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Discrete Wavelet Transformation based Multimodal Medical Image Fusion for Disease Identification

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Abstract—In medical science, image processing techniques play a significant function. Computational automation of the treatment is the most authentic and prominent method. The disease of the brain is identified using Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET). Many more scan variations of MRI and PET have been executed for the medical diagnosis. The medical expert needs a solid strain of the computational scan and it's related for diagnosis. The current era of computer research is turning towards clinical diagnosis and etiological analysis based on multimodal image processing. Based on individual medical modalities the accuracy of diseases diagnosis is decreases. Medical community requires a high accuracy in the disease's identification based on multimodal scan image data. For the diagnosis and treatment of disorders requires precise information that is attained through various modalities of medical images such as Computed Tomography (CT), Positron Emission Tomography (PET), and Magnetic Resonance Imaging (MRI). In image processing the image fusion is the method of merging two images into a single picture. The obtained single fused image using various multi-modality medical images is enhanced anatomical, highly desirable spectral information compared to the raw single scanned image. This multi – modal fused image is useful for clinical diagnosis of medical experts. In this research work, the system is prepared for the preprocessing of the MRI and PET scan images. The pre-processing techniques enhance the quality of the input images which are degraded and non-readable. For the pre-processing approach we have applied the Gaussian filters of spatial filtering techniques. The enhanced images passed to the fusion of different region of brain images using Discrete Wavelet Transform (DWT). The system achieved around 90- 95% more accurate outcomes by diluting the color change. The outcome fused image is achieved without losing the spectral and anatomical data. The experiment has been tested on Alzheimer's, normal axis, and normal coronal brain disease images dataset. The quantitative and graphical analysis indicates that's the Discrete Wavelet Transform (DWT) significantly improves the quality of fused images.

Keywords— Resonance Imaging (MRI), Positron Emission Tomography (PET), Multi-modal,medical, discrete wavelet transform(DWT), fusion, Alzheimer's

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I. INTRODUCTION

In the current era of medical image processing the image fusion plays a substantial role in the diagnosis and treatment of diseases. Researchers have been proposed numerous methods of medical image fusion in which most of these approaches are sensitive towards noise and fusion distortion. The quality of spectral and spatial data in a solidity image is definitely preferred by medical experts for numerous uses such as monitoring and precise diseases diagnosing. On the basis of diseases diagnosing the medical expert is have been done treatment process [1]. The procedure of combining and registering multiple image modalities into a single image for improving the quality is known as medical image fusion. The objectives of multi-modal image fusion algorithms are to ameliorate the clinical accuracy of medical imaging. The researcher has been proposed numerous medical fusion techniques, imaging modalities and imaging organs for the fusion purpose [2]. Obtaining spatial clinical information on the foundation of the single modality image is more challenging task for the diagnosis of the disease.

Magnetic Resonance Imaging (MRI) is supplying the soft tissue information, but it lacks in boundary information. The real information on the flow of blood reveals in Positron Emission Tomography (PET) image. Every single modality of the image has own limitation for providing the clinical information because each picture taken with diverse radiation power [3]. To defeat the single modalities, image information extraction medical expert need a multiple modalities fusion of clinical picture such as MRI and PET [4]. Image fusion technique incorporates the suitable information from a combination of various modality input images into an outcome distinct image. The combined image provides enhanced resourceful information in comparing with single input image [5]. Using the wavelet transform in the multi band decomposition for the image fusion is the best appropriate method [6]. The spatial filtering method improves the blurring image into the high quality visual image [7].

The fused information about the image is useful for the medicine, diagnosis, treatment and monitoring of the patient. Numerous methods have been already suggested by the researcher for the medical image fusion. Fusion of MRI and PET images towards the diagnosis of the diseases has been already suggested by researchers. The proposed IHS substitution method obtained fused image with enriched anatomical and clinical data. It provides the affecting factor of color distortion in medical image. Many more approach proposed techniques for the fusion of less color distortion, but missing towards structural information. Multimodal image fusion extraction using the wavelet approach is the best selection, and then, we are using Discrete Wavelet Transform (DWT) approach for the fusion of MRI and PET image fusion.

The rest of the paper is organized as following. Review of related work is explained in section 2. The proposed fusion method is elaborated in section 3. Section 4 is describes the experimental analysis this research. Part 5 is highlighted the conclusion and followed by references.

II. RELATED WORK

First In the medical image processing, the image fusion is most significant tool for understanding of the quality of images through functional information. Numerous reviews have been proposed by researcher towards the research study and techniques of image fusion techniques [8]. The different cases of performance measure towards quality metrics of the

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fused image such as root mean square error (RMSE), percentage fit error (PFE), signal to noise ratio (SNR), peak signal to interference ratio (PSNR), correlation coefficient (CC), mutual information (MI), universal quality index (UQI), structural similarity index measure (SSIM) have been applied in research [9,10,11,12,13,14,15]. Normally the MRI images describe the structural information of the brain without functional parameter, but PET image shows the functional parameter with minimum longitude determination. Consequently, image fusion approach acquires the structural and operational parameter information concern for the without loss of information. The fusing of MRI and PET images using wavelet techniques eliminates the issue of image imbalance [16]. The principal factor analysis technique approach is in effect for the graphical and quantitative based fusion. The DWT approach overcomes the limitation of the PCA technique because it works for pixel averaging & maximum pixel replacement method [17]. Daubechies transform coefficient is the new method for the image fusion. This method concentrates on region segmentation and spatial frequency parameter. The fusion operation is compared along the basis of entropy, standard deviation and fusion factor. This proposed fusion approach proved good and groundbreaking in nature [18].

The researcher evaluated the Daubechies complex wavelet transform for the medical image fusion. The outcome fuse image is helpful for determine average information of the image [19].The proposed method with the compounding of the energy improves the more honest operation of fusion. The fusion is obtained from the combining magnetic resonance tomography and computed tomography images. The fused image is helpful for the medical expert in the diagnosis of the disease [20]. The combination of PET and CT image of the fusion approach is the best option for the researcher. The combined image has the advancement that improves the data regarding the pathological alterations. The fusion based approach of the image, detect and locate the features of disease, body tissues and pathological changes [21]. The methods of DWT based fusion are considerably varied the gray matter (GM) regarding anatomical structural information and patching white matter (WM) for spectral information [22]. For the multi-spectral image fusion for each band such as GIS, remote sensing data, PCA is the best option of the researcher. The PCA based fusion approach fused the eigen-values and corresponding align vector for the specific multi-spectral image regarding each bands extracted a matrix of principal component [23]. The quality analysis of the fused image is should be simple, soft and most reliable based on the experience of the observer and performance conditions [24].

III. Proposed Fusion Approach

The DWT approach is used for the decomposition of the image. The figure 1 describes the graphical representation of wavelet decomposition of the image. From the figure 1, image is decomposed the 3 level. In this experiment we are collecting the data for the three dieses. Preprocessed all data using the Gaussian filtering and enhancement has been performed. The flow diagram of the proposed wavelet based fusion is indicated in image 2. The MRI and PET images have taken input for the system. PET image is decomposed into IHS transform and the high activity area is transforming towards low activity region

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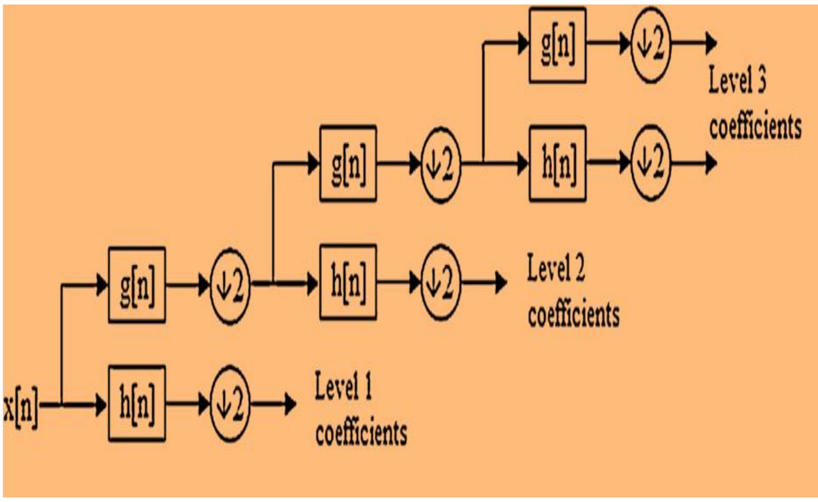

Fig.1. filter block diagram of Discrete Wavelet Transform (DWT)

Later, the transformation combines the high frequency coefficient of MRI and PET image using the averaging method. Put the inverse of DWT to extract the fused image result. The perfect set of wavelet coefficient is taken out by combining the low frequency coefficient of PET and MRI image. The output fused image quality is checked by MSE and PSNR metrics. The output icon is extracted with less color distortion without losing structural information.

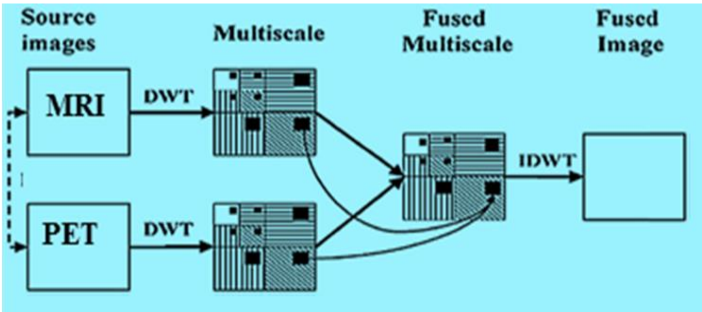

Fig. 2. block diagram of wavelet based fusion approach

IV. Experimental Analysis

For the experimental analysis, the database is collected for preprocessing and fusion from the web portal www.med.harvard.edu. The total 03 set of brain disease such as the MRI Normal Axial, MRI Normal Coronal and MRI Alzheimer with the supporting PET Normal Axial, PET Normal Coronal, PET Alzheimer dataset are collected [25]. The graphical results of MRI and PET normal axial are shown in figure 3. The figure 4 is elaborated graphical representation of the MRI and PET normal coronal images. MRI and PET normal coronal images are graphically shown in figure 5.

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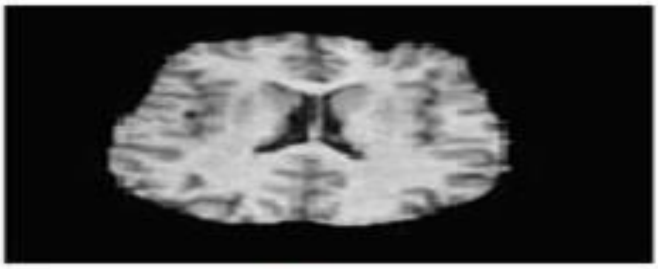
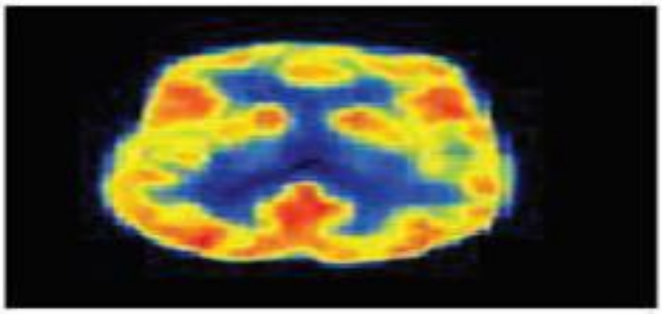
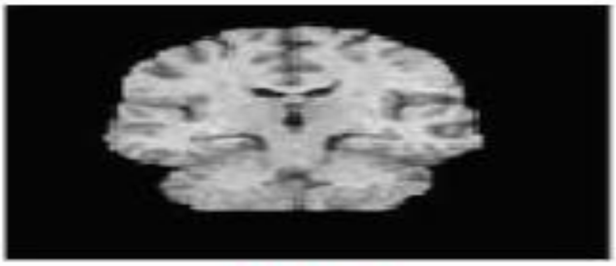


(A)

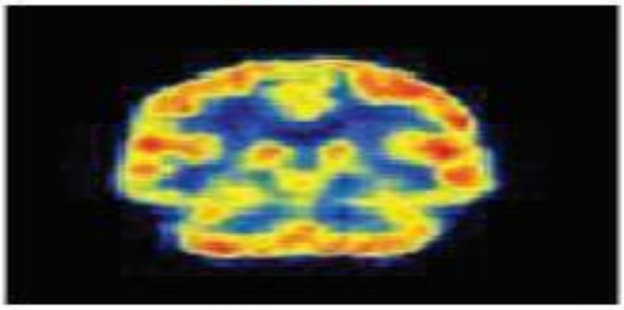


(B)

Fig.3. original MRI normal axial (A) and PET normal axial (B) scan of the subject



(A1)



(B1)

Fig.4. original MRI normal coronal (A1) and PET normal coronal (B1) scan of the subject

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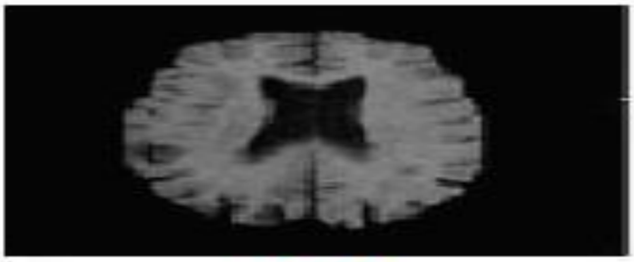
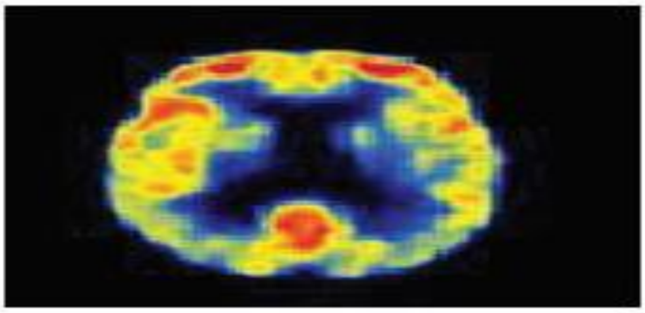


(A2)



(B2)

Fig.5.original MRI Alzheimer (A2) and PET Alzheimer (B2) scan of the subject

The performance measure of the fusion method is calculated as PSNR and MSE. For the clustering 70% and 90% variability is passed). W is the weight for clustering. The performance standard of the combined image using the DWT approach for MSE approach is reported in table 1.

TABLE I. PERFORMANCE MEASURE BASED ON MEAN SQUARE ERROR OF THE OUTPUT FUSED IMAGE

Sr. No	Method	Database 1	Database 2	Database 3	Average
1	DWT (w=0.7)	0.01954	0.10962	0.09749	0.07555
2	DWT (w=0.9)	0.1903	0.17935	0.19046	0.186703
				Average	0.131127

The performance of the proposed system using the measure peak signal to noise ratio (PSNR) is explained in table 2

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TABLE II. PERFORMANCE MEASURE BASED ON PSNR OF THE OUTPUT FUSED IMAGE

Sr. No	Method	Database 1	Database 2	Database 3	Average
1	DWT (w=0.7)	43.1234	42.3561	45.897	43.1234
2	DWT (w=0.9)	31.90987	38.986	32.981	31.90987

The graphical results of the normal explained MRI and PET normal axial fused image are shown in figure 6. Figure 7 is elaborated the MRI normal coronel and PET normal coronal fused image. The extracted fused image of MRI Alzheimer and PET Alzheimer is shown in figure 6.

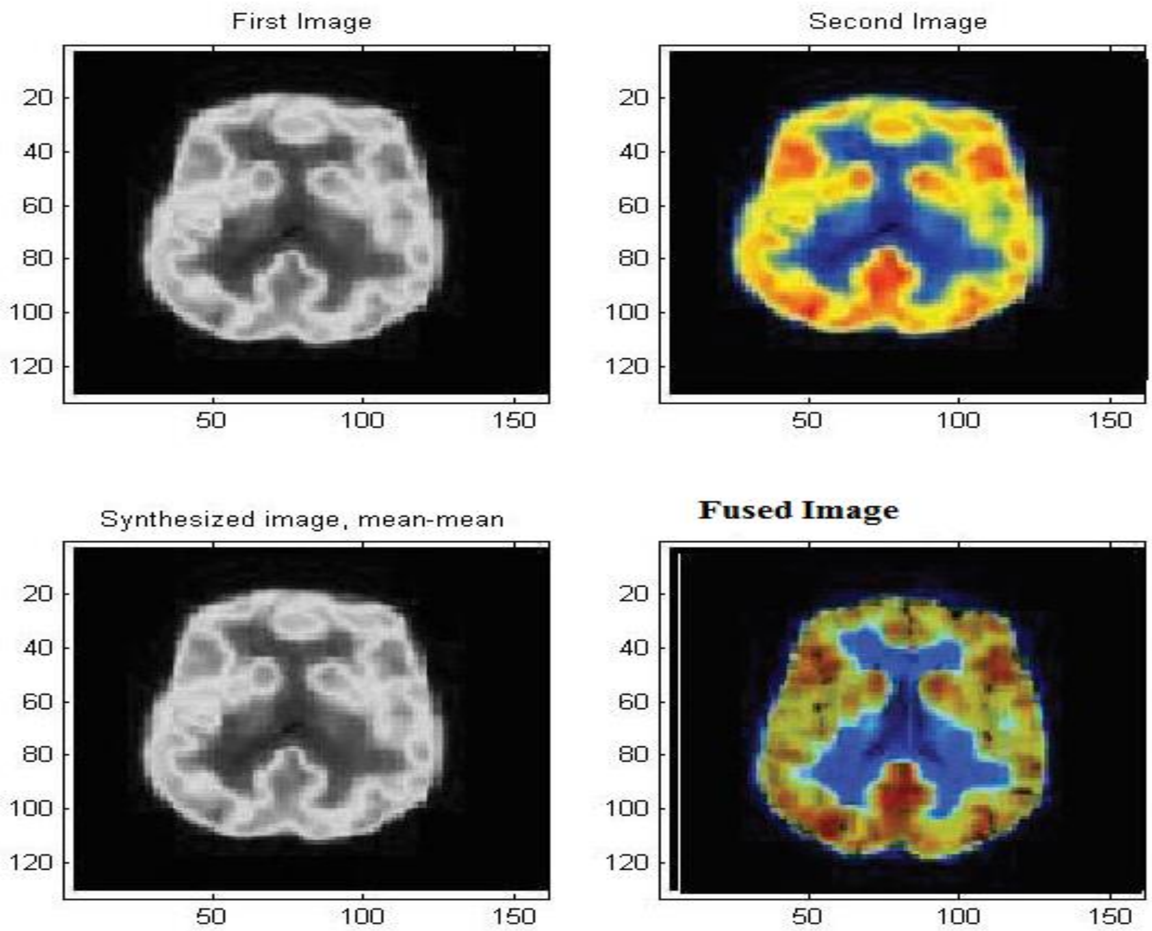

Fig.6. fused image of MRI and PET normal axial

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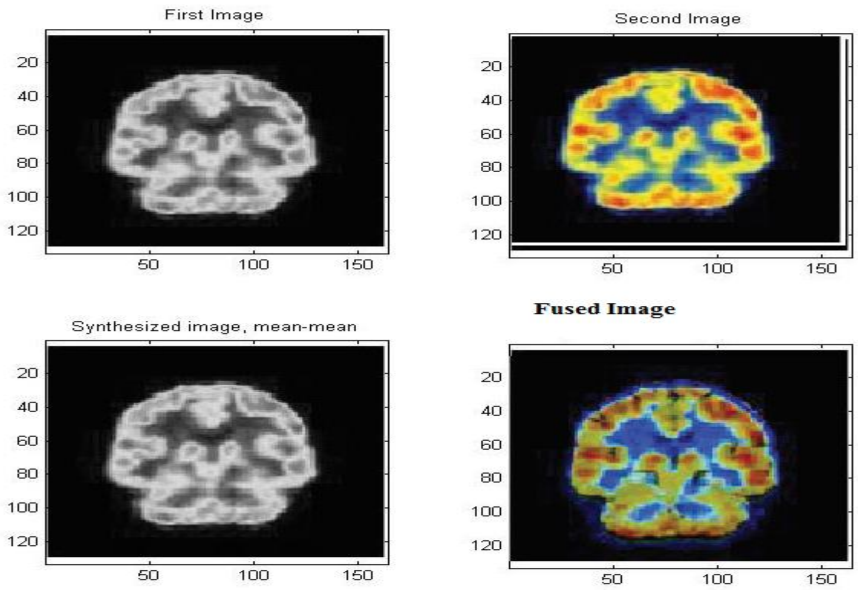

Fig.7. Fused image of MRI and PET normal coronol images

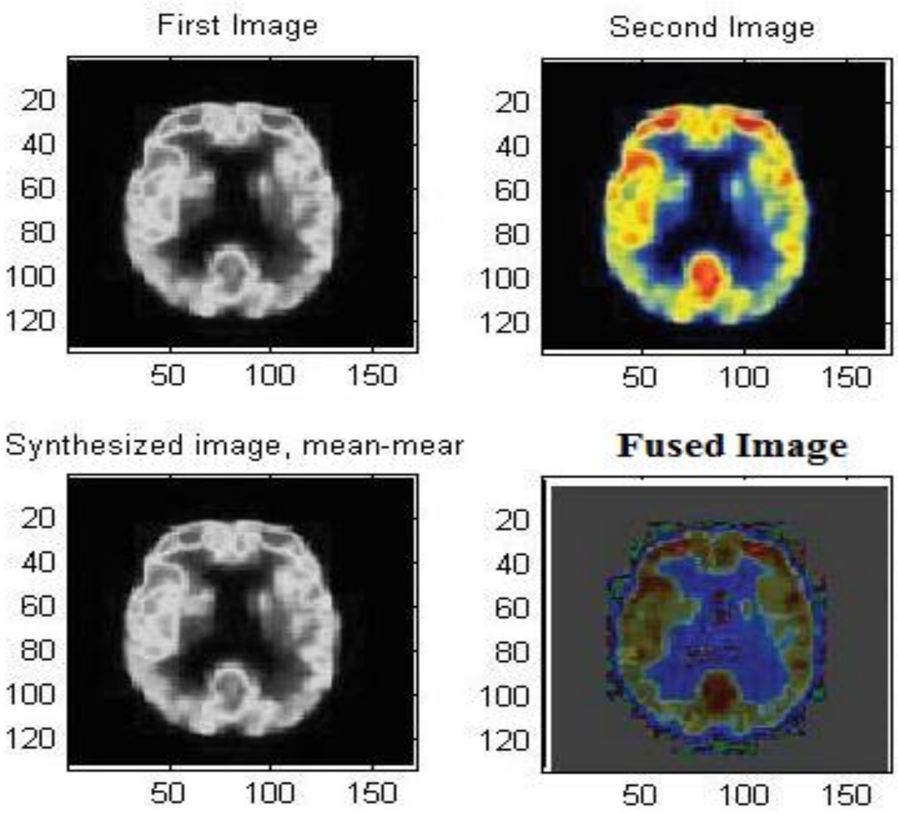

Fig.8. fused image of MRI and PET Alzheimer image

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The graphical representation of the developed system in Matlab is shown in figure 9. In this system the Haar wavelet is used for the fusion approach.

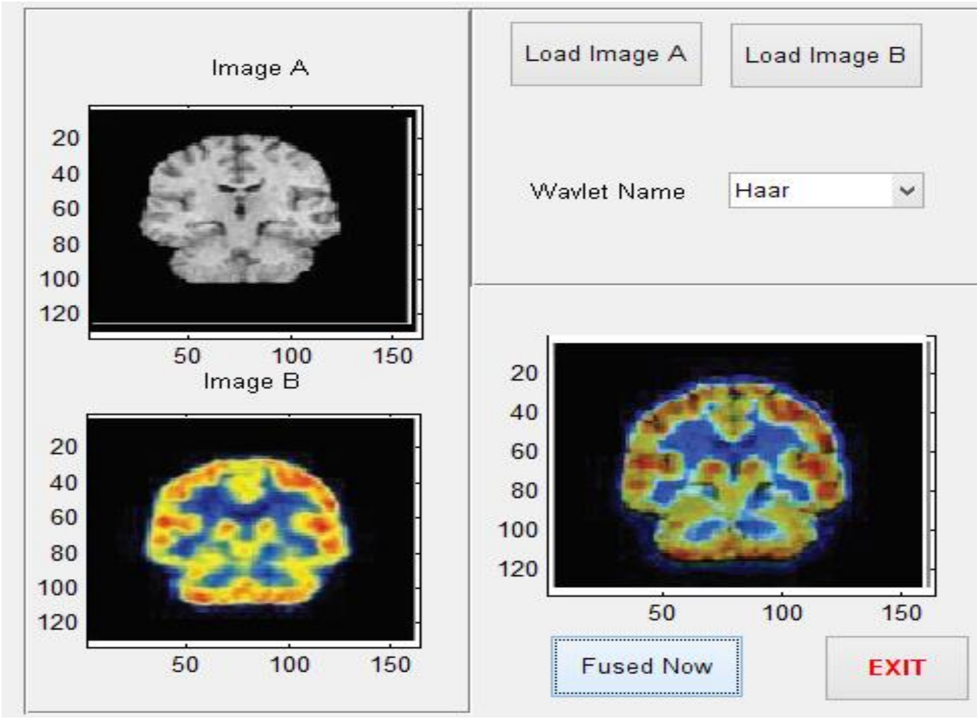

Fig.9. Graphical representation of developed fusion system

From the above experimental results, it is observed that the basic input data has less color distortion and richer anatomical structure information. The system performs the most promising result regarding the three datasets - normal axial, normal coronal and Alzheimer's brain disease images. The system achieved 90-95 % more accurate results with reduced color distortion.

V. CONCLSUION

In this research, we proposed the wavelet based fusion approach for the PET and MRI image. The experiment has tested three dieses dataset named for normal axial, normal coronal and Alzheimer's disease brain images. The wavelet decomposition of the dataset has been done on four levels with low and high activity regions. The quality of the fused image is tested using the MSE and PSNR approach. This proposed method gives 90-95% accuracy for the fusion. The experiment is tested over the haar wavelet approach.

This experiment can be extended towards the haar and db1 wavelet for the three-dimensional medical multi-model database with for fusion.

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