitioning in Hierarchical Trees (MSPIHT) [15-16] and Hybrid coding of MSPIHT with Huffman entropy encoder are used to compress the image. [11-14]

III. IMAGE QUALITY METRICES

In order to evaluate the performance of the process, the objective image quality metrics like compression ratio, Peak Signal to Noise Ratio (PSNR), Root Mean Squared Error (RMSE), correlation, Var analysis, absolute mean error, Entropy, Normalized absolute error, structural content, Normalized crossed correlation, Maximum difference and average difference are used for the evaluation of this approach.[18-19]

The above image quality metrics plays a vital role in performance analysis of the image compression.

IV. EXPERIMENTATION AND RESULT ANALYSIS

In this section, the experimental results were discussed and a analyzed. MATLAB is used for the evaluation of these approaches. The evaluation results compares the all the performance metrics which has been given in the previous section. The Standard image of Lena has been taken for experimentation.

Fig. 2. Standard Image of Lena

The standard original image of Lena is subjected to various levels of DC shift and Gaussian blur and Gaussian noise.

Fig. 3. Lena - DC shift (10,15,20,25,30)

Thus from the above figures it is observed that an increase in DC shift of the images led to the decrease in the brightness of the image. Similarly the change in the clarity of image with introduction of different level of Gaussian blur are shown in the following figures.

Fig. 4. Lena – Gaussian Blur

Fig. 5. Lena – Gaussian Noise

Hence the performance analysis of standard Lena image was compared with different image quality matrices with the addition of different DC levels and Gaussian blur and Gaussian noise with respect to each transform technique.So with addition to these non linearities like DC shift of various levels from 10 to 30 with intervals of 10 and Gaussian blur of 3 ,5,7,,11 and with the addition of Gaussian noise from 10 to 50 in the interval of 10 This section clearly evaluates the performance of the proposed approaches of the present research work. The experiments are carried out using MATLAB. The performance metrics used for evaluating the approaches are Peak Signal to Noise Ratio, Root Mean Square Error, Compression Ratio, Correlation and other performance characteristics with respect to each transform techniques which include SPHIT, MSPHIT, and hybrid MSPHIT encoding individually.

TABLE I.PERFORMANCE ANALYSIS OF LENA IMAGE USING WAVELET TRANSFORM (SPHIT ENCODING)

							GAUSSIAN BLIR					GAUSSIAN NOISE				
PARAMETERS	**Original Image**	**DC SHIFT 10**	**DC SHIFT 15**	**DC SHIFT 20**	**DC SHIFT 25**	**DC SHIFT 30**	**BLUR 3**	**BLUR 5**	**BLUR 7**	**BLUR 9**	**BLUR 11**	**10**	**20**	**30**	**40**	**50**
Compression Ratio	15.8091	15.789	15.8777	15.7195	15.7283	15.8898	11.8804	-0.6535	-5.9739	-7.1966	-8.5431	18.4929	18.4658	18.511	17.7684	18.0781
PSNR	66.7209	68.5549	62.9643	69.6081	70.0336	62.3491	65.1274	59.6867	63.2304	62.3716	62.2037	65.5839	46.637	52.6641	52.2211	50.5987
RMSE	0.0138	0.0091	0.0329	0.0071	0.0065	0.0379	0.02	0.0699	0.0309	0.0377	0.0391	0.018	1.4105	0.3521	0.3899	0.5665
Correlation	0.9894	0.9893	0.9893	0.9893	0.9893	0.9893	0.9908	0.9927	0.9932	0.9932	0.9932	0.959	0.959	0.9586	0.9587	0.9588
Var analysis	2682.5	2682.7	2683.2	2682.9	2682.7	2682.8	2489.4	2335.2	2190.5	2056.5	1937.9	2981.2	2962.9	2965.9	2955.6	2964
Mean absolute error	7.5216	7.5289	7.5292	7.5294	7.5314	7.5273	6.8031	6.036	5.7031	5.5302	5.3921	18.3264	18.2618	18.3819	18.3403	18.3365
ENTROPY	0.1538	0.1442	0.1437	0.1424	0.1424	0.1422	0.1431	0.1424	0.1419	0.1419	0.1419	0.1986	0.1952	0.2002	0.1948	0.198

Normalized Absolute Error	0.0777	0.0705	0.0673	0.0644	0.0618	0.0593	0.0709	0.0632	0.0599	0.0583	0.0571	0.1877	0.1874	0.1882	0.1883	0.1876
Structural Content	0.9997	0.9997	0.9998	0.9998	0.9998	0.9999	0.9997	1	0.9999	1	1	0.9946	0.9901	0.9933	0.9933	0.9927
Normalized Cross Correlation	0.9907	0.992	0.9926	0.9931	0.9936	0.9939	0.9923	0.994	0.9948	0.9948	0.9951	0.9647	0.9692	0.9656	0.9656	0.9665
Maximum Difference	88.0134	88.0134	88.0134	88.0134	88.0134	88.0134	78.0134	54.0134	46.0134	46.0134	48.0134	101.0134	86.0134	86.0134	88.0134	90.0134
Average Difference	0.0054	0.0035	0.0128	0.0028	0.0025	0.0148	0.0078	0.0273	0.0121	0.0147	0.0153	0.007	-0.551	-0.1375	-0.1523	-0.2213

TABLE II.PERFORMANCE ANALYSIS OF LENA IMAGE USING WAVELET TRANSFORM (MSPHIT ENCODING)

		DC SHIFT					GAUSSIAN BLIR				GAUSSIAN NOISE					
PARAMETERS	Original Image	DC SHIFT 10	DC SHIFT 15	DC SHIFT 20	DC SHIFT 25	DC SHIFT 30	BLUR 3	BLUR 5	BLUR 7	BLUR 9	BLUR 11	10	20	30	40	50
Compression Ratio	20.8042	20.6383	20.6294	20.5781	20.5337	20.7285	17.4852	16.9494	17.0413	17.8462	16.4248	20.411	20.2878	19.9851	20.2009	20.1983
PSNR	66.1192	59.2112	75.3843	62.913	59.1123	79.6167	59.5788	59.5481	62.4626	61.1101	62.1052	51.0349	50.4966	50.4937	50.6116	50.6815
RMSE	0.0159	0.078	0.0019	0.0332	0.0798	0.00071025	0.0716	0.0722	0.0369	0.0504	0.04	0.5124	0.58	0.5804	0.5648	0.5558
Correlation	0.9976	0.9976	0.9976	0.9975	0.9975	0.9976	0.9994	0.9996	0.9997	0.9997	0.9998	0.986	0.9859	0.9859	0.9861	0.986
Var analysis	2759.1	2758.5	2760.1	2758.3	2758.5	2759.8	2554.9	2384.9	2232.8	2097.9	1977.2	3275.2	3255.7	3266.4	3253.4	3258
Mean absolute error	3.5172	3.5262	3.5273	3.525	3.5268	3.5251	1.7742	1.3469	1.1785	1.0862	1.0067	10.7127	10.7096	10.7408	10.6008	10.6736
ENTROPY	0.1665	0.1461	0.1435	0.1426	0.1422	0.1419	0.1426	0.1419	0.1419	0.1419	0.1419	0.3381	0.34	0.3361	0.3395	0.3398
Normalized Absolute Error	0.0363	0.033	0.0315	0.0302	0.0289	0.0278	0.0185	0.0141	0.0124	0.0115	0.0107	0.1097	0.1099	0.11	0.1088	0.1092
Structural Content	0.9989	0.9993	0.9991	0.9993	0.9995	0.9993	0.9999	1	1	1	0.9999	0.9899	0.9894	0.9892	0.9896	0.9897
Normalized Cross Correlation	0.9989	0.9988	0.9992	0.999	0.999	0.9993	0.9996	0.9997	0.9998	0.9998	0.9999	0.9957	0.9961	0.9963	0.9961	0.9959
Maximum Difference	45.0134	44.0134	45.0134	45.0134	44.0134	45.0134	18.0134	12.0134	9.0134	8.0134	8.0134	60.0134	74.0134	63.0134	55.0134	62.0134
Average Difference	-0.0062	0.0305	0.00073521	0.013	0.0312	0.00027744	0.028	0.0282	0.0144	0.0197	0.0156	-0.2001	-0.2266	-0.2267	-0.2206	-0.2171

TABLE III.PERFORMANCE ANALYSIS OF LENA IMAGE USING WAVELET TRANSFORM (HYBRID MSPHIT ENCODING)

		DC SHIFT					GAUSSIAN BLIR				GAUSSIAN NOISE					
PARAMETERS	Original Image	DC SHIFT 10	DC SHIFT 15	DC SHIFT 20	DC SHIFT 25	DC SHIFT 30	BLUR 3	BLUR 5	BLUR 7	BLUR 9	BLUR 11	10	20	30	40	50
Compression Ratio	30.6527	30.6117	30.6206	30.6056	30.6144	30.6629	26.7281	25.8343	25.7192	26.5128	24.9127	31.8762	31.7238	31.7314	31.7039	31.5672
PSNR	76.5526	62.2081	63.8425	61.1067	61.4498	63.122	61.7646	59.2483	59.0615	59.091	60.581	50.9086	50.9273	50.9506	50.3069	50.3925
RMSE	0.0014	0.0391	0.0268	0.0504	0.0466	0.0317	0.0433	0.0773	0.0807	0.0802	0.0569	0.5275	0.5252	0.5224	0.6059	0.5941
Correlation	0.997	0.997	0.997	0.997	0.997	0.997	0.9993	0.9995	0.9996	0.9997	0.9997	0.9807	0.9805	0.9804	0.9807	0.9806
Var analysis	2755.9	2754.5	2756.9	2754.9	2754.5	2756.5	2554.8	2384.7	2232.3	2097.2	1976	3234.5	3212.3	3220.7	3213.8	3215.6
Mean absolute error	3.8468	3.8531	3.8574	3.8585	3.8531	3.8546	2.0242	1.5469	1.3487	1.2632	1.1673	12.556	12.5756	12.6344	12.4852	12.5661
ENTROPY	0.1675	0.1464	0.1437	0.1426	0.1419	0.1419	0.1433	0.1419	0.1419	0.1419	0.1419	0.3279	0.3276	0.3219	0.3273	0.3255
Normalized Absolute Error	0.0397	0.0361	0.0345	0.033	0.0316	0.0304	0.0211	0.0162	0.0142	0.0133	0.0124	0.1286	0.129	0.1294	0.1282	0.1285
Structural Content	0.9988	0.9992	0.9991	0.9993	0.9994	0.9993	0.9995	0.9999	1.0001	1.0001	1	0.989	0.9888	0.9887	0.9885	0.9888
Normalized Cross Correlation	0.9985	0.9985	0.9988	0.9987	0.9987	0.999	0.9999	0.9997	0.9996	0.9996	0.9997	0.9912	0.9912	0.9912	0.9918	0.9914
Maximum Difference	49.0134	50.0134	49.0134	49.0134	50.0134	49.0134	17.0134	12.0134	9.0134	9.0134	8.0134	66.0134	69.0134	69.0134	80.0134	74.0134
Average Difference	-0.00056179	0.0153	0.0105	0.0197	0.0182	0.0124	-0.0169	0.0302	0.0315	0.0313	0.0222	-0.2061	-0.2052	-0.2041	-0.2367	-0.2321A

TABLE IV.PERFORMANCE ANALYSIS OF LENA IMAGE USING CURVELET TRANSFORM (SPHIT ENCODING)

							GAUSSIAN BLIR				GAUSSIAN NOISE					
PARAMETERS	Original Image	DC SHIFT 10	DC SHIFT 15	DC SHIFT 20	DC SHIFT 25	DC SHIFT 30	BLUR 3	BLUR 5	BLUR 7	BLUR 9	BLUR 11	10	20	30	40	50
Compression Ratio	12.3993	12.3404	12.3404	12.3504	12.3504	12.3715	10.0045	9.2464	9.6368	10.1026	9.4617	11.6801	11.6159	11.5782	11.4363	11.6393
PSNR	65.4173	62.7331	62.5369	62.4811	62.3897	62.1649	61.7514	61.6817	63.8173	60.632	57.8023	50.8597	50.6029	50.7944	50.6269	50.978
RMSE	0.0187	0.0347	0.0363	0.0367	0.0375	0.0395	0.0434	0.0441	0.027	0.0562	0.1079	0.5335	0.566	0.5416	0.5628	0.5191
Correlation	0.9979	0.9979	0.9979	0.9979	0.9979	0.9979	0.9995	0.9997	0.9998	0.9998	0.9998	0.9894	0.9894	0.9894	0.9895	0.9894
Var analysis	2759	2759.6	2759.7	2759.7	2759.6	2759.5	2556.2	2385.1	2232.8	2098.6	1975.8	3294.3	3272.8	3281.6	3271.4	3277.3

Mean absolute error	3.2879	3.2941	3.2947	3.2949	3.2947	3.2937	1.6084	1.212	1.0558	0.9681	0.8935	9.3162	9.2953	9.3248	9.2275	9.3046
ENTROPY	0.1609	0.145	0.1428	0.1422	0.1419	0.1419	0.1426	0.1419	0.1419	0.1419	0.1419	0.3435	0.3402	0.3418	0.345	0.3387
Normalized Absolute Error	0.0339	0.0308	0.0295	0.0282	0.027	0.026	0.0168	0.0127	0.0111	0.0102	0.0095	0.0954	0.0954	0.0955	0.0947	0.0952
Structural Content	0.9992	0.9993	0.9994	0.9994	0.9995	0.9995	0.9998	0.9999	1	1	1.0003	0.9909	0.9908	0.9908	0.9908	0.9909
Normalized Cross Correlation	0.9989	0.999	0.9991	0.9991	0.9992	0.9992	0.9998	0.9999	0.9998	0.9998	0.9996	0.9981	0.9983	0.9983	0.9984	0.9982
Maximum Difference	41.0134	41.0134	41.0134	41.0134	41.0134	41.0134	11.0134	10.0134	7.0134	7.0134	7.0134	49.0134	52.0134	59.0134	50.0134	54.0134
Average Difference	0.0073	0.0135	0.0142	0.0143	0.0147	0.0154	0.017	0.0172	0.0105	0.022	0.0421	-0.2084	-0.2211	-0.2115	-0.2199	-0.2028

TABLE V.PERFORMANCE ANALYSIS OF LENA IMAGE USING CURVELET TRANSFORM (MSPHIT ENCODING)

		DC SHIFT					GAUSSIAN BLIR				GAUSSIAN NOISE					
PARAMETERS	Original Image	DC SHIFT 10	DC SHIFT 15	DC SHIFT 20	DC SHIFT 25	DC SHIFT 30	BLUR 3	BLUR 5	BLUR 7	BLUR 9	BLUR 11	10	20	30	40	50
Compression Ratio	24.9668	24.867	24.8936	24.8958	24.7983	24.8582	20.9641	20.2725	20.1698	20.6838	19.4011	25.1104	25.0694	24.8025	24.9559	25.0108
PSNR	76.8752	60.1526	58.3729	59.8625	59.5083	60.8964	65.9071	71.2726	57.8608	58.6221	61.0036	50.3689	50.3988	50.5638	50.1423	50.8795
RMSE	0.0013	0.0628	0.0946	0.0671	0.0728	0.0529	0.0167	0.0049	0.1064	0.0893	0.0516	0.5973	0.5932	0.5711	0.6293	0.531
Correlation	0.9974	0.9973	0.9973	0.9973	0.9973	0.9973	0.9994	0.9996	0.9997	0.9997	0.9997	0.9838	0.9836	0.9836	0.9839	0.9837
Var analysis	2756.2	2758.5	2758.8	2758.3	2758.3	2757.7	2554.7	2384.6	2233.4	2097.4	1977	3261	3239.7	3250.5	3237.8	3243.3
Mean absolute error	3.6366	3.649	3.6513	3.6546	3.6539	3.6501	1.8594	1.4159	1.2376	1.1481	1.0614	11.5022	11.5156	11.5628	11.4293	11.5128
ENTROPY	0.1673	0.1457	0.1435	0.1428	0.1422	0.1419	0.1431	0.1419	0.1419	0.1419	0.1419	0.3331	0.3361	0.333	0.3348	0.3371
Normalized Absolute Error	0.0375	0.0342	0.0326	0.0313	0.03	0.0288	0.0194	0.0148	0.013	0.0121	0.0112	0.1178	0.1181	0.1184	0.1173	0.1178
Structural Content	0.999	0.9992	0.9993	0.9993	0.9994	0.9994	0.9997	0.9997	1.0001	1.0002	1	0.9891	0.9889	0.9887	0.9889	0.9892
Normalized Cross Correlation	0.9986	0.9988	0.9988	0.9989	0.9989	0.999	0.9997	0.9999	0.9996	0.9996	0.9999	0.9943	0.9943	0.9945	0.9945	0.9941
Maximum Difference	53.0134	51.0134	51.0134	51.0134	52.0134	52.0134	15.0134	11.0134	10.0134	8.0134	8.0134	67.0134	61.0134	72.0134	62.0134	63.0134
Average Difference	0.00052158	0.0245	0.0369	0.0262	0.0284	0.0207	0.0065	0.0019	0.0416	0.0349	0.0202	-0.2333	-0.2317	-0.2231	-0.2458	-0.2074

TABLE VI.PERFORMANCE ANALYSIS OF LENA IMAGE USING CURVELET TRANSFORM (HYBRID MSPHIT ENCODING)

		DC SHIFT					GAUSSIAN BLIR				GAUSSIAN NOISE					
PARAMETERS	Original Image	DC SHIFT 10	DC SHIFT 15	DC SHIFT 20	DC SHIFT 25	DC SHIFT 30	BLUR 3	BLUR 5	BLUR 7	BLUR 9	BLUR 11	10	20	30	40	50
Compression Ratio	33.7614	33.7677	33.8121	33.8239	33.7796	33.7796	29.4793	28.2397	28.0616	28.6325	27.2827	35.7319	35.6883	35.5205	35.5722	35.5567
PSNR	60.8932	61.3609	59.7675	59.2221	64.0297	64.0297	64.5953	61.1202	58.1271	59.3281	59.5013	50.9283	50.7632	50.8642	51.0919	50.9131
RMSE	0.0529	0.0475	0.0686	0.0778	0.0257	0.0257	0.0226	0.0502	0.1001	0.0759	0.0729	0.5251	0.5455	0.5329	0.5057	0.5269
Correlation	0.9968	0.9968	0.9968	0.9968	0.9968	0.9968	0.9992	0.9995	0.9996	0.9996	0.9997	0.9788	0.9786	0.9785	0.9789	0.9787
Var analysis	2752.1	2755	2753.9	2755.6	2755.1	2755.1	2554	2383.6	2233.1	2097.7	1975.8	3216	3193.9	3204.6	3195.6	3198
Mean absolute error	3.9673	3.9743	3.9791	3.9769	3.9745	3.9745	2.1241	1.6209	1.424	1.3245	1.2415	13.1459	13.1567	13.2404	13.0769	13.1498
ENTROPY	0.1683	0.1463	0.1439	0.1424	0.1419	0.1419	0.1428	0.1419	0.1419	0.1419	0.1419	0.3207	0.3174	0.3131	0.3229	0.3151
Normalized Absolute Error	0.041	0.0372	0.0356	0.034	0.0326	0.0326	0.0221	0.017	0.015	0.014	0.0131	0.1346	0.135	0.1356	0.1343	0.1345
Structural Content	0.9992	0.9988	0.9993	0.9992	0.9992	0.9992	0.9995	0.9999	1.0001	1.0001	1.0001	0.989	0.9888	0.9885	0.9888	0.9889
Normalized Cross Correlation	0.998	0.9987	0.9984	0.9986	0.9988	0.9988	0.9997	0.9997	0.9996	0.9996	0.9997	0.9893	0.9893	0.9895	0.9896	0.9894
Maximum Difference	58.0134	58.0134	58.0134	59.0134	58.0134	58.0134	18.0134	13.0134	12.0134	9.0134	8.0134	80.0134	73.0134	73.0134	78.0134	72.0134
Average Difference	0.0207	-0.0186	0.0268	0.0304	0.01	0.01	-0.0088	0.0196	0.0391	0.0297	0.0285	-0.2051	-0.2131	-0.2082	-0.1975	-0.2058

TABLE VII.PERFORMANCE ANALYSIS OF LENA IMAGE USING NON SUBSAMPLED COUNTERLET TRANSFORM (SPHIT ENCODING)

							GAUSSIAN BLIR				GAUSSIAN NOISE				
PARAMETERS	**Original Image**	**DC SHIFT 10**	**DC SHIFT 15**	**DC SHIFT 20**	**DC SHIFT 25**	**DC SHIFT 30**	**BLUR 3**	**BLUR 5**	**BLUR 7**	**BLUR 9**	**10**	**20**	**30**	**40**	**50**
Compression Ratio	16.8276	16.8174	16.7287	16.7568	16.7568	16.776	14.0291	13.2369	13.7085	14.2564	16.2936	16.0418	15.9459	16.003	16.0403
PSNR	63.0688	59.4551	68.2719	61.4717	61.1202	61.3538	59.7257	62.0186	65.1905	64.816	50.6553	50.4152	51.0772	50.4509	50.4776
RMSE	0.0321	0.0737	0.0097	0.0463	0.0502	0.0476	0.0693	0.0409	0.0197	0.0215	0.5592	0.591	0.5074	0.5861	0.5825
Correlation	0.9977	0.9977	0.9977	0.9977	0.9977	0.9977	0.9995	0.9997	0.9997	0.9998	0.9877	0.9876	0.9877	0.9878	0.9877
Var analysis	2759.5	2759.3	2759.6	2759.7	2759.7	2758.9	2555.6	2383.8	2233.7	2098.7	3285.5	3266.2	3275.3	3263.9	3270.4
Mean absolute error	3.4081	3.4186	3.4158	3.418	3.4176	3.4143	1.6904	1.2803	1.1146	1.0263	10.0528	10.031	10.045	9.9438	10.0255
ENTROPY	0.1643	0.1448	0.1433	0.1424	0.1424	0.1422	0.1428	0.1419	0.1419	0.1419	0.3442	0.3416	0.3371	0.3428	0.3398
Normalized Absolute Error	0.0352	0.032	0.0305	0.0293	0.028	0.1422	0.0176	0.0134	0.0117	0.0108	0.1029	0.1029	0.1029	0.1021	0.1025
Structural Content	0.9991	0.9994		0.9994	0.9994	0.0269	0.9999	0.9997	0.9997	0.9999	0.9902	0.9899	0.99	0.99	0.9899
Normalized Cross Correlation	0.9988	0.9989	0.9992	0.9991	0.9991	0.9993	0.9996	1.0000	1.0001	0.9999	0.9971	0.9974	0.9973	0.9974	0.9974
Maximum Difference	43.0134	42.0134	43.0134	42.0134	42.0134	0.9994	14.0134	10.0134	8.0134	8.0134	50.0134	68.0134	70.0134	49.0134	59.0134
Average Difference	0.0125	0.0288	-0.0038	0.0181	0.0196	43.0134	0.0271	-0.016	-0.0077	0.0084	-0.2184	-0.2308	-0.1982	-0.229	-0.2276

TABLE VIII.PERFORMANCE ANALYSIS OF LENA IMAGE USING NON SUBSAMPLED COUNTERLET TRANSFORM (MSPHIT ENCODING)

		DC SHIFT					GAUSSIAN BLIR				GAUSSIAN NOISE					
PARAMETERS	**Original Image**	**DC SHIFT 10**	**DC SHIFT 15**	**DC SHIFT 20**	**DC SHIFT 25**	**DC SHIFT 30**	**BLUR 3**	**BLUR 5**	**BLUR 7**	**BLUR 9**	**BLUR 11**	**10**	**20**	**30**	**40**	**50**
Compression Ratio	20.8042	20.6383	20.6294	20.5781	20.5337	20.7285	17.4852	16.9494	17.0413	17.8462	16.4248	20.411	20.2878	19.9851	20.2009	20.1983
PSNR	66.1192	59.2112	75.3843	62.913	59.1123	79.6167	59.5788	59.5481	62.4626	61.1101	62.1052	51.0349	50.4966	50.4937	50.6116	50.6815
RMSE	0.0159	0.078	0.0019	0.0332	0.0798	0.00071025	0.0716	0.0722	0.0369	0.0504	0.04	0.5124	0.58	0.5804	0.5648	0.5558
Correlation	0.9976	0.9976	0.9976	0.9975	0.9975	0.9976	0.9994	0.9996	0.9997	0.9997	0.9998	0.986	0.9859	0.9859	0.9861	0.986
Var analysis	2759.1	2758.5	2760.1	2758.3	2758.5	2759.8	2554.9	2384.9	2232.8	2097.9	1977.2	3275.2	3255.7	3266.4	3253.4	3258
Mean absolute error	3.5172	3.5262	3.5273	3.525	3.5268	3.5251	1.7742	1.3469	1.1785	1.0862	1.0067	10.7127	10.7096	10.7408	10.6008	10.6736
ENTROPY	0.1665	0.1461	0.1435	0.1426	0.1422	0.1419	0.1426	0.1419	0.1419	0.1419	0.1419	0.3381	0.34	0.3361	0.3395	0.3398
Normalized Absolute Error	0.0363	0.033	0.0315	0.0302	0.0289	0.0278	0.0185	0.0141	0.0124	0.0115	0.0107	0.1097	0.1099	0.11	0.1088	0.1092
Structural Content	0.9989	0.9993	0.9991	0.9993	0.9995	0.9993	0.9999	1	1	1	0.9999	0.9899	0.9894	0.9892	0.9896	0.9897
Normalized Cross Correlation	0.9989	0.9988	0.9992	0.999	0.999	0.9993	0.9996	0.9997	0.9998	0.9998	0.9999	0.9957	0.9961	0.9963	0.9961	0.9959
Maximum Difference	45.0134	44.0134	45.0134	45.0134	44.0134	45.0134	18.0134	12.0134	9.0134	8.0134	8.0134	60.0134	74.0134	63.0134	55.0134	62.0134
Average Difference	-0.0062	0.0305	0.00073521	0.013	0.0312	0.00027744	0.028	0.0282	0.0144	0.0197	0.0156	-0.2001	-0.2266	-0.2267	-0.2206	-0.2171

TABLE IX.PERFORMANCE ANALYSIS OF LENA IMAGE USING NON SUBSAMPLED COUNTERLET TRANSFORM (HYBRID MSPHIT ENCODING)

		DC SHIFT					GAUSSIAN BLIR				GAUSSIAN NOISE					
PARAMETERS	**Original Image**	**DC SHIFT 10**	**DC SHIFT 15**	**DC SHIFT 20**	**DC SHIFT 25**	**DC SHIFT 30**	**BLUR 3**	**BLUR 5**	**BLUR 7**	**BLUR 9**	**BLUR 11**	**10**	**20**	**30**	**40**	**50**
Compression Ratio	35.329	35.328		35.2336	35.2691	35.2091	30.8663	29.4911	29.4608	30.2564	28.7158	37.4272	37.4008	37.2097	37.3965	37.5122
PSNR	61.0632	60.7899	59.9778	59.4138	64.699	66.2055	66.4519	61.0765	58.1102	59.4436	59.6673	51.2282	50.9806	50.9503	51.2109	51.1368
RMSE	0.0509	0.0542	0.0654	0.0744	0.022	0.0156	0.0147	0.0507	0.1005	0.0739	0.0702	0.4901	0.5188	0.5225	0.492	0.5005
Correlation	0.9967	0.9967	0.9967	0.9967	0.9967	0.9967	0.9992	0.9995	0.9996	0.9996	0.9996	0.9779	0.9777	0.9776	0.9779	0.9778
Var analysis	2751.1	2754.1	2753	2754.6	2754.2	2753.8	2553.9	2384	2233.5	2097.5	1976	3207.5	3185	3194.6	3185.5	3187.3
Mean absolute error	4.0204	4.0277	4.0339	4.0341	4.0283	4.0329	2.1571	1.6494	1.4486	1.3557	1.2708	13.4229	13.4369	13.5092	13.3507	13.4066
ENTROPY	0.1679	0.1457	0.1437	0.1428	0.1424	0.1419	0.1437	0.1419	0.1419	0.1419	0.1419	0.3129	0.3117	0.3125	0.3218	0.3122
Normalized Absolute Error	0.0415	0.0377	0.0361	0.0345	0.0331	0.0318	0.0225	0.0173	0.0152	0.0143	0.0135	0.1374	0.1379	0.1383	0.1371	0.1371
Structural Content	0.9992	0.9988	0.9993	0.9992	0.9992	0.9992	0.9996	0.9999	1.0001	1.0001	1.0001	0.9891	0.9889	0.9886	0.9889	0.9892

Normalized Cross Correlation	**0.9979**	**0.9987**	**0.9984**	**0.9985**	**0.9987**	**0.9989**	**0.9997**	**0.9997**	**0.9996**	**0.9996**	**0.9997**	**0.9883**	**0.9883**	**0.9885**	**0.9885**	**0.9882**
Maximum Difference	**58.0134**	**57.0134**	**58.0134**	**59.0134**	**57.0134**	**58.0134**	**18.0134**	**12.0134**	**12.0134**	**11.0134**	**9.0134**	**77.0134**	**76.0134**	**68.0134**	**76.0134**	**78.0134**
Average Difference	**0.0199**	**-0.0212**	**0.0255**	**0.0291**	**0.0086**	**-0.0061**	**-0.0057**	**0.0198**	**0.0392**	**0.0289**	**0.0274**	**-0.1914**	**-0.2027**	**-0.2041**	**-0.1922**	**-0.1955**

The approaches taken for comparison are wavelet transform, wavelet based contourlet transform, curvelet transform and non-subsampled contourlet with SPIHT, MSPIHT and hybrid MSPIHT with Huffmancoding. It is observed from the above experimental results that the proposed Nonsubsampled contourlet based approach provides better performance when compared with the other curvelet, Contourlet and wavelet approach. The PSNR values of nonsubsampled contourlet transformation provide higher values than other transformations. Moreover, considering the encoding approaches, nonsubsampled contourlet with Hybrid SPIHT and Huffman encoding provides good results. The RMSE value of the nonsubsampled contourlet transform with hybrid coding approach gives less error when compared with other transforms. The Correlation is high with nonsubsampled contourlet with SPIHT and with MSPIHT and Hybrid coding it is decreasing slightly, but this will not affect the quality of the image. This section clearly discussed about the performance evaluation of all the proposed approaches. It is observed from the experimental results that the proposed nonsubsampled contourlet transform approach gives better results compared to the other approaches and the hybrid encoding approaches gives good results except in correlation comparatively.

V. CONCLUSION

The present research work focuses on image compression with noisy images which uses an efficient transformation approach to examine the non-stationary phenomena. Three transformation approaches are used in this research work namely Curvelet Transform, Wavelet based Curvelet Transform and Non subsample contourlet Transform. . The performance and quality of image compression with Dc shift, Gaussian blur and Gaussian noise were analyzed SPHIT, MSPHIT, and hybrid MSPHIT encoding individually.

REFERENCES

[1] Ragab, A. S., Abdalla SA Mohamed, and M. S. Hamid. "Efficiency of analytical transforms for image compression." Radio Science Conference, 1998. NRSC'98. Proceedings of the Fifteenth National. IEEE, 1998.

[2] Meyer, François G., Amir Z. Averbuch, and Ronald R. Coifman. "Multilayered image representation: Application to image compression." IEEE Transactions on Image Processing 11.9 (2002): 1072-1080.

[3] Said, Amir, and William A. Pearlman. "An image multiresolution representation for lossless and lossy compression." IEEE Transactions on image processing 5.9 (1996): 1303-1310.

[4] Averbuch, Amir, Danny Lazar, and Moshe Israeli. "Image compression using wavelet transform and multiresolution decomposition." IEEE Transactions on Image Processing 5.1 (1996): 4-15.

[5] Wang, Jung-Hua, and Ker-Jiang Gou. "Image compression using wavelet transform and self-development neural network." Systems, Man, and Cybernetics, 1998. 1998 IEEE International Conference on. Vol. 4. IEEE, 1998

[6] Khieovongphachanh, V., Hamamoto, K. and Kondo, S., 2008, October. Study on image quality for medical ultrasonic echo image compression by wavelet transform. In Communications and Information Technologies, 2008. ISCIT 2008. International Symposium on (pp. 160-165). IEEE

[7] R Arokia, Priya. "Image Compression Using Redundant and Non-Redundant Wavelet Transform." (2011).

[8] Wen-juan, Yao, and Ye Zhi-ming. "Analytical solution of bending-compression column using different tension-compression modulus." Applied Mathematics and Mechanics 25.9 (2004): 983-993.

[9] Mansoor, Awais, and Atif Bin Mansoor. "On image compression using digital curvelet transform." In 9th International Multitopic Conference, IEEE INMIC 2005, pp. 1-4. IEEE, 2005

[10] Li, Yuancheng, Qiu Yang, and Runhai Jiao. "Image compression scheme based on curvelet transform and support vector machine." *Expert Systems with Applications* 37, no. 4 (2010): 3063-3069.

[11] Do, Minh N., and Martin Vetterli. "The contourlet transform: an efficient directional multiresolution image representation." IEEE Transactions on image processing 14.12 (2005): 2091-2106.

[12] Da Cunha, Arthur L., Jianping Zhou, and Minh N. Do. "The nonsubsampled contourlet transform: theory, design, and applications." IEEE transactions on image processing 15.10 (2006): 3089-3101.

[13] Xu, Liang, Junping Du, and Qingping Li. "Image fusion based on nonsubsampled contourlet transform and saliency-motivated pulse coupled neural networks." Mathematical Problems in Engineering 2013 (2013).

[14] Tang, Xiaoli, Sungdae Cho, and William A. Pearlman. "3D set partitioning coding methods in hyperspectral image compression." In Image Processing, 2003. ICIP 2003. Proceedings. 2003 International Conference on, vol. 2, pp. II-239. IEEE, 2003

[15] Cagnazzo, Marco, Giovanni Poggi, Luisa Verdoliva, and Andrea Zinicola. "Region-oriented compression of multispectral images by shape-adaptive wavelet transform and SPIHT." In *Image Processing, 2004. ICIP'04. 2004 International Conference on*, vol. 4, pp. 2459-2462. IEEE, 2004.

[16] Ragupathy, U. S., D. Baskar, and A. Tamilarasi. "New method of image compression using multiwavelets and set partitioning algorithm." In *Industrial and Information Systems, 2008. ICIIS 2008. IEEE Region 10 and the Third international Conference on*, pp. 1-6. IEEE, 2008.

[17] Reddy, K.S.N., Reddy, B.R.S., Rajasekhar, G. and Rao, K.C., 2012. A fast curvelet transform image compression algorithm using with modified SPIHT. International Journal of Computer Science and Telecommunications, 3(2), pp.1-8.

[18] Zhu, Dandan, and Qiang Tong. "A new image watermarking algorithm using CT and normalization." In Systems, Man, and Cybernetics (SMC), 2012 IEEE International Conference on, pp. 3239-3244. IEEE, 2012.

[19] Hanling, Zhang, Geng Guangzhi, and Xiong Caiqiong. "Image steganography using pixel-value differencing." In Electronic Commerce and Security, 2009. ISECS'09. Second International Symposium on, vol. 2, pp. 109-112. IEEE, 2009.