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A Hybrid Approach for Multiview Image Fusion Using DWT, PCA and Neural Network

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Abstract: Image Fusion is the process in which core information from a set of component images is merged to form a single image, which is more informative and complete than the component input images in quality and appearance. This research presents a fast and effective image fusion method for creating high quality fused images by merging component images. In the proposed method, the input image is broken down to a two-scale image representation with a base layer having large scale variations in intensity, and a detail layer containing small scale details. Here fusion of the base and detail layers is implemented by means of a Local Edge preserving filtering based technique. The proposed method is an efficient image fusion technique in which the noise component is very low and quality of the resultant image is high so that it can be used for applications like medical image processing, requiring very accurate edge preserved images. Performance is tested by calculating PSNR, entropy, MSE and SSIM of images. The benefit of the proposed method is that it removes noise without altering the underlying structures of the image. Experimental results showed that the when PSNR value is calculated, the noise ratio is found to be very low for the resultant image portion. All the simulations have been carried out in MATLAB simulator tool.

Keywords: Image fusion, DWT, PCA, BPNN, PSNR, Entropy, MSE and SSIM

I. INTRODUCTION

Image Fusion is a mechanism to get better the quality of information from a group of images. Applications of image fusion include medical imaging, remote sensing, microscopic imaging, computer vision, and robotics. Image fusion algorithm is divided into various levels namely: low, middle, high, feature and decision level. Image fusion is the process that combines information from multiple images of the same scene. These images may be captured from different sensors, acquired at various times, or having different spatial and spectral characteristics.

Figure 1.1: Image focused on left

Figure 1.2: Image focused on right

Figure 1.3: Focused image

Image fusion is an image processing process in which we combined two pieces of the original image to get a single image and try to keep the original image features. Figure 1.1, 1.2 and 1.3 gives the basic idea about image fusion. It is clearly shown in above figure that the figure 1.3 is obtained by combining two pieces of original images shown in figure 1.1 and figure 1.2.

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1.1 Methods of Image Fusion

There are many methods available for image Fusion. Basic methods are described below:

i. Pixel level method
This method works in the spatial or in the transformation domain. This fusion method works directly on the pixels obtained from the imaging sensor outputs.

ii. Feature level fusion
This method works on the features extracted from the original images. But this method requires all the images being getting by the same sensor, so that the output image produces similar physical properties of the scene. In this algorithm all the images get segmented into similar areas, and by using their properties it will fuse the images.

iii. Decision level fusion
In this method, fusion is performed on the output of the detected image. Another algorithm based on wavelet and PCA are also used.
In image fusion technique digital image can be improved without spoiling it. The improvement techniques are of two types [3]:

a) *Spatial domain*

b) *Frequency domain*

a) In Spatial domain method, we will deal directly with the pixels of image. The desired image is obtained by changing the value of pixels [4]. The spatial domain consist different fusion methods like averaging, the Brovey method, PCA (Principle component analysis) and HIS based methods.

b) In frequency domain method, firstly, the image is converted into frequency domain. For this conversion, Fourier transform is applied on the image [5]. Different enhancement techniques are applied on the Fourier transform image in order to change the brightness, contrast or the distribution of the image. After these operations the inverse Fourier transform is applied to get back the original image.

An Image fusion is the development of amalgamating two or more image of common characteristic to form a single image which acquires all the essential features of original image [6]. Nowadays, lot of work is done on the field of image fusion and is also used in various applications such as medical imaging and multi spectra sensor image fusing etc [7]. The concept of multi-focus image fusion is used to combine multiple images with different objects in focus to obtain all the objects in focus and for better information in a scene. But the challenge is to how evaluate the information of the input images with better quality of image [8]. For fusing the image, various techniques have been proposed by different authors such as wavelet transform, IHS and PCA based methods etc [9]. In the proposed work, neural network has been used for classification, for extracting features PCA technique has been used. DWT method is also used for decomposition of the fused image [10].

II. LITERATURE REVIEW

Li et al. (2013) presented the region based multifocused image fusion by using the spatial frequency in spatial domain. Region based multi-focus image fusion method using local spatial frequency first segments the average image of source images to get the region map and then calculates local spatial frequency for each pixel in source images from a local window. After this, regional spatial frequency is calculated for each region. Then a fused image is constructed from the selected regions according to the RSF calculated.
Metwalli and Murugan (2013) described the combination of the (Principal Component Analysis) PCA and High performance for tan (HPF) to produce sharpened image with larger spatial resolution and low spectral distortion. The empirical result shows the procedures retain the spectral characteristics of multispectral image and improve the spatial resolution.
Phamila and amutha (2013) presented a multifocused image scheme, based on higher highly valued alternating coefficients (AC) worked out throughout Discrete cosine change (DCT). This method was used to provide security and reduce high risk atmosphere including battlefields.
Rani and Lin (2013) represented the study of discrete wavelet and Discrete Multi-wavelet. For multi resolution fusion, the technique used was Discrete Wavelet Transform. Multiwavelet has many advantages over the scalar wavelet, multi-wavelets are extension over the scalar wavelet. Multi-wavelet can provide more absolute image. Multi-wavelet can also provide fine edges and boundary details.
James and Dasarathy (2014) represented the lower similarities was lead to pixel based Laplacian fusion algorithm and for higher approximations. The primary result described the medical image fusion research based on imaging modalities, and imaging of organs. It was concluded that even there exists several open ended technological, and

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scientific challenges, the fusion of medical images proved to be useful for advancing the clinical reliability of using medical imaging for medical diagnostics, and analysis. In future equipment's can develop that may perform multi-modal scanning to reduce the risk of exposing the patients to additional radiation, longer examination time, and increased cost of the device.

Joshitha et al. (2014) discussed the PCA based image fusion which improves the resolution of the images. In this first decomposes the image into the sub images and then perform the information fusion and finally the resultant image is formed from sub images. Palm-print recognition is done by using PCA.

Jasmeet and Rajdavinder (2014) discussed different image fusion techniques. Image fusion is the process of incorporating the details through different images of a single scene into single image which is more appropriate for human visualization and additional image processing. Image fusion techniques based on discrete cosine transform (DCT) domain are fit to provide valuable information in fused image and is time conserving in real time systems for still images or videos.

Krishn et al. (2014) discussed image fusion techniques based on 2level Discrete Wavelet Transform and Principal Component Analysis (PCA). PCA was applied on the decomposed coefficients of dwt to maximize the spatial resolution. Experimental results showed that the fused image is more refined in spectral and spatial information representation, as well as details of tumor in soft tissues and showed improvement in restoration of information and quality features.

Parvatikar and Phadke (2014) discussed image fusion techniques such as averaging method, discrete wavelet transform, brovey method, intensity hue saturation, and principal component analysis. This paper concluded that spatial domain techniques provided high spatial resolution. But these methods had blur problem in fused image. Problem of blurry fused image can be removed in future.

Pavithra and Lin (2015) presented a method of wavelet transform using image fusion via combine gradient and smoothness criteria. The result of this method compared with widely used wavelet transform. The result shows that this method produces better fusion.

Gadicha and Alyi (2015) proposed a password generator method which will restrict the Intruders to crack the password or a scheme should exist which will cause sufficient delay in cracking of a password so that the Generator of the password will change the previous password. Authors proposed a strong password generator scheme by using Image Fusion & Visual key Cryptography. The strength of proposed system lies in a sufficiently large collection of images to avoid short repeating cycles. Compared to other methods reviewed, our system may require human-interaction and careful selection of images.

Singh and Mehra (2016) investigated that transforming the RGB values of a three-channel composite to Intensity Hue Saturation values. Each wavelet also has a unique image decompression and reconstruction characteristics that lead to different fusion results, however if a wavelet transform and a traditional transform such as PCA transform are integrated for a better fusion result may be achieved.

III. METHODOLOGY

In this research, PCA (Principal component analysis) has been used for the extraction of features and NN (Neural network) has been used for the classification [11].

3.1 Steps followed

The aim of proposed technique is to combine useful information present in natural images. Image local features are extracted and combined with neural network to compute weights for each pixel. The following steps are used for the research work.

Step 1: Upload two images taken from different viewpoints of the same scene as an input.

Step II: Apply Pre-processing on both images.

Step III: Apply 2 level discrete wavelet transform for decomposing both images to get approximation details (LL), horizontal Details (HL), vertical details (LH), and diagonal details (HH).

Step IV: Apply principal component analysis on approximation details (LL) of decomposed images for feature extraction.

Step V: Initialize the Neural Network to detect the good pixels and bad pixels. If a pixel is good then it will merge the pixel of both input images. But if a pixel is bad then it will replace the pixel.

Step VI: Combine changed values of good pixels and bad pixels for the final fused image.

Step VII: Display final fused image.

3.2 Work Flow of Proposed Work

To achieve desired objectives various steps must be followed. Figure 2 represents those various steps that must be followed for evaluation of proposed work. The flow chart of the proposed work is described below:

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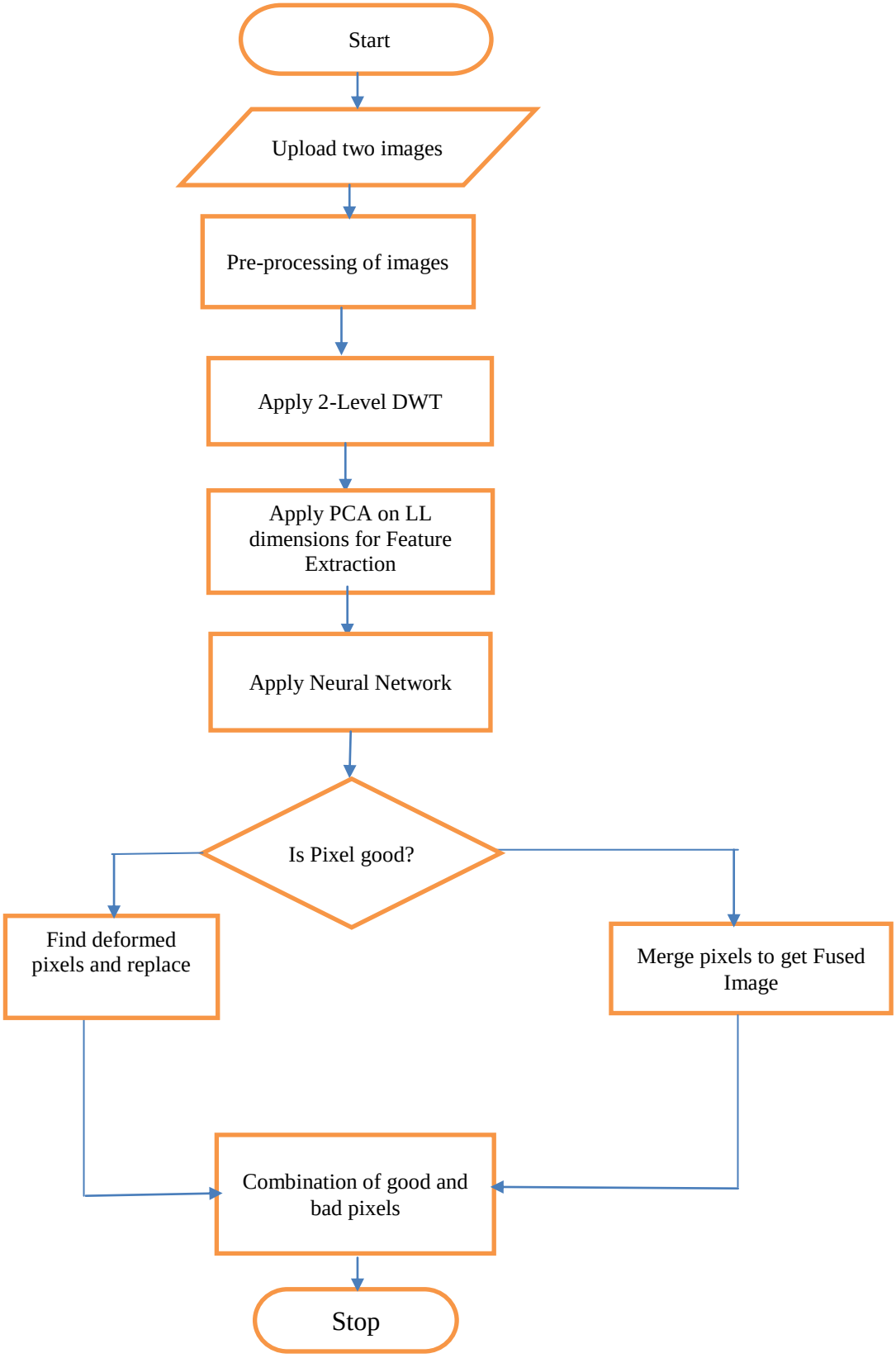

Figure 2: Flow chart of proposed work

3.3 Evaluation Metrics

Following metrics are used for the simulation of work. Comparison of proposed work with the existing work has also been done on the basis of these metrics:

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i. Peak signal to noise ratio (PSNR)

PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. PSNR measure is given by:

$$\text{PSNR (dB)} = 20\log\frac{255\sqrt{3PQ}}{\sqrt{\sum_{i=1}^{p}\sum_{j=1}^{N}(B'(i,j)-B(i,j)2}}$$

Here B' (I,j) is the fused image, B(I,j) is the perfect image.

ii. Mean square error (MSE)

Mathematically MSE is defined as

$$\text{MSE}=\frac{1}{PQ}\sum_{i=1}^{m}\sum_{j=1}^{n}(B_{ij}-C_{ij})2$$

Here, B(i,j) is perfect image, C(i,j) is the fused image

iii. Entropy

Entropy is an index to evaluate the information quality contained in an image. If the value of the entropy becomes higher after fusing, it indicates that the information increases and fusion performances are improved. Entropy is defined as follows

$$\text{E}=\sum_{i=0}^{l-1}M_i log_2 M_i$$

iv. SSIM

It is known as structure similarity index. It is used for measuring the similarity between two images. More is the value of SSIM more is the similarity between the images that we want to combine. The SSIM index is measured on various windows of an image.

IV. RESULTS

The work has been evaluated using MATLAB. MATLAB denotes for MATRIX LABORATORY. MATLAB stood writing initially headed for providing simple admission to matrix application developed by the LINEAR SYSTEM PACKAGE in addition to EIGEN SYSTEM PACKAGE assignments. The following section explains the results obtained after the simulation of the proposed work:

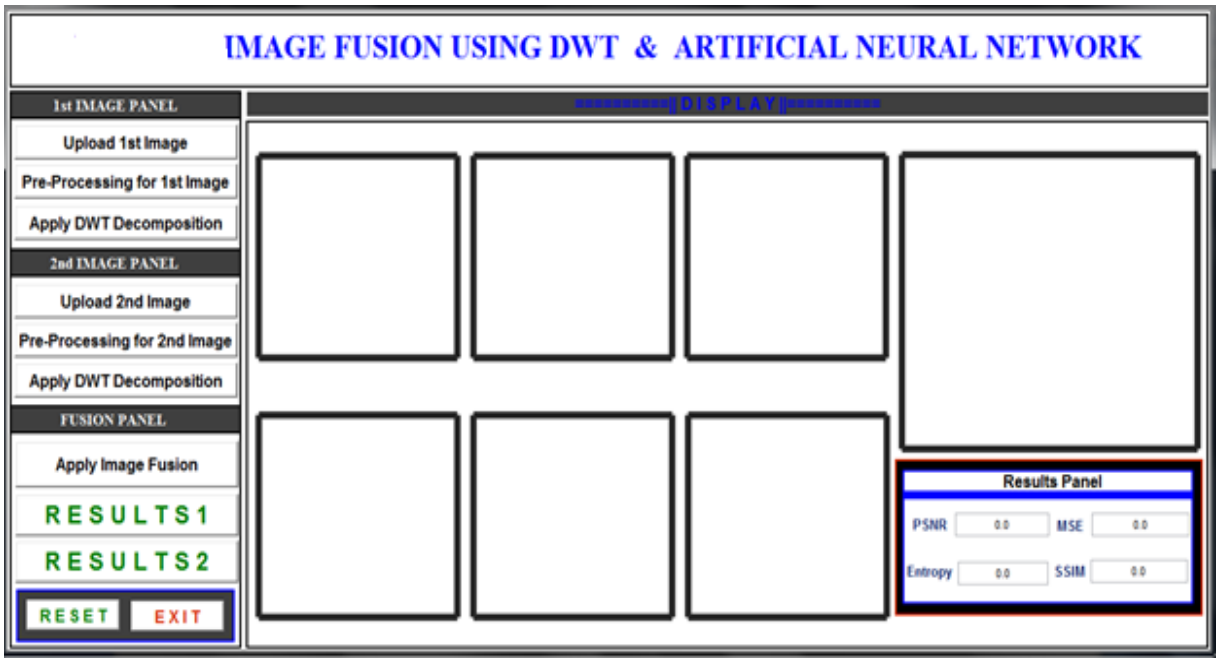

Figure 3: Working window

In the above figure 3, there are two panels named as 1st image panel and 2nd image panel. On the right hand side there is a display panel, which shows whatever be the action applied in the left hand side panel that is if we click on the upload image ten the image has been displayed in the display panel. There are number of steps applied for testing the image like pre-processing, feature extraction and DWT decomposition.

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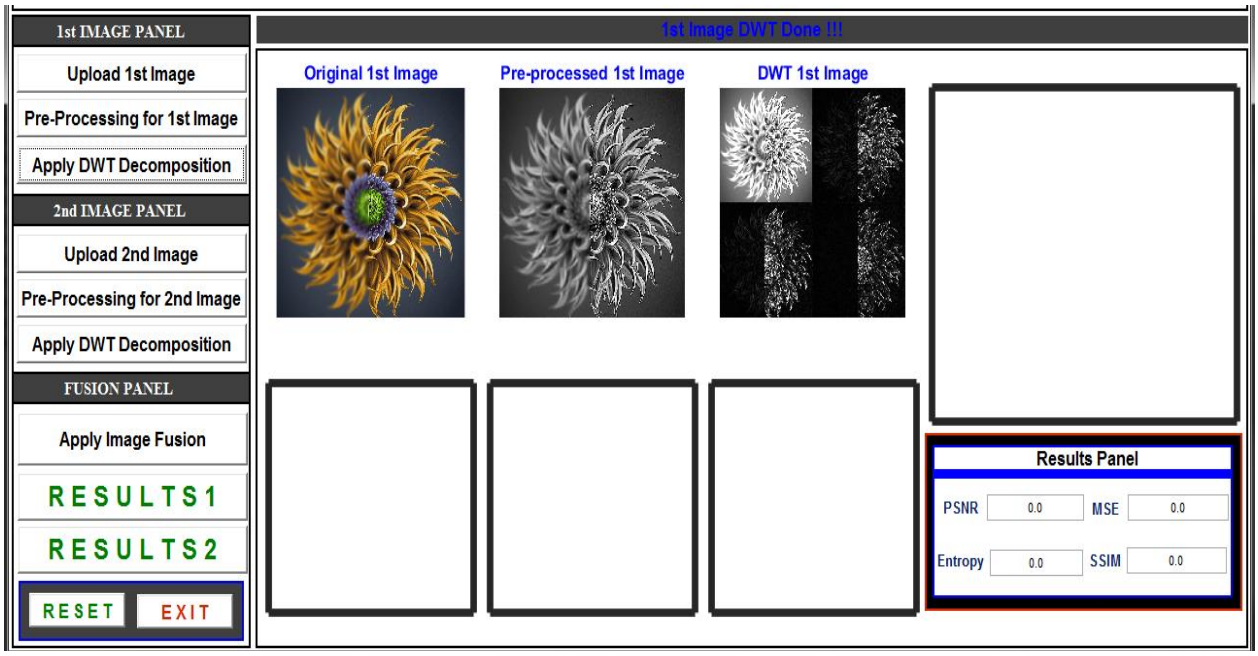

Figure 4: Working figure window with 1st distorted image

In the above figure 4, click on the upload 1st image, the original first image has been uploaded as shown in the display window. After uploading the image pre-processing is applied for removing the unwanted signal like noise or converting the color image into gray image as shown in the figure. The 3rd image in the display window is DWT 1stimage, that is when DWT is applied on the pre-processed image. It provides better spatial and spectral resolution than other traditional multi resolution techniques. Fused coefficients are selected from the original image and we will get better quality image.

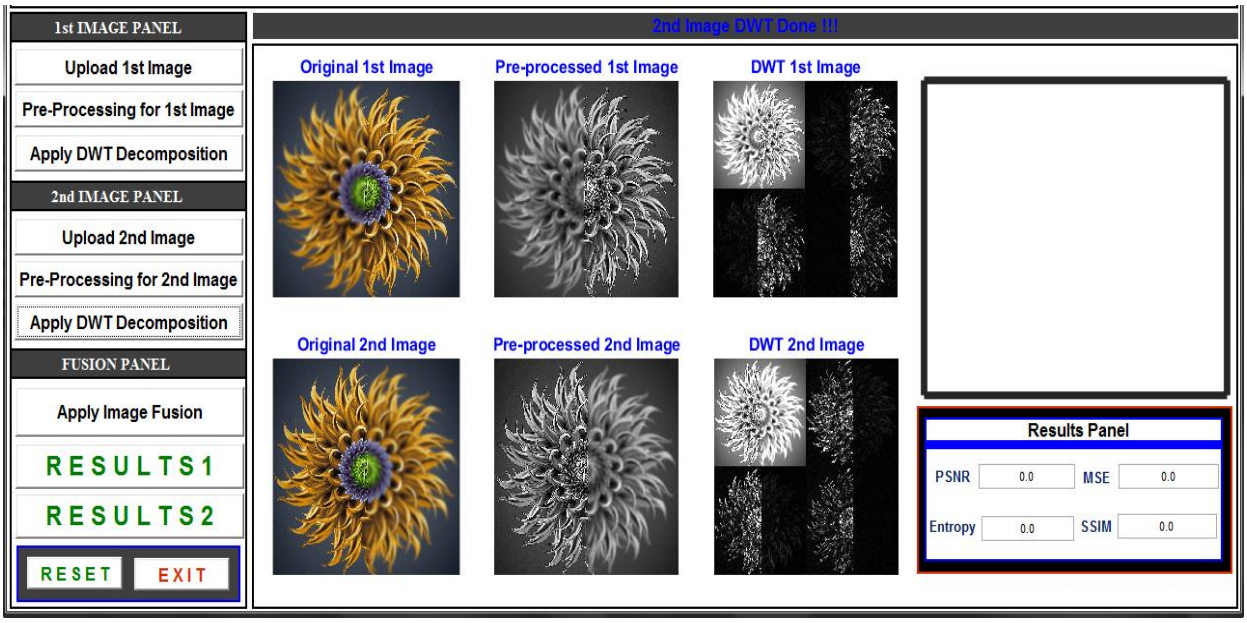

Figure 5: Working figure window with 2nd distorted image

Figure 5 shows uploading of 2nd image. When click on the uploaded 2nd image, the 2nd image of sunflower has been uploaded and displayed on the display window. Same process is applied for the processing of the 2nd image as it is applied for the 1st image. After pre-processing DWT 2nd image has been obtained.

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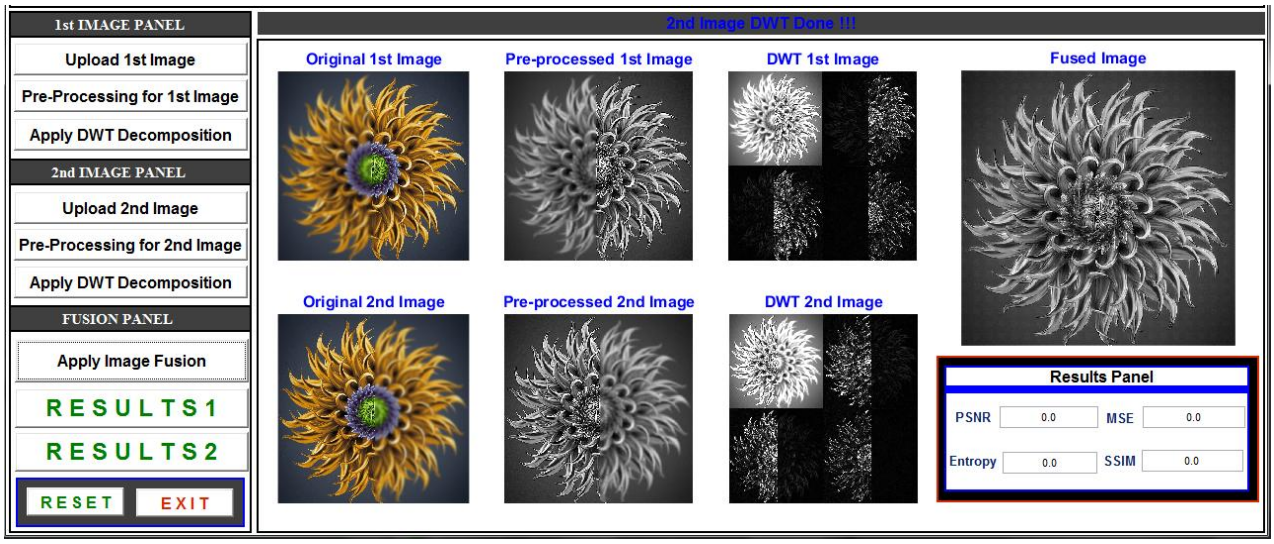

Figure 6: Working figure window with fused image using ANN

After uploading the two images, the fused image is obtained by using artificial neural network which is shown in figure 6. When click on "apply image fusion", a fused imaged with high quality has been displayed on the right hand side top corner of the display window. In the fusion process, these two images are combined into a single image and try to keep the original image feature.

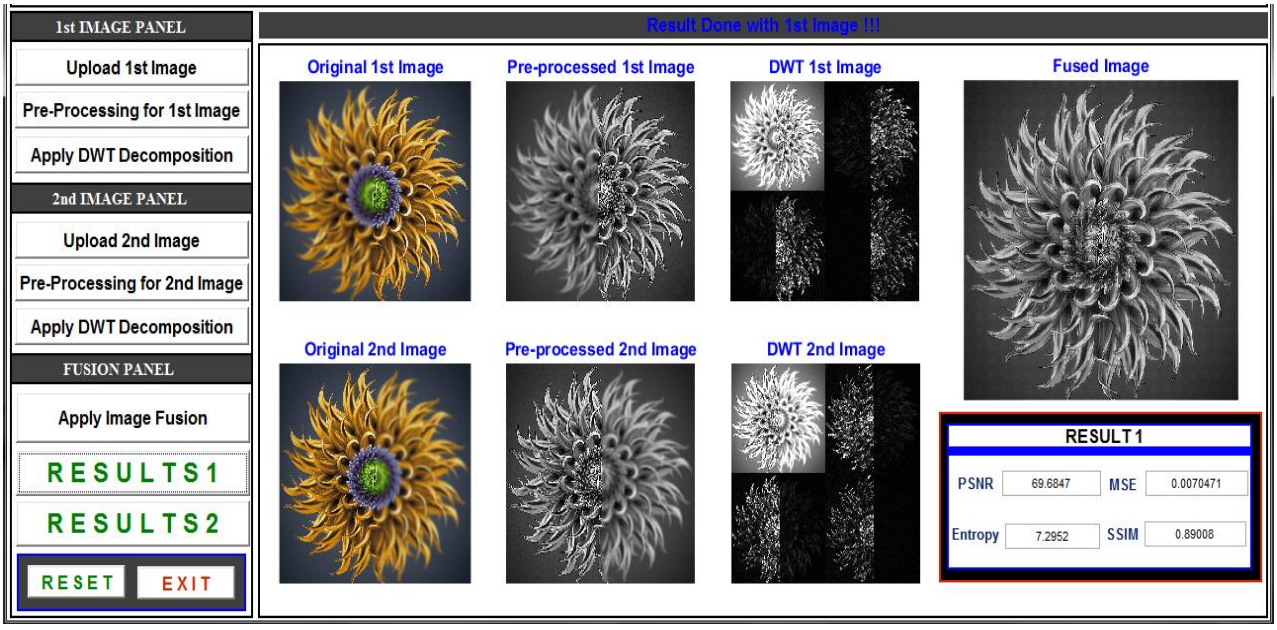

Figure 7: Working figure window with result with respect to 1st image

In Figure 7, the result panels are described at the bottom of left hand side, when click on result 1, the performance metrics with respect to 1st image has been displayed under the result 1 panel.

Table 4.1: Results for 1st image

Performance Parameters	Values
PSNR	69.6847
MSE	.0070471
Entropy	7.2952
SSIM	.89008

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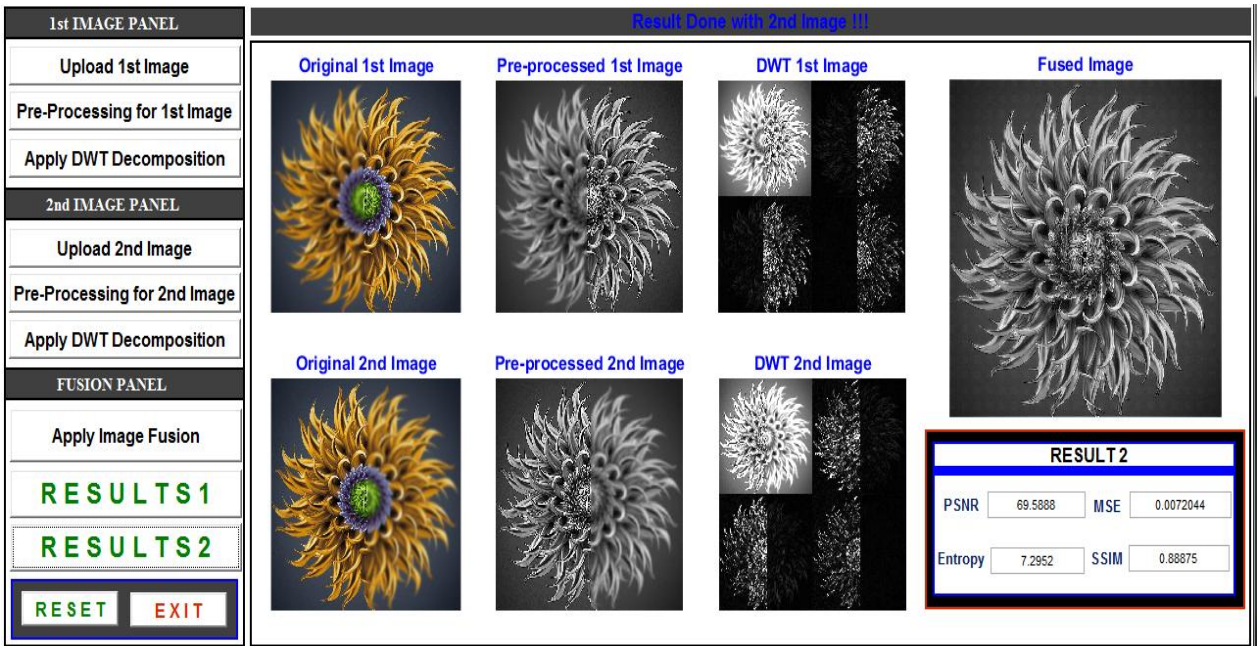

Figure 8: Working figure window with result with respect to 2nd image

In Figure 8 the left hand side describes the result panels at the bottom, when click on result 2, the performance metrics with respect to 2nd image has been displayed under the result 2 panel.

Table 2: Results for 2nd image

Performance parameters	Values
PSNR	69.5888
MSE	0.0072044
Entropy	7.2952
SSIM	0.88875

Table 3: Comparison of existing work and proposed work

Sr. No.	PSNR		MSE		Entropy		SSIM	
	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing
1	69.5888	14.0479	0.0072044	0.07557	7.2952	5.7868	0.88875	0.834
2	67.2154	9.2990	0.0014847	0.08535	7.2952	3.2352	0.88875	7.5874
3	65.8751	14.5478	0.0058433	0.08426	7.2952	4.872	0.88875	8.4577
4	63.5165	10.8755	0.0047625	0.07842	7.2952	5.8968	0.88875	0.4154
5	67.6547	11.4549	0.0071824	0.07578	7.2952	4.2559	0.88875	0.8741

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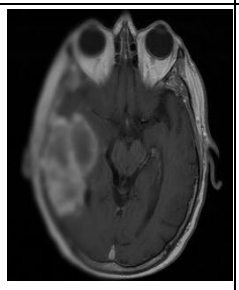
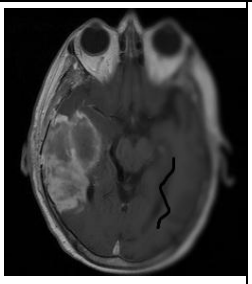
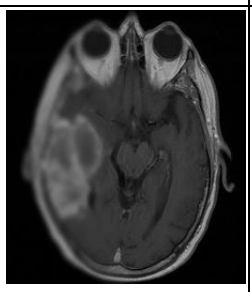
Table 4: Comparative Study of Image fusion

Sr. No.	Image 1	Image 2	Fused Image	Metrices
1				PSNR-69.5888 MSE-0.0072044 ENTROPY-7.2952 SSIM- 0.88875
2				PSNR-67.2154 MSE-0..0058433 ENTROPY-7.2952 SSIM-0.88875
3				PSNR-65.8751 MSE-0.0014847 ENTROPY-7.2952 SSIM-0.88875
4				PSNR-63.5165 MSE-0.0047625 ENTROPY-7.2952 SSIM-0.88875
5				PSNR-67.6547 MSE-0.0071824 ENTROPY-7.2952 SSIM-0.88875

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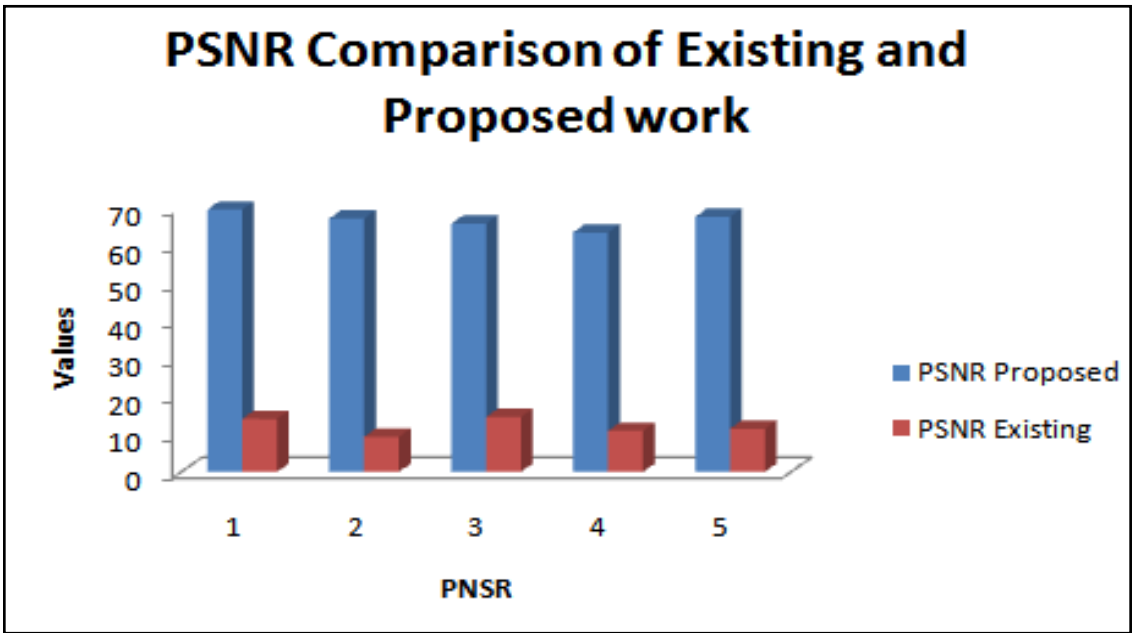

Figure 9: PSNR Comparison

Figure 9 is defining the comparison of PSNR (Peak Signal to Noise ratio) for existing and proposed work. As shown in the graph, blue line is defining the result obtained for proposed work and red line is defining the value of the existing work. It is clear from the figure that the value of proposed work for PSNR is enhanced as compare to PSNR existing. The average value of PSNR proposed work is 69.5888 and for existing work, it is 12.04502

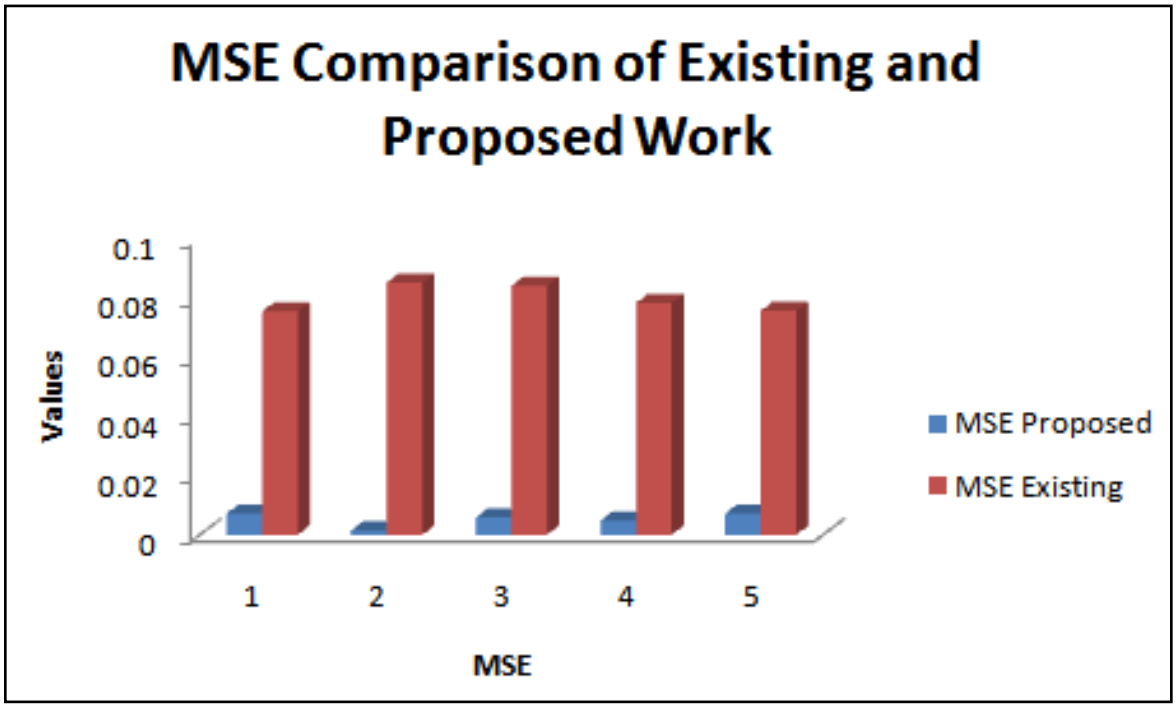

Figure 10: MSE Comparison

Comparison of MSE is shown in figure 10. The comparison has been made for existing and proposed work. As shown in the figure, red line is defining the value of MSE of existed work and blue line is defining the value of the work being proposed. The value of MSE proposed is very less as compare to MSE existing. The average value of MSE proposed is 0.0072044 and MSE existing is 0.079876 which is higher than the work being proposed.

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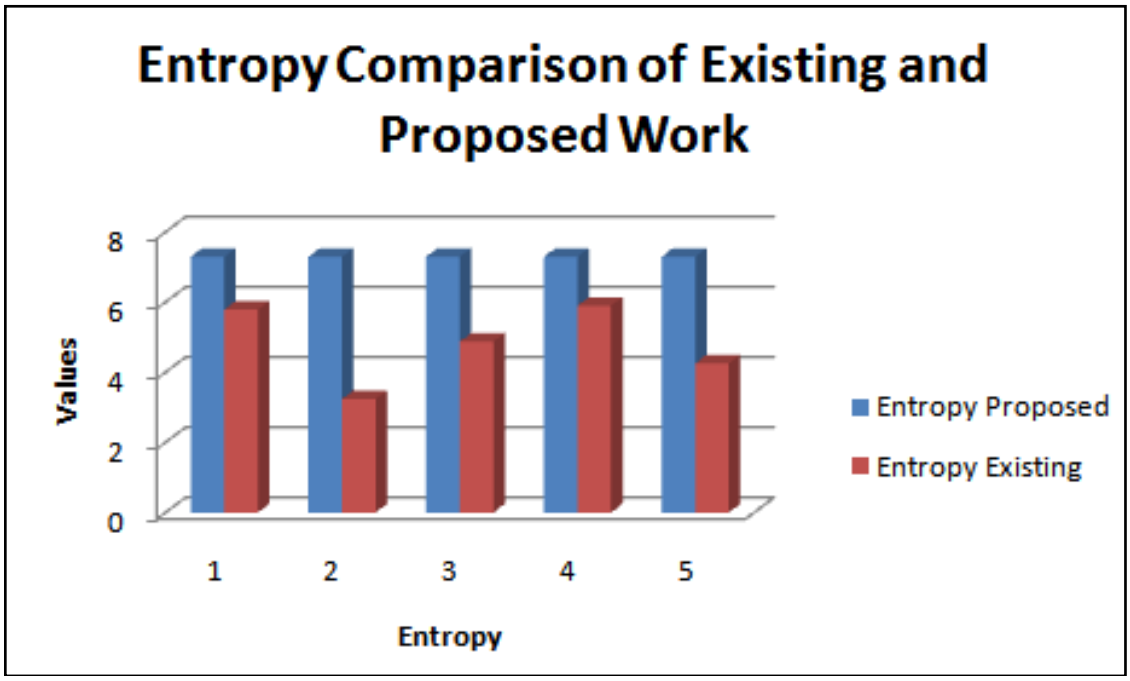

Figure 11: Entropy Comparison

Entropy is the measure of the level of disorder in a closed but changing system, a system in which energy can only be transferred in one direction from an ordered state to a disorder state. Higher the entropy, higher the disorder and lower the availability of the systems energy to do useful work. Comparison of Entropy is shown in figure 11. In figure 11 Blue lines are defining the value of entropy of the proposed work whereas the red lines are defining the value of entropy of the existing work. It is clear from the above figure that entropy is higher in case of proposed work as compare to existing work. The average value for entropy is 7.2952 and in case of existing, it is 4.80934.

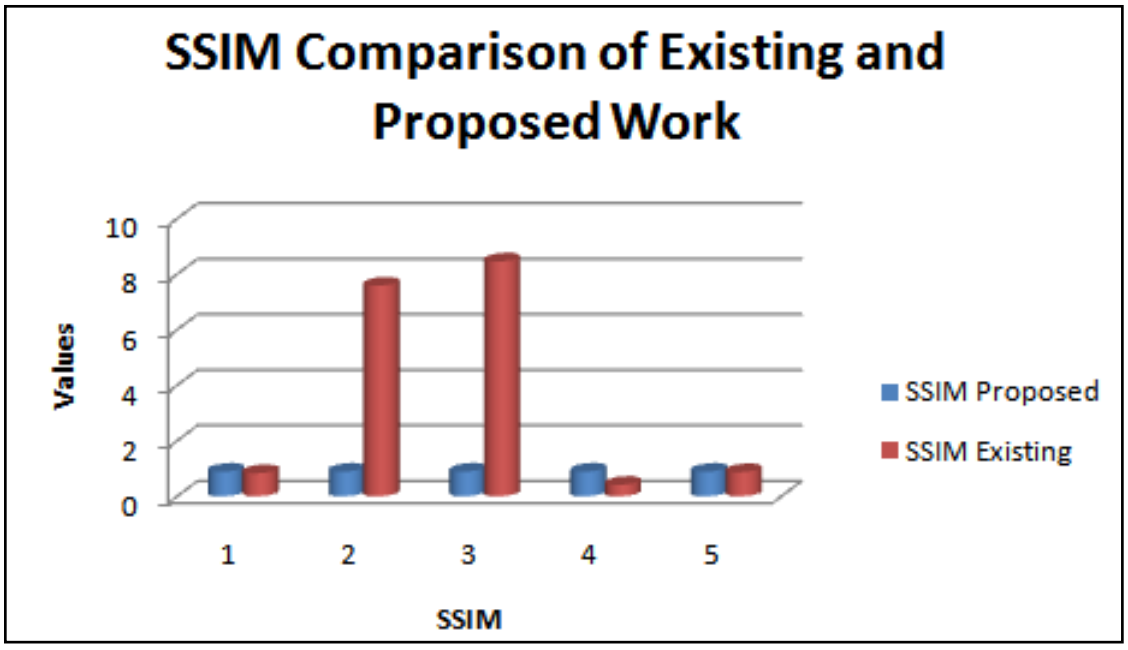

Figure 12: SSIM Comparison

The comparison of existing and proposed work based on SSIM metric is shown in above figure 12. In this, Blue lines are defining the values obtained for proposed work whereas red lines are for the existing work values. The average value of SSIM proposed is 0.88875 whereas for existing, it is 3.63372. Therefore, it is clear that the value of SSIM is less in case of proposed work and for existing, it is higher.

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V. CONCLUSIONS AND FUTURE SCOPE

Conclusions: Due to the requirement of high quality image, image fusion is used. It is the process in which we combined two pieces of the original image to a single image and try to keep the original image features. Due to the growing technology, it is now possible to gather information from multi source images to produce a high quality fused image with spatial and spectral information. Image Fusion is a mechanism to get better the quality of information from a group of images. Applications of the fusion of images include medical imaging, remote sensing, microscopic imaging, computer vision, and robotics. In the proposed work, we used two flower images which are pre-process and then DWT has been applied for decomposing them. DWT is a widely used multi resolution fusion technique as it provides better spatial and spectral resolution than other traditional multi resolution techniques. In DWT based fusion methods, the "max-absolute" rule is used to select the fused coefficients from source images. But this method is sensitive to noise and artifacts. After applying DWT technique, images get fused and we will get better image. Their performance parameters have also been calculated separately for the image 1 and for image 2. The values obtained for PSNR, MSE, Entropy and SSIM for image 1 are 69.6847, .0070471, 7.2952, and .89008, whereas for image 2 the results are 69.5888, .0072044, 7.2952, and.88875 respectively. Proposed work has improved the problems of blurry image. It gives a clear fused image, by utilizing the techniques of Discrete Wavelet Transform (DWT), Principal Component Analysis (PCA) and Neural Network. Discrete wavelet transform (DWT) for decomposition of images into sub-bands, Principal component analysis (PCA) for feature extraction to find the unique value and Neural Network for fusion of bits as a classifier. The validation of is done through quantitative analysis using metrics such as peak signal to noise ratio (PSNR), mean square error (MSE), structural similarity index (SSIM), and compression ratio (CR).

Future Scope: It has been observed that for many types of image fusion the images are not fused properly. Secondly, the fused image doesn't have proper clarity. It had also a problem of blurry fused image. Researchers have used number of techniques to improve these fusion problems but still it does not give better result. In future these problems can be solved by using some other methods.

REFERENCES

[1] GazalMalhotra and Dr.Vinay Chopra. "Improved multi-focus image fusion using ac-dct, edge preserving smoothing & DRSHE" In Proceedings of International Conference on Computer Science , Cloud Computing and Applications July 24-25, 2014.
[2] Huaxun Zhang and Xu Cao. "A way of image fusion based on wavelet transform" In 9th International Conference on Mobile Ad-hoc and Sensor Networks, IEEE, 2013.
[3] Jasmeetkaur and Er. Rajdavinder Singh Boparai. "An evaluation on different image fusion techniques" IPASJ International Journal of Computer Science (IIJCS) Volume 2, Issue 4, April 2014.
[4] K Sharmila, S Rajkumar, V Vijayarajan. "Hybrid method for Multimodality Medical image fusion using Discrete Wavelet Transform and Entropy concepts with Quantitative Analysis." In International conference on Communication and Signal Processing (ICCSP), IEEE, April 3-5, 2013.
[5] L Ganesh, S P Krishna Chaitanya, J DurgaRao and M N V S S Kumar. "Development of Image Fusion Algorithm for Impulse Noise Removal in Digital Images using the quality Assessment in Spatial Domain" In International Journal of Engineering Research and Applications (IJERA) Vol. 1, Issue 3, 2007.
[6] Lixin Liu, HongyuBian and Guofeng Shao. "An Effective Wavelet-based Scheme for Multi-focus Image Fusion" In IEEE International Conference on Mechatronics and Automation (ICMA), 2013.
[7] Mingjing Li and Yubing Dong. "Review on technology of pixel-level image fusion." In International Conference on Measurement, Information and Control (ICMIC),vol. 1, IEEE, 2013.
[8] Om Prakash, Richa Srivastava1, Ashish Khare1 "Biorthogonal wavelet transform based image fusion using absolute maximum fusion rule" Proceedings of 2013 IEEE Conference on Information and Communication Technologies (ICT) 2013.
[9] Qingping Li, Junping Du, Fuzhao Song, Chao Wang, Honggang Liu, Cheng Lu. "Region-based Multifocus Image Fusion Using the Local Spatial Frequency", In Control and Decision Conference (CCDC), 25th Chinese, IEEE, 2013.
[10] Y. AsnathVictyPhamila and R. Amutha. "Discrete Cosine Transform based fusion of multi-focus images for visual sensor networks." Signal Processing 95 (2014).
[11] AshwiniGalande and RatnaPatil, "The art of medical image fusion: A survey", In International Conference on Advances in Computing, Communications and Informatics (ICACCI), IEEE, 2013.
[12] RishuGarg, Preeti Gupta and HarvinderKaur "Survey on Multi-focus Image fusion algorithms". In Proceedings of RAECS UIET Panjab University Chandigarh, IEEE, 2014.
[13] Rong Fan. Qiufen Yang and Guanqun Liu, "Nonlinear Weighted Multiband Fusion Algorithm" In IEEE Workshop on Electronics, Computer and Applications, IEEE, 2014.
[14] Jinling Wang, Kefei Song and Xiaojun He, "Multispectral image fusion based on the characteristic of imaging system" In Proceeding of the International Conference on Information and Automation Yinchuan, China, IEEE, 2013.
[15] Wang Yang and Jin-Ren Liu, "Research and development of medical image fusion", IEEE, 2013.