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Image Fusion of Digital Colored Images using Enhanced E Laplacian Pyramid and DWT Techniques

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***Abstract*--- Image Fusion is the technique of merging several images from multi-modal sources with respective complementary information to form a new image, which carries all the common as well as complementary features of individual images. In Laplacian pyramid algorithm Implement pixel level selection approach so that the fused image can be constructed pixel by pixel level considering the features of two images at a time. In the Laplacian pyramid algorithm the input images are decomposed into four parts and then wavelet transformation is performed by predictive coding technique. Finally decomposed parts of images are combined pixel by pixel using E Laplacian pyramid technique. Finally to fuse the images inverse wavelet transformation is applied. Performance of the system is evaluated on various parameters like Mean, Standard Deviation(SD), Entropy, Covariance, Correlation Coefficient(CC), Structural Similarity Index for Measuring Image Quality(SSIM), Mutual Information(MI), Peak Signal to noise ratio(PSNR), Mean Square error(MSE).**

Keywords*— *Image Fusion, DWT, E-Laplacian Pyramid, Image processing.

I. INTRODUCTION

Image Fusion is the strategy of consolidating a few pictures from multi-modular sources with particular correlative data to frame another picture, which conveys all the basic and in addition integral components of individual pictures. With the late quick improvements in the space of imaging advancements, multisensory frameworks have turned into a reality in wide fields, for example, remote detecting, restorative imaging, machine vision and the military applications [1]. Picture combination gives a powerful strategy to empower examination and investigation of Multi-sensor information having reciprocal data about the concerned area. Picture combination makes new pictures that are more reasonable for the motivations behind human/machine discernment, and for further picture handling errands, for example, division, object location or target acknowledgment in applications, for example, remote detecting and therapeutic imaging.

The alignment of multi-sensor images is also one of the most important preprocessing steps in image fusion. The arrangement of multi-sensor pictures is likewise a standout amongst the most vital preprocessing ventures in picture combination.

Similar to different types of data combination, picture combination is typically performed at one of the three diverse handling levels: sign, component and choice. Signal level picture combination, otherwise called pixel-level picture combination, speaks to combination at the most minimal level, where various crude info picture signs are joined to deliver a solitary intertwined picture signal [9]. Object level picture combination, likewise called highlight level picture combination, wires highlight and question marks and property descriptor data that have as of now been removed from individual information pictures. At long last, the most abnormal amount, choice or image level picture combination speaks to combination of probabilistic choice data acquired by nearby chiefs working on the consequences of highlight level preparing on picture information created from individual sensors [4][8].

The paper is Presented as follows. The Section II defines the Image fusion system. The Image fusion Techniques described in Section III and Section IV presents the Methodology and Section V presents the Results and Discussion. The conclusion of the paper is presented in Section VI.

II. IMAGE FUSION SYSTEM

A. Single Sensor Image Fusion System

This sensor captures the real world as a sequence of images. The sequence of images are then fused together to generate a new image with optimum information content. For instance in enlightenment variation and loud environment, a human administrator will be unable to identify objects of his advantage which can be highlighted in the resultant combined picture.

The conditions under which the framework can work, the dynamic extent, determination, and so forth are all confined by the competency of the sensor. for example, the advanced camera is proper for a brilliantly enlightened environment and sunlight scenes however is not reasonable for ineffectively lit up circumstances found amid night, or under antagonistic conditions, for example, in mist or rain.

B. Multi-Sensor Image Fusion System

A Multi-sensor picture combination plan beats the constraints of a solitary sensor picture combination by blending the pictures from a few sensors to frame a composite picture [7].

An infrared camera is going with the advanced camera and their individual pictures are converged to get an intertwined picture. This methodology defeats the issues alluded to some time recently. The advanced camera is reasonable for sunlight scenes; the infrared camera is proper in ineffectively lit up situations.

III. IMAGE FUSION TECHNIQUES

The most essential dispute concerning image fusion is to decide how to merge the sensor images. In recent years, a number of image fusion methods have been projected.

A. Pyramid Transform

The pyramid transform solves this purpose in the transformed domain. The essential thought is to play out a multi determination decay on every source picture, then incorporate every one of these disintegrations to build up a composite portrayal lastly reproduce the melded picture by playing out a backwards multi-determination change. Various pyramid decay strategies have been produced for picture combination, for example, Laplacian Pyramid [1], Ratio-of-low-pass Pyramid, and Gradient Pyramid.

B. Principal Component Analysis

PCA is a helpful factual procedure that has discovered application in fields, for example, face acknowledgment and picture pressure, and is a typical system for discovering designs in information of high measurement. It is a scientific apparatus from connected straight polynomial math. It is a basic non-parametric technique for extricating important data from confounding information sets [2][5].

C. Discrete Wavelet Transform

The genuine Discrete Wavelet Transform (DWT) has the property of good pressure of sign vitality. Impeccable recreation is conceivable utilizing short bolster channels. The one of a kind element of DWT is the nonappearance of repetition and low calculation [1][2].The Discrete Wavelet Transform essentially experiences the different issues, for example, motions, associating, shift fluctuation and absence of directionality.

D. Discrete Cosine Transform

A Discrete Cosine Transform (DCT) is a vital change in picture handling. It is constantly used to express an arrangement of limited information focuses regarding a whole of cosine capacities swaying at various frequencies. Extensive DCT coefficients are packed in the low recurrence district; henceforth, it is known not magnificent vitality conservativeness properties [5][10].

IV. METHODOLOGY

A System is developed to fuse both gray scale and colored images using Enhanced Laplacian pyramid and Discrete wavelet transformation Approach. The algorithm decomposes the input image using 2D Wavelet Transformation. After decomposition E Laplacian pyramid approach is performed on pixel level to merge these two images. The final step performs the Inverse Wavelet Transformation to fuse the images.

The system works in following steps:

1. Image Preprocessing: In First step, input images are divided into different levels based on their frequency using DWT.

2. Pyramid Extraction and Construction: The next step is to extract various pyramids like LL, LH, HL and HH.

3. Image Formation: Final image using Inverse DWT is formed.

4. Performance Evaluation: The last step is to evaluate the performance of the proposed system on various parameters like Mean, Standard Deviation(SD), Entropy, Covariance, Correlation Coefficient(CC), Structural Similarity Index for Measuring Image Quality(SSIM), Mutual Information(MI), Peak Signal to noise ratio(PSNR), Mean Square error(MSE). The flow chart representation of the system is shown in fig 1.

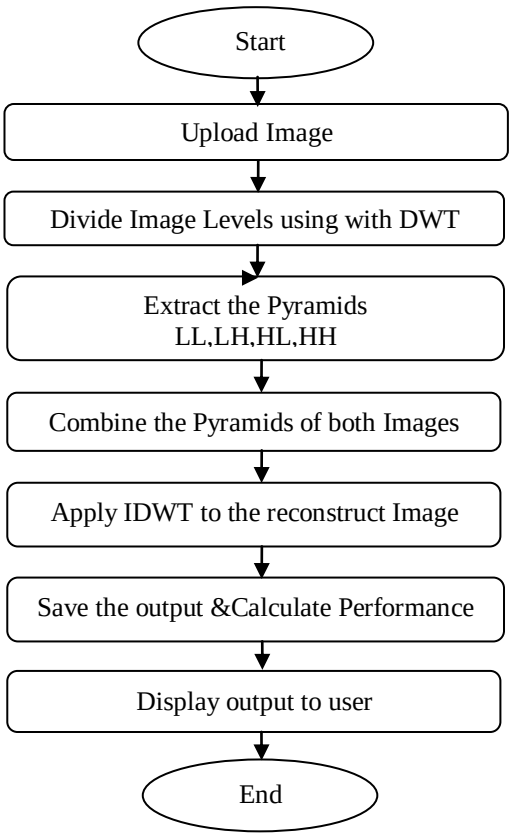


Fig.1: Flow Chart Representation of the System

V. RESULTS AND DISCUSSION

The performance of the system is evaluated on Gray Scale and Colored images using E Laplacian Pyramid and DWT Technique. Evaluation the performance of the system based on various parameters which are MSE, PSNR, Mean, SD, Entropy, Covariance, CC, SSIM, MI. Comparison of Existing[1] and Proposed method is also made based on

above parameters. Proposed system generated better results as compare to Existing System[1].

Table I: Results Obtained by the System on Colored Images

Image no.	Image Size	Total Pixels	Test Images	Resultant Image	Image Format
1.	356×267	95052			JPEG
2.	356×267	95052			
3.	356×267	95052			
4.	356×268	95408			
5.	356×180	64080			
6.	356×356	126736			

The above table I shows the results obtained by the system on the colored images. The results are evaluate on JPEG colored images.

Table II: Performance Evaluation of System on Different Parameters on Colored Images

Image no.	Mean	SD	Entropy	Covariance	CC	SSIM	MI	PSNR	MSE
1.	60.1269	72.7878	7.6610	2.5536	1	3.0644	0.48588	70.7509	0.2348
2.	60.1269	78.8627	7.5740	2.5246	1	3.0296	1.01144	73.257	0.1506
3.	60.1269	72.7806	7.7119	2.5706	1	3.0847	1.05667	73.3433	0.1483
4.	60.1269	67.4218	7.6126	2.5375	1	3.0450	0.80473	70.9432	0.2269
5.	60.1269	95.6402	7.7754	2.5918	1	3.1101	6.96362	94.4613	0.0035
6.	60.1269	84.6271	7.5549	2.5183	1	3.0219	4.33225	87.3587	0.0123

The above table II shows the Performance of the system on different parameters which are Mean, SD, Entropy, Covariance, CC, SSIM, MI, PSNR, MSE. The average Value of Mean is 60.126, SD is 78.6867, Entropy is 7.6483, Covariance is 2.5494, CC is 1, SSIM is 3.0593, MI is 2.4424, PSNR is 78.3524, MSE is 0.1294. Table II shows the overall performance of the proposed system on colored images. The values obtained by the proposed system better than the existing system.

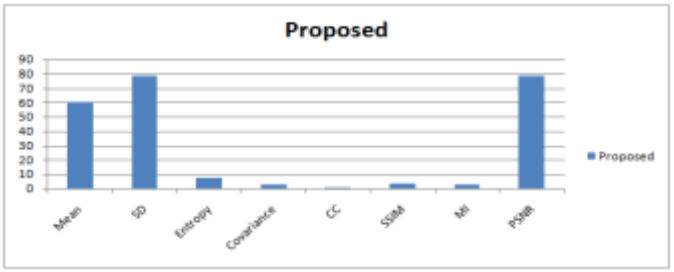


Fig.2: Quality Measures of Colored Images on the basis of different Parameters.

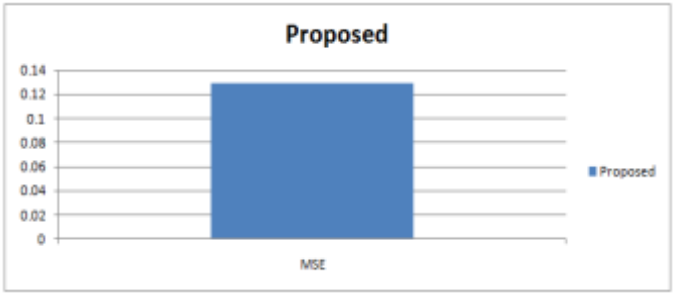
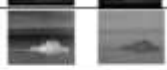
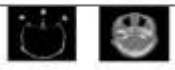
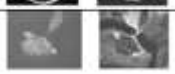


Fig.3: Quality Measures of Colored Images on the basis of MSE Parameter.

Above Fig.2&3 shows the system on the basis of various parameters which are Mean, SD, Entropy, Covariance, CC, SSIM, MI, PSNR, MSE. Table III shows the Test images and their Resultant image after fusion on gray scale images.

Table III: Results Obtained by the System on Gray Scale Images

Image no.	Image Size	Total Pixels	Test images	Resultant Image	Image Format
1.	356×267	95052			BMP
2.	356×267	95052			
3.	356×267	95052			
4.	356×267	95052			
5.	300×256	91136			

The above table III shows the results obtained by the system on the gray scale images. The results are evaluate on BMP gray scale images.

Table IV: Performance Evaluation of System on Different Parameters on Gray Scale Images

Image no.	Mean	SD	Entropy	Covariance	CC	SSIM	MI	PSNR	MSE
1.	42.5393	59.0641	7.3151	2.4384	1	2.9260	4.1182	89.8969	0.0079
2.	42.5393	22.397	6.0818	2.0272	1	2.4327	1.8567	74.8074	0.0044
3.	42.5393	51.7071	4.3435	1.4478	1	1.7374	0.5411	71.2307	0.0025
4.	42.5393	57.5892	6.2520	2.0840	1	2.5008	1.5115	71.3114	0.2125
5.	42.5393	35.5935	6.4821	2.1607	1	2.5928	0.9812	78.3227	0.0614

The above table IV shows the performance of the system on different parameters which are Mean, SD, Entropy, Covariance, CC, SSIM, MI, PSNR, MSE. The avg. Value of Mean is 42.5393, SD is 45.2701, Entropy is 6.0949, Covariance is 2.0316, CC is 1, SSIM is 2.4379, MI is 1.8017, PSNR is 77.1143, MSE is 0.1223. Table IV shows the overall performance of the system on gray scale images. The values

obtained by the proposed system better than the existing system.

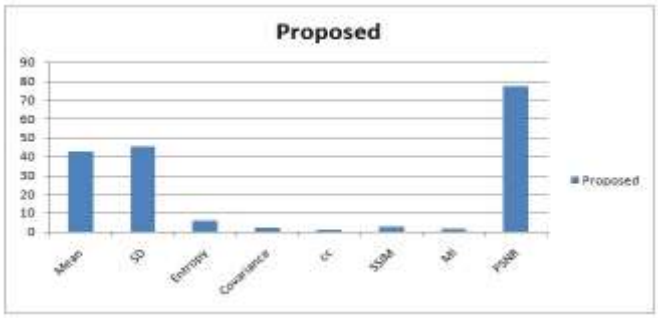


Fig.4: Quality Measures of Gray Scale Images on the basis of different Parameters.

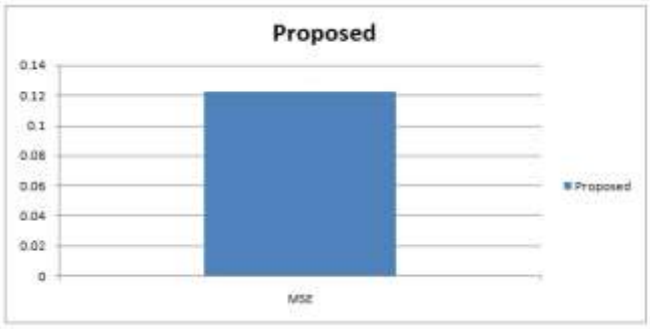


Fig. 5: Quality Measures of Gray Scale Images on the basis of MSE Parameter.

Above Fig.4&5 shows the system on the basis of various parameters which are Mean, SD, Entropy, Covariance, CC, SSIM, MI, PSNR, MSE.

Table V: Comparison Table of Existing System[1] and Proposed System on Different Parameters on Colored Images

Parameters	Existing[1]	Proposed
PSNR	36.334	90.91
MSE	0.1662	0.0079
MI	2.4691	5.6480
SD	63.578	90.133

Above table V shows Comparison of Existing System[1] and Proposed System on different parameters on colored images. The value of PSNR of existing system is 36.3347 and that of proposed system is 90.91 which shows the improvement of the result. The value of MSE of existing system is 0.1662 and that of proposed system is 0.0079 which shows the improvement of the result. The value of MI of existing system is 2.469 and that of proposed system is 5.648 which shows the improvement of the result. The value of SD of existing system is 63.578 and that of proposed system is 90.133 which shows the improvement of the result.

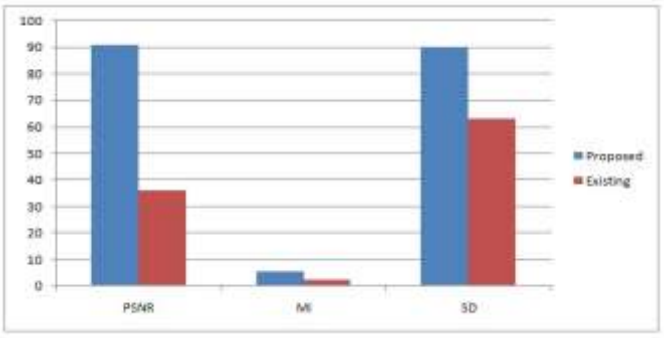


Fig.6: Comparison of Existing[1] and Proposed System on Colored images on the basis of PSNR,MI and SD.

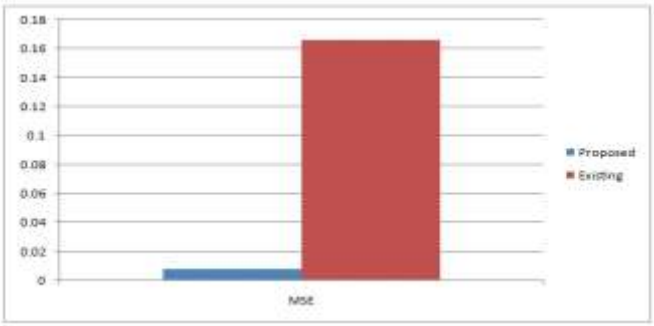


Fig.7: Comparison of Existing[1] and Proposed System on Colored images on the basis of MSE.

Above Fig.6&7 shows the Comparison of Existing[1] and Proposed system on Colored Images on the basis of PSNR, MI, SD and MSE.

Table VI: Comparison Table of Existing System[1] and Proposed System on Different Parameters on Gray Scale Images

Parameters	Existing[1]	Proposed
PSNR	62.250	77.114
MSE	0.0643	0.0577
Entropy	7.1365	6.0249
SSIM	0.9861	2.4379
MI	1.0219	1.8017
SD	19.8603	45.270

Above table VI shows comparison of Existing System[1] and Proposed System on different parameters on gray scale images. The value of PSNR of existing system is 62.250 and that of proposed system is 77.11 which shows the improvement of the result. The value of MSE of existing system is 0.064 and that of proposed system is 0.057 which shows the improvement of the result. The value of Entropy of existing system is 7.136 and that of proposed system is 6.094 which shows the improvement of the result. The value of SSIM of existing system is 0.986 and that of proposed system is 2.43 which shows the improvement of the result. The value

of MI of existing system is 1.021 and that of proposed system is 1.801 which shows the improvement of the result.

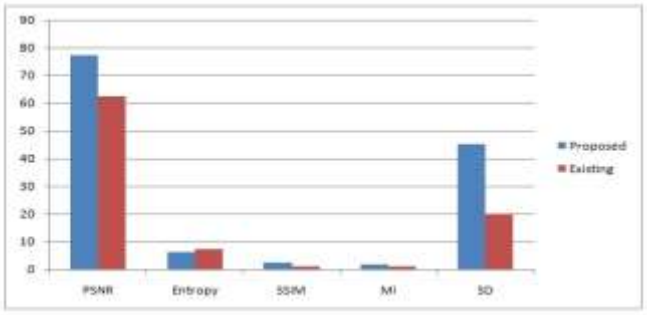


Fig.8: Comparison of Existing[1] and Proposed System on Gray Scale images on the basis of PSNR, Entropy, SSIM, MI and SD.

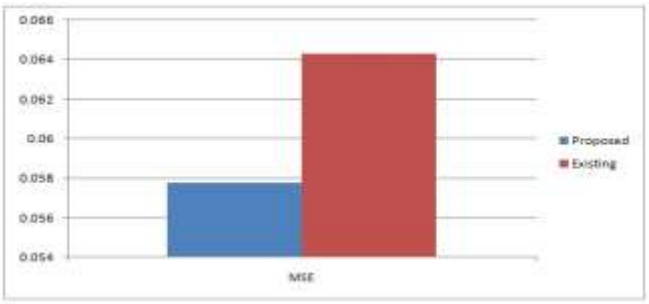


Fig.9: Comparison of Existing[1] and Proposed System on Gray Scale images on the basis of MSE.

Above Fig. 8&9 shows the Comparison of Existing[1] and Proposed system on Gray Scale Images on the basis of PSNR, Entropy, SSIM, MI, SD and MSE.

VI. CONCLUSION

The system is developed to fuse the images of type Gray scale and colored Images. The proposed system is use the E-Laplacian pyramid technique to fuse the gray scale and colored images. The system is evaluated on standard data set as well as real world images collected from various sources. Experimental results shows that the results of the proposed system are better than that of existing system[1] in terms of Mean, SD, Entropy, Covariance, CC, SSIM, MI, PSNR, MSE. In future, system can be extended to fuse more than two images simultaneously using E-Laplacian pyramid technique. Also values of PSNR, MSE, SSIM, MI, CC, Covariance, Mean, SD, Entropy can be improved in future. The system can also be tested on real medical images which can be collected from various hospitals and CT & MRI scan centers.

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