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Performance Evaluation Of Fuzzy Based DWT Approach To Enhance CT Image Using Image Fusion

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Abstract
Image fusion is about to combine the features of two or more partial occluded or damaged images to generate a new effective image. The proposed algorithm is about to improve the quality of CT image by using the concept of image fusion. In this work, an effective image analysis model is been presented under multiple parameters. The parameters that will be considered in this work are contrast analysis, entropy analysis and frequency analysis. The proposed algorithm begin, with the decomposition of images using DWT. These decomposed image parts will be analyzed using multiple parameters defined above. To perform the effective pixel area selection, the fuzzy logic will be applied. In this work, a two layered analysis is been performed for image fusion. The first level fusion will be done using DWT and second level fusion will be done using parametric fuzzy logic approach. As the presented work is defined on the basis of multiple parameters so that more effective results are expected from the defined approach. The work will be implemented in matlab environment. The obtained results shows the effective generation of fusion image. The analysis of work is done under different parameter that shows the work has improved the visibility of medical image.

Index terms: Image fusion , wavelet decomposition , Morphological operators, .

1. Introduction

The visual information system is one of the most required form of human requirement to represent the information in image form. This visual information is required to present the perception so that the effective information reterival will be performed. The similarity analysis over the visual information is performed to extract the image feature. But the images are having the problems related to its visibility. This visual information can be degraded or not fully visible because of some environmental vector or the hardware problem. There are number of such integrated problems to visualize this information.

1.1 DIGITAL IMAGES PROCESSING

Image processing is about to perform different operations on extracted digital image by using different enhancement methods. These processes accept the image as input to the system and perform different processes over it.These processes then sample and quantize the image for extraction of information. The information process is defined as the sample and quantization process called digitalization. This quantization process includes the pixel selection for processing. The work can be checked for different size so that the quantization values will convert the data to discrete data so that the enhancement to image pixels will be obtained. The enhancement can be here obtained in terms of brightness and contrast values so that the effective pixel modification will be obtained.

Image processing is defined to improve the signal processing in the form of images so that the image characteristics will be captured and the parametric adjustment to image will be done. The work includes the parameter based adjustment over the images under different input and output images[1]. Image processing itself is divided in number of sub processes shown here under

1. Image Acquisition is the basic process comes under image processing that includes the extraction of image from the real time source.

2. Another associated process for enhancement of image is Image Enhancement. This process basically improves the image features upto an extent and provides the pixel level improvement over the image. The enhancement is done in terms of image pixel intensity to improve the contrast and brightness of image. These image features are improved to provide the better look over the image. The improvement to image pixels is subjective to image processing.

3. Image restoration is about to repair the image if some distortion occur over the image. This distortion exist in the form of image. The restoration is defined under some mathematical or probabilistic methods so that the enhancement over the image will be obtained.

4. Color image processing over the image is performed under different color intensity value analysis.

5. The wavelet based decomposition over the image is performed under different degree of resolution to obtained the improved values.

6. Compression is the approach to reduce the image size to get the maximum utilization of bandwidth during the transmission phase. The transmission capacity is analyzed under the pictorial representation and the compression values of the image are defined with different extension. One of most used compressed format is jpg image.

7. Morphological operators are used in images to improve the image components after the component level extraction under the shape and size estimation.

Segmentation is the procedure defined for image improvement for images and image part so that the object extraction and object generation will be done effectively

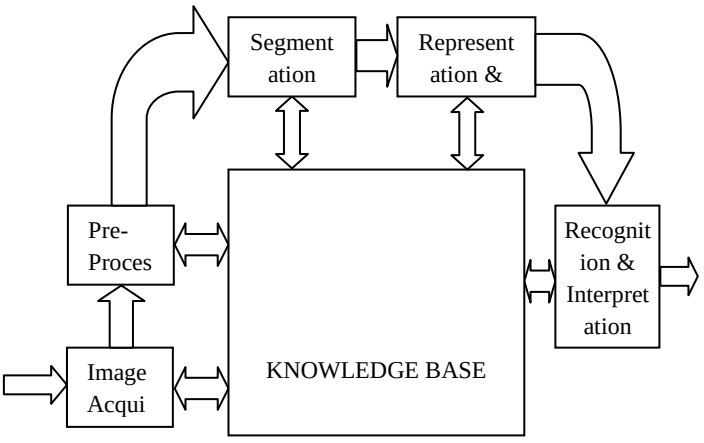

Figure 1.1 Fundamental steps in digital image processing

8. The representation and descriptive form of image segmentation of pixel data and constitute the boundary region for image. The pixel level separation over the image is performed for region analysis. The analysis is here defined under the processing form of image so that the boundary extraction and representation will be done effectively. Author defined the inflexions and corner extraction from the image. The internal object extraction for the image is done under the texture and shape extraction. The object level improvement is done so that the ROI will be extracted effectively over the image and the image attributes will be highlighted so that the extraction of data values will be done effectively over the system. The feature selection over the attribute so that the quantitative information analysis and the interest analysis with class of object will be obtained.

9. The important image processing operation includes the recognition of object or image so that the image identification from the image set will be performed.

Image processing provides the specific solution so these all elements so that the significant research over the research area will be obtained. The functions includes the significant image processing so that the attributes over the image will be improved so that the effective visibility over the image. These functions are obtained from image acquisition and image extraction process from the source.

2. Literature survey

R.Maruthi performed a work," Multi Focus Image Fusion Based on the Information Level in the Regions of the Images". An image fusion algorithm based on activity measures like Spatial frequency and Visibility for fusing multi focus images is presented in this paper. The fusion procedure is performed by a selection mode according to the magnitude of the spatial frequency and Visibility. The fused images are then assessed using the same activity measures that is used for fusion. Experiments results shows that the proposed algorithm works well in multi focus image fusion.

Shuo-Li Hsu performed a work," Region-Based Image Fusion with Artificial Neural Network". In this paper, we propose a region–based image fusion which combines aspects of feature and pixel-level fusion method to replace only by pixel. The basic idea is to segment far infrared image only and to add information of each region from segmented image to visual image respectively. Then we determine different fused parameters according different region. The experimental results present the method we proposed indeed have good adaptive capacity with automatic determined fused parameters**.**

Manjusha Deshmukh performed a work," Image Fusion and Image Quality Assessment of Fused Images". The paper presents PCA based image fusion and also focuses on image fusion algorithm based on wavelet transform to improve resolution of the images in which two images to be fused are firstly decomposed into sub-images with different frequency and then the information fusion is performed and finally these sub-images are reconstructed into result image with plentiful information. . Author also propose image fusion in Radon space. This paper presents assessment of image fusion by measuring the quantity of enhanced information in fused images.

Milad Ghantous performed a work," A Gradient-Based Hybrid Image Fusion Scheme using Object Extraction". This paper presents a new hybrid image fusion scheme that combines features of pixel and region based fusion, to be integrated in a surveillance system. The background information is then fused in a multi-resolution pixel-based fashion using gradient-based rules to yield a more reliable feature selection. According to Piella and Petrovic quantitative evaluation metrics, the proposed scheme exhibits a superior performance compared to existing fusion algorithms**.**

Tao Wan performed a work," Compressive Image Fusion". In this paper, we present a study of three sampling patterns and investigate their performance on CS reconstruction. Author then propose a new image fusion algorithm in the compressive domain by using an improved sampling pattern. There are few studies regarding the applicability of CS to image fusion. The main purpose of this work is to explore the properties of compressive measurements through different sampling patterns and their potential use in image fusion.

Andreja Svab performed a work," High-resolution Image Fusion: Methods to Preserve Spectral and Spatial Resolution". The main topic of this paper is high-resolution image fusion. The techniques used to merge high spatial resolution panchromatic images with high spectral resolution multispectral images are described. It was discovered that for preserving spectral characteristics, one needs a high level of similarity between the panchromatic image and the respective multispectral intensity. In order to achieve this, spectral sensitivity of multispectral and panchromatic data was performed, and digital values in individual bands have been modified before fusion.

Saurabh Singh performed a work," Infrared and Visible Image Fusion for Face Recognition". In this paper, we propose fusing IR with visible images, exploiting the relatively lower sensitivity of visible imagery to occlusions caused by eyeglasses. Two different fusion schemes have been investigated in this study: (1) imagebased fusion performed in the wavelet domain and, (2) feature-based fusion performed in the eigenspace domain. In both cases, we employ Genetic Algorithms (GAs) to find an optimum strategy to perform the fusion. To evaluate and compare the proposed fusion schemes, we have performed extensive recognition experiments using the Equinox face dataset and the popular method of eigenfaces. Presented results show substantial improvements in recognition performance overall, suggesting that the idea of fusing IR with visible images for face recognition deserves further consideration.

Hong ZHENG performed a work," Study on the Optimal Parameters of Image Fusion Based on Wavelet Transform". Selection of wavelet type, decomposition level and fusing rule is a key problem when wavelet transform is applied to image fusion. 2916 kinds of different fusing methods are analyzed and compared in the experiment of fusing multi-focus images in this paper. Through calculating the comparability degree of fused images, the fusion performances are evaluated. And the experiment shows that the similarities of the results and the ideal pictures are all over 0.999, showing pretty good performance.

G. Simone performed a work," Image fusion techniques for remote sensing applications". Image fusion refers to the acquisition, processing and synergistic combination of information provided by various sensors or by the same sensor in many measuring contexts. The aim of this survey paper is to describe three typical applications of data fusion in remote sensing.

Wenzhong Shi performed a work," Wavelet-based image fusion and quality assessment". This paper addresses two issues in image fusion (a) the image fusion method and (b) corresponding quality assessment. Firstly, a multi-band wavelet-based image fusion method is presented, which is a further development of the two-band wavelet transformation. This fusion method is then applied to a case study to demonstrate its performance in image fusion. Secondly, quality assessment for fused images is discussed.

Luciano Alparone performed a work," Fusion of Multispectral and SAR Images by Intensity Modulation". This paper presents a novel multi-sensor image fusion algorithm, which extends pan-sharpening of multispectral (MS) data through intensity modulation to the integration of MS and SAR imagery. The method relies on SAR texture, extracted by ratioing the despeckled SAR image to its lowpass approximation. The texture modulated pan-sharpened GI replaces the GI calculated from the resampled original MS data; then the inverse transform is applied to obtain the fusion product.

YAO Wan-qiang performed a work," Multi-Spectral Image Fusion Method Based On Wavelet Transformation". The paper focuses on image fusion between multi-spectral images and panchromatic images using a wavelet analysis method with good signal processing and image processing traits. A new weighting technique is developed based on wavelet transformation for the fusion of a high spatial resolution image and a low-resolution, multi-spectral image. The experimental results show that the new method presented is clearly better in

not only preserving spectral and improving spatial presentation, but also avoiding mosaic occurring.

3. Steps of Proposed Algorithm

Algorithm(image1,image2)
/*Accept two partially distorted CT (Computed Tomography) images as input for the fusion process**/**
{
1. Perform Histogram Equalization to Enhance the Image Features
2. Decompose the Images using DWT to perform the frequency level analysis over the images
3. Extract the Image Cofficient under Horizontal, Vertical and Diagonal Features
4. Extract the Image features under Different image cofficient analysis
5. Perform the Extraction of Contrast Value, Entrophy Value and Frequency Value Analysis over the decomposed Image
6. Fuzzify the Parameters under fuzzy rules
7. Perform the Block division over the image for the fuzzy based parametric Analysis
8. For i=1 to NoOfBlocks
[Process All Blocks Under Fuzzification]
{
9. ent=FuzzyEntroy(Block(i).Image1,Block(i).Image2)
[Apply Fuzzy entrophy Value Analysis]

10. fre=FuzzyFrequency(Block(i).Image1,Block(i).Image2)
[Apply Fuzzy Frequency Value Analysis]

11. con=FuzzyContrast(Block(i).Image1,Block(i).Image2)
[Apply Fuzzy Contrast Value Analysis]
12. if (frq=High and con=High And ent=High)
{
ResultBlock(i)=Block(i).Image1
}
13. else if (freq=High and con=High)
{
ResultBlock(i)=Block(i).Image1
}
14. else if (freq=High)
{
ResultBlock(i)=Block(i).Image1
}
15. else
{
ResultBlock(i)=Block(i).Image2
}
}
16. Compose the Blocks to regenerate the image
17. Perform wavelet to generate image back as fusion image
18. return ResultImage
}

4. Experimental Results

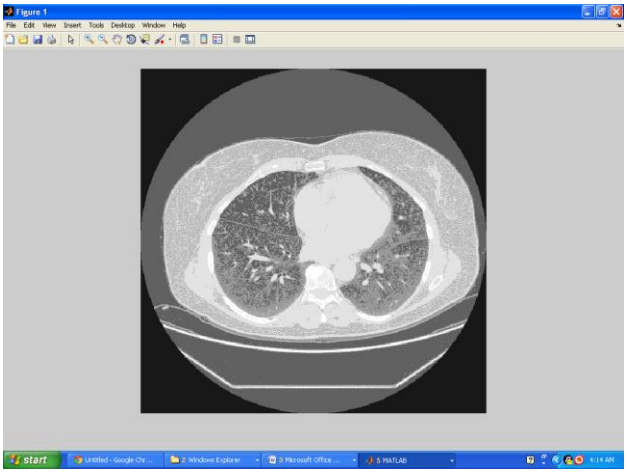

Figure 4.1 : Input Image 1

Figure 4.1 is showing the input image1, As we can see the image is not proper and it is distorted in terms of some blurring over the mage.

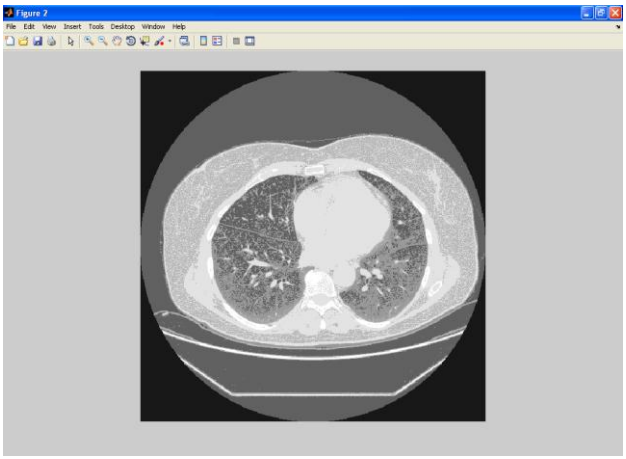

Figure 4.2 : Input Image 2

Figure 4.2: Input Image 2**:** As we can see the image is not proper and it is distorted in terms of some blurring over the mage.

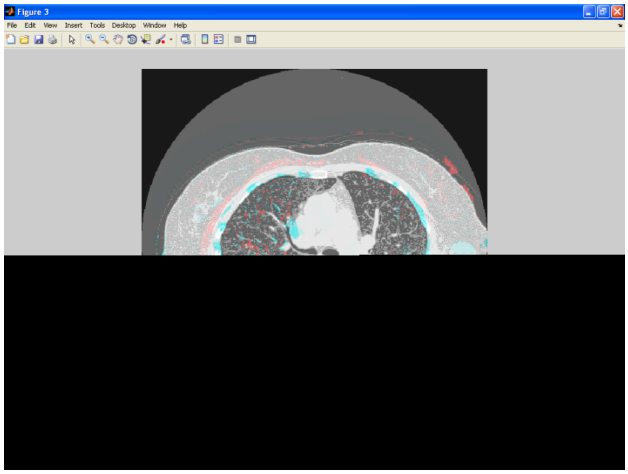

Figure 4.3: Result Image

Figure 4.3: is showing the input image1, Showing the result Image. As we can see the output image is much clear then input images. It means the presented work is working efficiently and accurately.

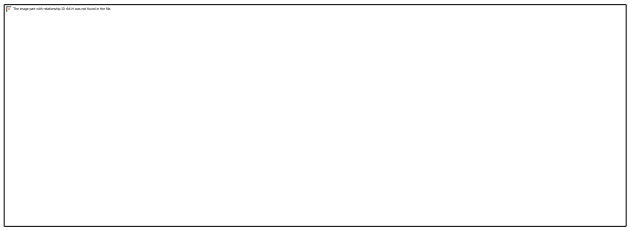

Figure 4.4 : Input Image 1

Figure 4.4 is showing the input image1, As we can see the image is not proper and it is distorted in terms of some blurring over the mage.

Figure 4.5: Input Image 2

Figure 4.5 is showing the input image2, As we can see the image is not proper and it is distorted in terms of some blurring over the mage.

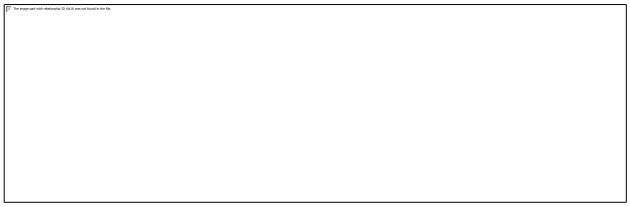

Figure 4.6: Result Image

Figure 4.6 is showing the input image1, Showing the result Image. As we can see that output image is much clear than the input images. Therefore it is clear from the results that the proposed algorithm is working accurately and more efficiently

5. Performance analysis:

As we can see from the results, there is much difference between the result image after fusion and the distorted input images to be fused. The work is tested on multiple images under different parameters. The results obtained from the work are given here under:

5.1 Mean Value Analysis:

Figure 5.1 : Mean Value Analysis

As we can see in figure 5.1, the mean value analysis is shown. Higher the mean value more clear the result image will be. As we can see, figure 3 is having the higher mean values so that the results of figure 5 are better than other images where as the result of figure 4 is worst.

5.2 Standard Deviation Analysis:

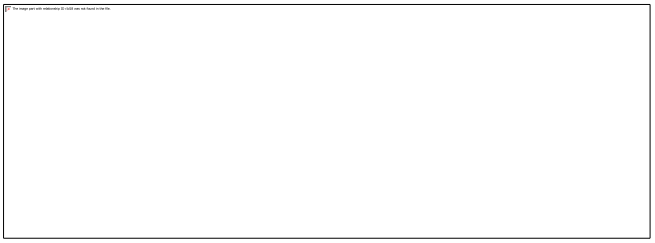

Figure 5.2 : Standard Deviation Analysis

As we can see in figure 5.2, the standard deviation analysis is shown. Higher the STD value more clear the result image will be. As we can see, figure 3 is having the higher STD values so that the result of figure 5 are better than other images where as the result of figure 4 is worst.

5.3 Entrophy Analysis:

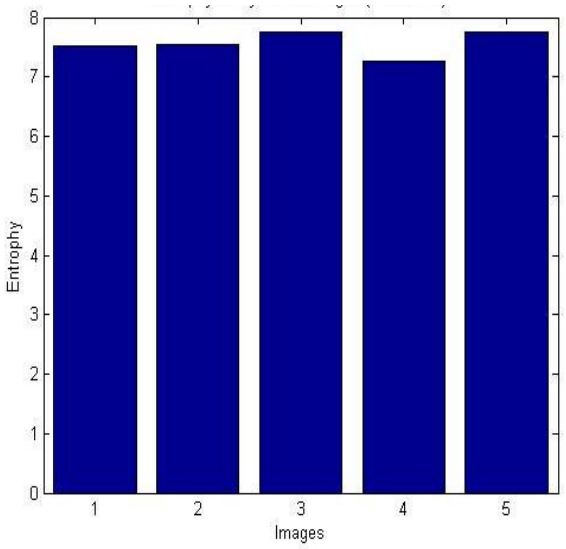

Figure 5.3: Entrophy Analysis

As we can see in figure 5.3, the Entrophy analysis is shown. Lower the Entrophy value more clear the result image will be. As we can see, figure 4 is having the lower frequency values so that the result of figure 4 is better than other images.

5.4 Frequency Analysis:

Figure 5.4 : Frequency Analysis

As we can see in figure 5.10, the Frequency analysis is shown. Lower the frequency value more clear the result image will be. As we can see, figure 5 is having the lower frequency distribution values so that the results of figure 5 are better than other images.

5.5 Visibility Analysis:

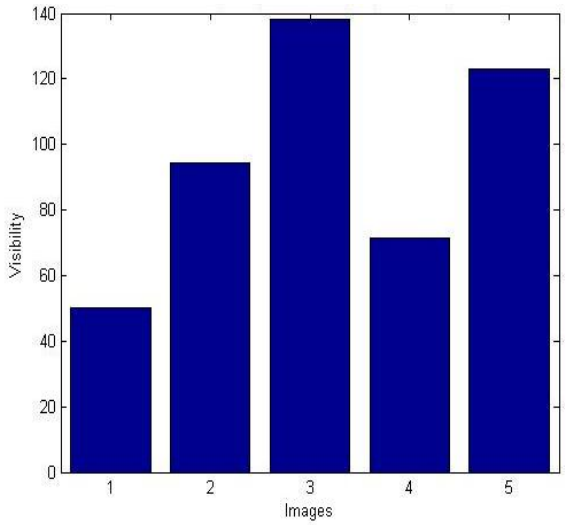

Figure 5.5 : Visibility Analysis

As we can see in figure 5.11, the Frequency analysis is shown. Higher the visibility value more clear the result image will be. As we can see, figure 3 is having the higher visibility values so that the results of figure 3 are better than other images.

6. Comparative analysis

The presented work is about to perform the improvement over the medical images by using the concept of image fusion. The medical images include the brain and lung images available in .cm and .tiff format. The importance of work is associated with the dataset and the instances of each medical image. The dataset properties are described here under

Table 5.1 : Dataset Description

Properties	**Values**
Dataset Name	Brain database
Dataset URL	http://brainweb.bic.mni.mcgill.ca/brainweb/
Number of Images	20
Size	Random
Type of Images	Brain
Format	.DCM
Color	black & white

In this work, the image fusion is applied using DWT and the fuzzy logic to generate the effective image by using two or more distorted images. The comparison of work is done some earlier methods called Orthogonal Approach, Biorthogonal Approach, Trous and WPCA approaches. The analysis of work is done under four main parameters called mean value analysis, standard deviation analysis, covariance analysis and entropy value analysis. The effectiveness of work can be identified if the mean and standard deviation values are low and the entropy and covariance coefficient values are high. The results are here shown in table 2.

Table 2: Comparative Analysis

	Proposed	**Orthogonal Approach**	**Biorthogonal**	**Trous**	**WPCA**
Mean	0.533	32.83	32.834	32.83	32.83
StD	0.2492	30.2884	30.288	30.28	29.91
Entropy	5.5476	6.0039	6.0042	6.004	6.004
Covarience	0.0621	0.0526	0.0567	0.056	0.086

The comparison with these approaches with individual parameter is shown in the form of graph shown here under.

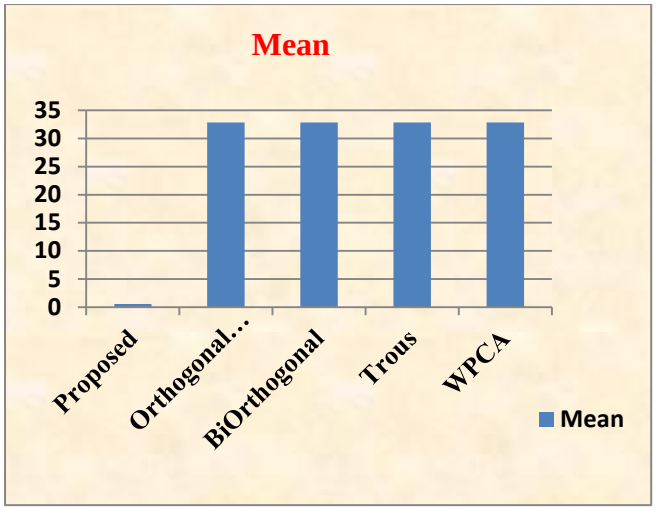

Figure 5.1 : Mean Value Analysis

Here figure 5.1 is showing the Mean Value analysis of presented work with existing approaches. As defined earlier if the mean value is lesser the work is considered effective. The figure shows that the mean value in this proposed work is much lesser than other approaches**.**

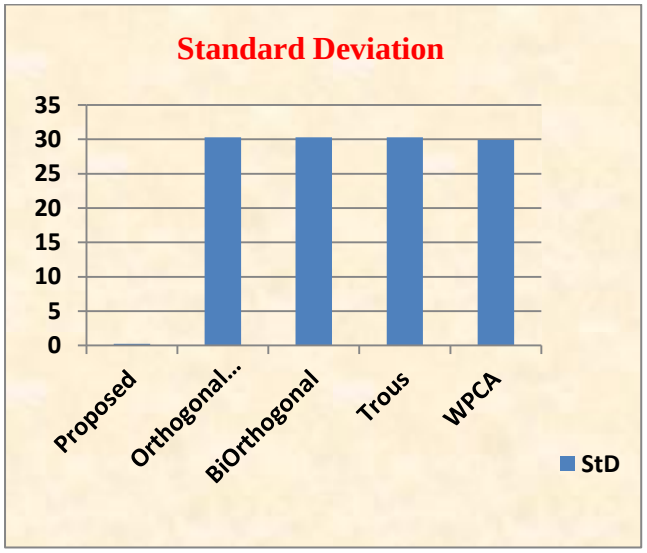

Figure 5.2 : Standard Deviation Value Analysis

Here figure 5.2 is showing the Standard Deviation analysis of presented work with existing approaches. As defined earlier if the standard deviation value is lesser the work is considered effective. The figure shows that the STD value in this proposed work is much lesser than other approaches**.**

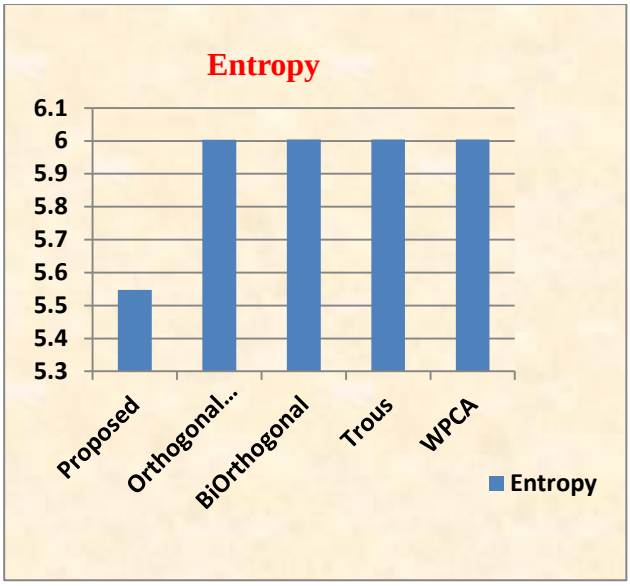

Figure 5.3 : Entropy Value Analysis

Here figure 5.3 is showing the Entropy analysis of presented work with existing approaches. As defined earlier if the Entropy value is higher the work is considered effective. The figure shows that the proposed approach is not much effective in terms of entropy value as the intensity value reduction is done here.

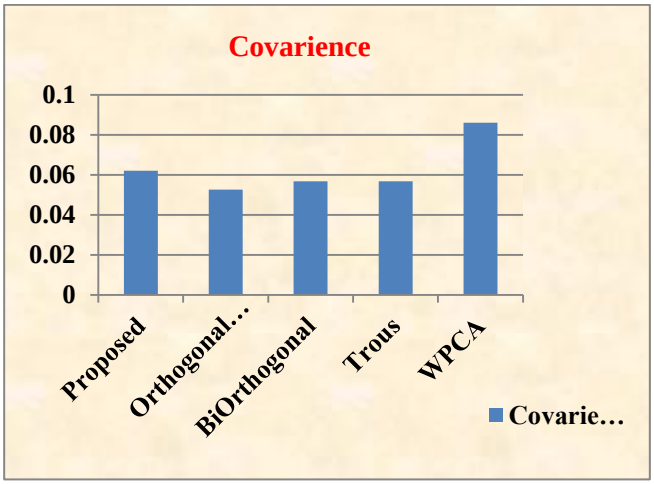

Figure 5.4 : Covariance Value Analysis

Here figure 5.4 is showing the covariance coefficient analysis of presented work with existing approaches. As defined earlier if the covariance value is higher the work is considered effective. The figure shows that the proposed approach is much effective in terms of covariance value than some of the existing approaches**.**

7. Conclusion

In this proposed work, we have used an enhanced approach to image processing. Image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or, a set of characteristics or parameters related to the image. In today's world, image processing is mostly used technique on images. But image

processing has various problems like noise and image sharpening. So, we have used image restoration concept in image processing. Image restoration concept helps to improve image's noise, image's contrast etc.
we have used Image fusion approach to construct a new improved image from two images. These images are of scene with some problem at different places of image. The problems can be in terms of contrast unbalancing, blurring, distortion etc. In this present work we have used fuzzy logic along with wavelet decomposition to construct a new image from two improper images. The results shows that the proposed approach has significantly improve the image.

The work can be extended in different forms:

1. Instead of using Two improper images we can use a set of images to derive a new improved Image.

2. We can use some other classification algorithm such as neural network to derive the better result.

3. We can implement the the same concept on some other image type such as medical image where high level accuracy is required.

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