# Diffusion Tensor MRI of Human Heart using Wavelet Based Approach

**A. Monica, D. Devarajan, L. Ramachandran**

***Abstract: Diffusion tensor MRI of human heart is a promising but challenging technique in the medical field. This work proposed the wavelet based image fusion using MRI images and three-dimensional of the diffusion tensor imaging. Medical image fusion is the idea to improve the image content by fusing images taken from different imaging tools like Magnetic Resonance Imaging (MRI) and three dimensional Diffusion Tensor Imaging (DTI) . Then the ten short axis slices images are taken entire heart using multiple shifted trigger delay under free breathing conditions. Then post processing scheme are used the algorithm based on wavelet based image fusion (WIF) method. Diffusion tensor Magnetic resonance image (MRI) image are fused and better it has been compared with existing method. The proposed of Wavelets are decompose the image into different sub-band images.***

***Keywords: Diffusion tensor MRI, Wavelet transform, Image fusion, Haar wavelet based fusion***

## I. INTRODUCTION

Magnetic resonance imaging and three dimensional diffusion tensor of the free breathing human heart image using in this wavelet based image fusion process. Image fusion is the process by which two or more images are combined into a single image retaining the important features from each of the original images. The fusion of images is often required for images acquired from different instrument modalities or capture techniques of the same scene or objects (like multi-sensor, multi-focus and multimodal images). For example, in multi-focus imaging one or more objects may be in-focus in a particular image, while other objects in the scene may be in focus in other images. In the arena of biomedical imaging, two widely used modalities, namely the magnetic resonance imaging (MRI) and diffusion tensor imaging (DTI). The MR images are much superior in depicting the soft tissues in the heart that play very important roles in detecting diseases affecting the skull base. These images are thus complementary in many ways and no single image is totally sufficient in terms of their respective information content. In the exciting systems they are used Principle Component Analysis (PCA). The advantages these images may be fully exploited by integrating the complementary features seen in different images through the process of image.

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**A.Monica**, Department of Electronics and Communication, E.G.S Pillay Engineering College, Nagapattinam (Tamil Nadu), India. E-mail: moninathan04@gmail.com

**D. Devarajan**, Asst. Prof, Department of Electronics and communication, E.G.S Pillay engineering College, Nagapattinam (Tamil Nadu), India. E-mail: devarajand@gmail.com

**L. Ramachandran**, Asst. Prof, Department of Electronics and communication, E.G.S Pillay engineering College, Nagapattinam Tamil (Tamil Nadu), India. E-mail: ramachandran@Egspec.org

Fusion that generates an image composed of features that are best detected or represented in the individual images. Important applications of the fusion of images include medical imaging, microscopic imaging, remote sensing, computer vision, and robotics. The first step toward fusion, which may be interpreted as a pre-processing step is the registration which brings down the constituting images to a common coordinate system as fusion of images is meaningful only when common objects in images have identical geometric configuration with respect to size, location and orientation in all the images. In the next step, the images are combined to form a single fused image through a judicious selection of proportions of different features from different images. In this paper, an image fusion algorithm based on wavelet transform is proposed. In the proposed scheme, the images to be processed are decomposed into sub-images with the same Fusion techniques Several approaches to image fusion can be distinguished, depending on whether the images are fused in the spatial domain or they are transformed into another domain, and their transforms fused. Then the information fusion is performed using high-frequency sub-images.

## II. WAVELET BASED IMAGE FUSION

The wavelet analysis concept is originally proposed by Matlab. Because of simultaneous analysis of both time and frequency, wavelets are used in image processing applications. The main advantage of the wavelet transform is that it can decompose the normal two dimensional images into multi resolution levels. Wavelet transforms are widely used in image fusion, edge detection, and texture analysis and data compression. The basic concept of wavelet based image fusion is to perform the multi resolution decomposition of the individual source images and the decomposed image coefficient combined using fusion rules. Generally coefficients with higher absolute value is selected which provides sharper brightness in the fused image. The fusion is combination of both the approximate coefficients and details coefficients in the source image. In the each decomposition levels, the image size is to be halved so that the multi resolution arrangements are established in both the spatial direction. Wavelet fusion techniques are commonly used to combine multiple images into a single image by retaining desired local features in each image and thus providing a more accurate description of the object. In our case, we would like to collect all of the meaningful diffusion information from the input images (multiple TDs) while discarding the parts that were strongly affected by motion. Fig. 1 shows a schematic diagram to better illustrate the concept and procedure of the WIF approach.


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The basic idea is to perform the multiple scale decomposition on each source image; the transform coefficients of both the low-frequency and high-frequency bands are then fused with a certain pixel-level fusion rule at each scale. The most important aspect in this scheme is the manner of combining the wavelet coefficients. The high-frequency band distribution is different for the images with different motion artifact levels. More specifically, the spreading of the wavelet coefficient distribution of the more motion-corrupted image is narrower than that of a less motion-degraded image. That is to say, the image with more motion effects yields more wavelet coefficients that are close to zero and less wavelet coefficients with large magnitudes compared with the images that are less influenced by motion.

**Steps of wavelet based image fusion are explained below:**

Step 1: Read the set of multi-focus images i.e. here in our proposed algorithm we have consider two images which are of same size (registered images).

Step 2: Apply wavelet decomposition on both the images with the use of Haar wavelets.

Step 3: Extracts from the wavelet decomposition structure [C, S] the horizontal, vertical, or diagonal detail.

Step 4: Perform average of approximation coefficients of both decomposed images.

Step 5: Compare horizontal, vertical and diagonal coefficient of both the images and apply maximum selection scheme to select the maximum coefficient value by comparing the coefficient of the two images. Perform this for all the pixel values of image i.e. m x n.

Step 6: Now apply wavelet decomposition on both the images with the use of Haar wavelet.

Step 7: Display the final fused image.

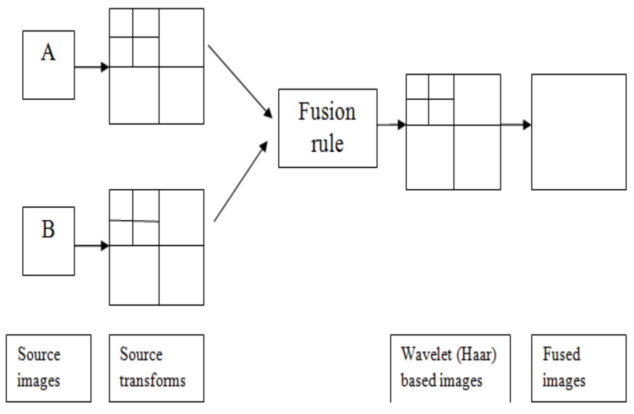


**Fig. 1. Block diagram of wavelet based image fusion**

### 2.1. Wavelet Transformation Method

Wavelet transform has been greatly used in many areas, such as texture analysis, data compression, feature detection, and image fusion. In this section, we briefly review and analyze the wavelet-based image fusion technique. The DWT can be interpreted as signal decomposition in a set of independent, spatially oriented frequency channels. The signal S is passed through two complementary filters and emerges as two signals, approximation and Details. This is called decomposition or analysis. The components can be assembled back into the original signal without loss of information. This process is called reconstruction. An image can be decomposed into a sequence of different spatial resolution images using Haar wavelet method. Wavelet based techniques for fusion of 2-D images is described here. In all wavelet based image fusion techniques the wavelet transforms W of the two registered input images I(x, y) and some kind of fusion rule Ø as show in below equation.

$$I(x,y) = W\text{-}1\ (Ø\ (\ W(\ I_1(x,y)\ ),\ W(\ I_2(x,y)\ )\ )$$

In the case of wavelet transform based fusion method, all respective wavelet coefficients from the input images are combined using the fusion rule Ø. Since wavelet coefficients having large absolute values contain the information about the salient features of the images such as edges and lines, a good fusion rule is to take the maximum of the corresponding wavelet coefficients.

### 2.2. Fusion Rules

Fusion rules determine how the source transforms will be combined:

- Fusion rules may be application dependent
- Fusion rules can be the same for all sub-bands or dependent on which sub-band is being fused.

There are two basic steps to determine the rules:

- compute measures corresponding to the individual source transforms
- decide how to combine the coefficients
- After comparing the measures

### 2.3. Image Fusion

Let $I_1(x, y)$, $I_2(x, y)$, in(x, y) be the n registered images to be fused. The decomposed low frequency also referred to as the approximation coefficient sub-images be $lI_{1j}(x,y)$, $lI_{2j}(x,y)$, … $lI_{nj}(x,y)$ and decomposed high frequency also called as the detailed coefficients be $hI1j^k(x,y)$, $hI_{2j}{}^k(x,y)$, … $hI_{nj}{}^k(x,y)$ respectively, where "j" is the parameter of resolution, j=1,2…J and for every "j", "k" = 1,2,3 which represent directional sensitive wavelet decomposition namely along horizontal, vertical and diagonal directions.

For every even parameter of resolution i.e. j=2, 4…J, the magnitude of the gradient of the image generated from the high frequency components be $GI_{ij}{}^k(x, y)$, i=1, 2…n.

For every odd parameter of resolution i.e. j=1, 3, J, the relative smoothness of the image generated from the high frequency components be $RI_{ij}{}^k(x, y)$, i=1, 2…n.

The fused high frequency sub-images are evaluated as:

$$I_n{}^k(x,y)= hI_{pj}{}^k(x,y)$$

Where $GI_{pj}{}^k(x,y)=maxi\{GI_{ij}{}^k(x,y)\}$ For j=2,4….J, k=1,2,3

$$I_j{}^k(x,y)=hI_{pj}{}^k(x,y)$$

If $RI_{pj}{}^k(x,y)=maxi\{RI_{ij}{}^k(x,y)\}$ For j=1,3..J , k=1,2,3

The fused low frequency sub-images are:

$$Ij(x,y)=\sum_{i=1}^{n} c_i lI_{ij}(x,y)$$

where $ci$ is the parameter which determine the contribution from each image.

## III. PROPOSED SYSTEM AND EQUATIONS

### 3.1. Haar wavelet based image fusion

Haar wavelets are also known as rescaled sequence of "square-shaped" function which is one of the oldest and simplest wavelets. Since it is not continuous in nature, it cannot be differentiable. Wavelet function $\varphi(t)$ and scaling function $\emptyset(t)$of the Haar wavelet is represented as:

$$\varphi(t) = \begin{cases} 1 & 0 \le t < 1/2 \\ -1 & \frac{1}{2} \le t < 1 \\ 0 & otherwise \end{cases}$$

$$\emptyset(t) = \begin{cases} 1 & 0 \le t < 1 \\ 0 & otherwise \end{cases}$$

Haar Wavelet based image fusion method
The process can be divided into three steps.
a) Wavelet decomposition using Haar
b) Details information combination
c) Inverse wavelet transforms

- Use the wavelet transforms to decompose new free breathing diffusion tensor MRI images and different bands of multispectral image twice, respectively.
- Add the detail images of the decomposed MRI images at different levels to the corresponding details of different bands in the multispectral image and obtain the new details component in the different bands of the
Multi spectral image and obtain the new details component in the different bands of the multispectral image.
- Perform the wavelet transform on the bands of multi spectral images, respectively and obtain the fused image.

### 3.2. Merits in Proposed System

1. High Performance Accuracy.
2. The region of fused image preserved effectively after reconstruction.
3. This method is suitable for Multi scale and non multi scale decomposition fusion process
4. It gives better contrast information.

## IV. RESULT

It retains most of the advantages for image fusion but has much more complete theoretical support. It represents level decomposition of fused image in our proposed Haar Transform method.

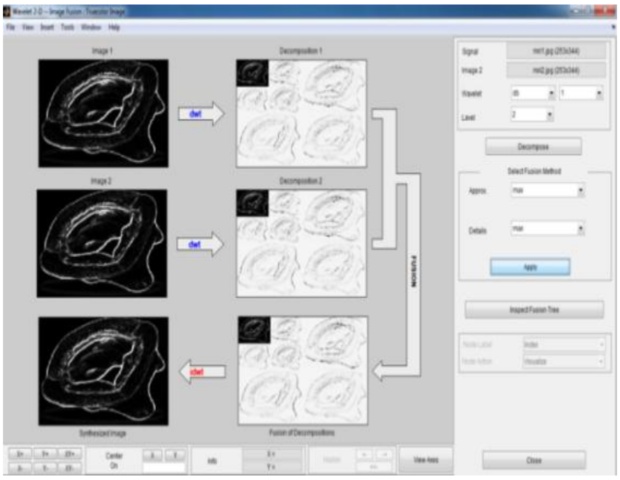

FIG. 2.FUSED IMAGE

Image decomposition on first level and second level using wavelet transform. Displays the result of the fusion Of MRI images, using the haar wavelet algorithm as a fusion rule, and two levels for images decomposition. The fusion algorithm is integrated into an application which also offers some facilities for image processing.

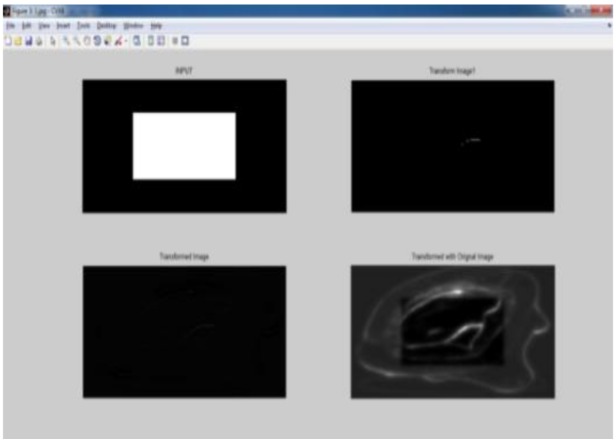

FIG. 3.TRANSFERED IMAGE

This is the three dimensional diffusion tensor of the decomposition fusion image.

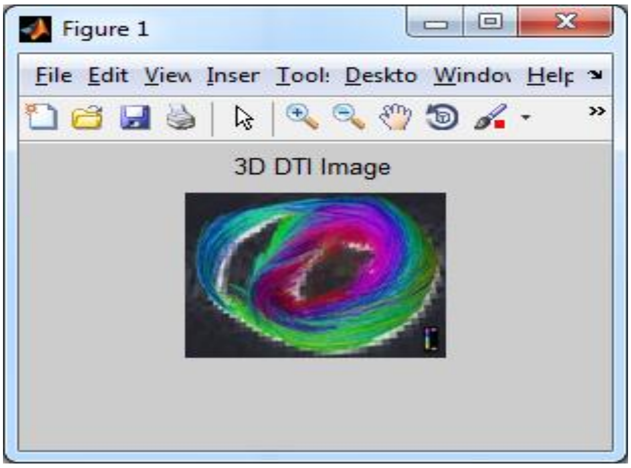


FIG. 4.DIFFUSION TENSOR IMAGE


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## V. CONCLUSIONS

The medical image fusion is a very important technique and there is a real interest in this kind of applications. There are many methods for realizing this purpose and they have to be studied to choose the better one to a dedicated domain. In conclusion, using wavelet transform and get a good fusion image of MRI compared to the two MRI .The proposed DWT based image fusion method is implement in MATLAB using wavelet families .and that fused image provide the better information of MRI images. The signal to noise ratio and standard deviation is same in all the wavelet families. In this paper a method is proposed for MRI image by fusion of two images. By taking MRI images of heart and decomposed the images into single level separately and then fused them before applying inverse DWT. Now we get a single image.

Then the single images are converted the three dimensional diffusion tensor imaging by using Matlab. Haar wavelet algorithms offer a wide variety of approaches for modifying images to achieve visually acceptable images.

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