

## Medical Image Fusion Based on Improved Wavelet Transform

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**Abstract:** *The objective of Image fusion is to combine information from multiple images of the same scene in to a single image retaining the important and required features from each of the original image. Nowadays, with the rapid development in high-technology and modern instrumentations, medical imaging has become a vital component of a large number of applications, including diagnosis, research, and treatment. Medical image fusion is the idea to improve the image content by fusing images taken from different imaging tools like Computed Tomography (CT), Magnetic Resonance Imaging (MRI). For medical diagnosis, Computed Tomography (CT) provides the best information on denser tissue with less distortion. Magnetic Resonance Image (MRI) provides better information on soft tissue with more distortion [1]. In this case, only one kind of image may not be sufficient to provide accurate clinical requirements for the physicians. Therefore, the fusion of the multimodal mmedical images is necessary. This paper presents a method of image fusion based on discrete wavelet transform. 2- D DWT is used to decompose the image. The fusion performance is evaluated on the basis of the mean square error (MSE) and peak signal to noise ratio (PSNR).*

**Keywords:** *CT scan, MRI scan, DWT, MSE, PSNR*

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### 1. INTRODUCTION

The term fusion means in general an approach to extraction of information acquired in several domains. The objective of Image fusion is to combine information from multiple images of the same scene in to a single image retaining the important and required features from each of the original image. The main task of image fusion is integrating complementary information from multiple images in to single image. The resultant fused image will be more informative and complete than any of the input image and is more suitable for human visual and machine perception. Image fusion is the process that combines information from multiple images of the same scene. Medical image fusion is the technology that could compound two mutual images in to one according to certain rules to achieve clear visual effect. By observing medical fusion image, doctor could easily confirm the position of illness. Medical imaging provides a variety of modes of image information for clinical diagnosis, such as CT, X-ray, DSA, MRI, PET, SPECT etc. Different medical images have different characteristics, which can provide structural information of different organs. For example, CT (Computed tomography) and MRI (Magnetic resonance image) with high spatial resolution can provide anatomical structure information of organs. And PET (Positive electron tomography) and SPECT (Emission computed tomography) with relatively poor spatial resolution, but provides information on organ metabolism. Thus, a variety of imaging for the same organ, they are contradictory, but complementary and interconnected. Therefore the appropriate image fusion of different features becomes urgent requirement for clinical diagnosis. In this paper, a novel approach for the fusion of computed tomography (CT) and magnetic resonance images (MR) images based on wavelet transform has been presented. Different fusion rules are then performed on the wavelet coefficients of low and high frequency portions. The registered computer tomography (CT) and magnetic resonance imaging (MRI) images of the same people and same spatial parts have been used for the analysis.

### 2. IMAGE FUSION BASED ON WAVELET TRANSFORM

“Wavelet transforms allow time – frequency localization” Wavelet means “small wave” so wavelet analysis is about analyzing signal with short duration finite energy functions.

They transform the signal under investigation in to another representation which presents the signal in a more useful form. Mathematically, we denote a wavelet as;

$$\psi_{a,b}(t) = \frac{1}{\sqrt{|a|}} \psi((t-b)/a)$$

Where b= is location parameter

a= is scaling parameter for a given scaling parameter a, we translate the wavelet by varying the parameter b. we define the wavelet transform as

$$w(a,b) = \int_t f(t) \frac{1}{\sqrt{|a|}} \psi((t-b)/a)$$

According equation, for every (a, b), we have a wavelet transform co-efficient, representing how much the scaled wavelet is similar to the function at location,

$$t = b/a$$

“If scale and position is varied very smoothly, then transform is called continuous wavelet transform.”

“If scale and position are changed in discrete steps, the transform is called discrete wavelet transform.”

Image fusion method can be generally grouped in to three categories

### 3. EXISTING FUSION METHODS

#### 3.1. Average Method

In this method the resultant fused image is obtained by taking the average intensity of corresponding pixels from both the input image.

$$F(x, y) = (A(x, y) + B(x, y)) / 2$$

Where A (x, y), B (x, y) are input image and F (x, y) is fused image. And point (x, y) is the pixel value.

For weighted average method

$$F(x, y) = \sum_{x=0}^m \sum_{y=0}^n (WA(x, y) + (1-W)B(x, y))$$

Where W is weight factor and point (x, y) is the pixel value.

#### 3.2. Select Maximum

In this method, the resultant fused image is obtained by selecting the maximum intensity of corresponding pixels from both the input image.

$$F(x, y) = \sum_{x=0}^m \sum_{y=0}^n \text{Max}(A(x, y) + B(x, y))$$

Where A (x, y), B (x, y) are input image and F (x, y) is fused image, and point (x, y) is the pixel value.

#### 3.3. Select Minimum

In this method, the resultant fused image is obtained by selecting the minimum intensity of corresponding pixels from the both the input image.

$$F(x, y) = \sum_{x=0}^m \sum_{y=0}^n \text{Min}((A(x, y) + B(x, y)))$$

Where A (x, y), B(x, y) are input image F(x, y) is fused image and the point (x, y) is the pixel value.

### 3.4. Laplacian Pyramid

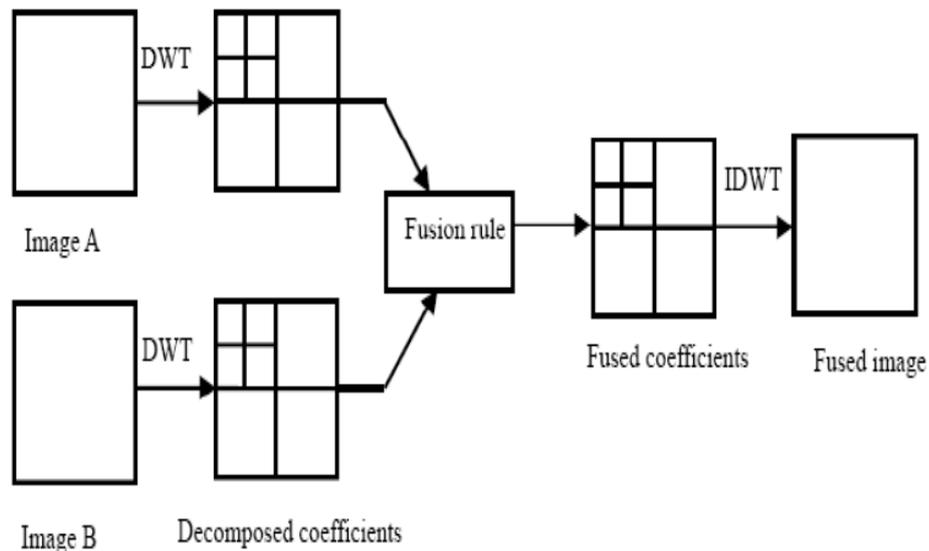
The Laplacian Pyramid implements a “pattern selective” approach to image fusion, so that the composite image is constructed not a pixel at a time. The basic idea is to perform a pyramid decomposition on each source image, then integrate all these decompositions to form a composite representation, and finally reconstruct the fused image by performing an inverse pyramid transform.

### 3.5. Demerits in Existing Systems

1. In Simple Average method the disadvantage is undesirable side effect such as reduced contrast.
2. Blurring effect is more in Select maximum method.
3. Resultant fused image is not clear in Select minimum method.
4. In laplacian pyramid method the edges of the source images are not preserved effectively in fused image. That's why we are going to DWT, where we can preserve the edges of source images perfectly and also we can get improved PSNR, Entropy and RMSE.

## 4. PROPOSED SYSTEM

### 4.1. Image Fusion by Wavelet Process



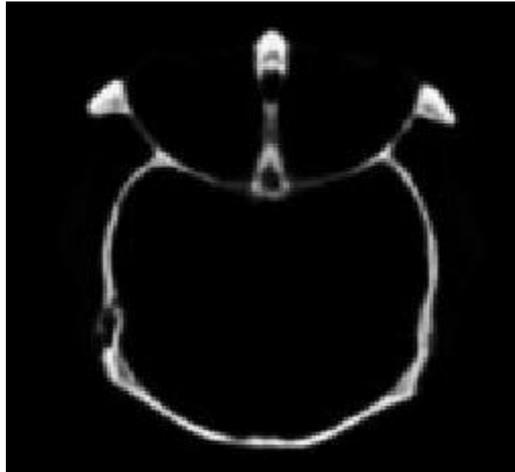
**Fig. Block Diagram of DWT**

The source images such as CT and MRI are subjected to DWT (It is a local transformation from time and frequency domain and easily generate a variety of different resolution images). It decomposes the image into different sub band images, namely, LL, LH, HL, and HH. A high-frequency sub band contains the edge information of input image and LL sub band contains the clear information about the image, enhancing the appearance of the image with help of this sub bands information for fusion process. The clarity based selection algorithm can be used to fuse the high-frequency coefficients obtained from the source images and the high-frequency enhanced coefficients. The low frequency coefficients obtained from the source images and the low-frequency enhanced coefficients can be fused in terms of weighted fusion algorithm. Carry Inverse Discrete Wavelet Transform on fused decomposed level, for reconstruction of final fused image. 2-D DWT is very useful for image processing because the image data are discrete and the spatial-spectral resolution is dependent on the frequency. The DWT has the property that the spatial resolution is small in low-frequency bands but large in high-frequency bands. The left-top sub-image (the band with lowest frequencies) has the smallest spatial resolution and represents the approximation information of the original image. Thus, the DWT is suitable for image compression. On the contrast, the other sub-images (the bands with high frequencies) show the detailed information of the original image. Therefore, these sub-images can be used for edge detection or corner detection.

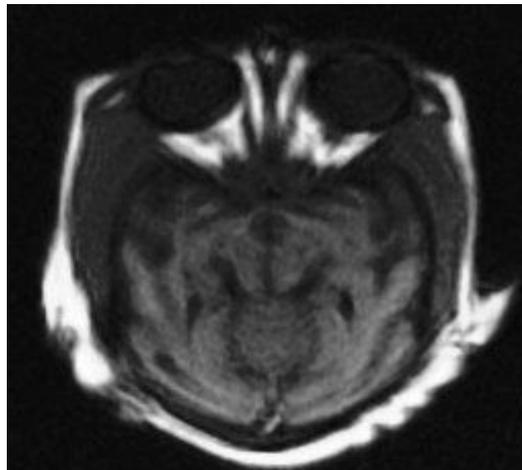
#### 4.2. Merits in Proposed System

1. High Performance Accuracy.
2. The edges 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.
5. The Parameters obtained from this technique are: Entropy: 10.52, RMSE: 30, PSNR: 42.56 which are better than the Laplacian pyramid technique (Entropy: 10.36, RMSE: 30, PSNR: 31.922) and other Existing techniques.

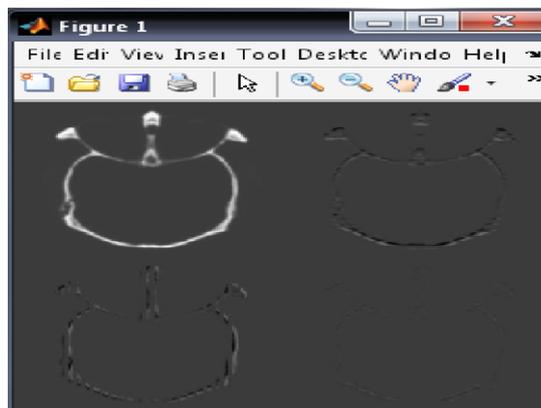
#### 5. RESULTS



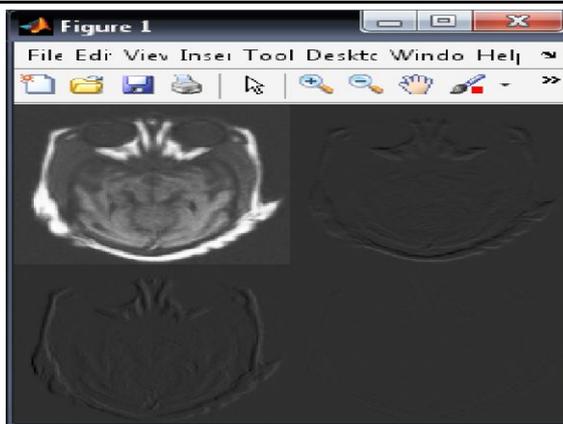
**Fig1.** *CT scan image*



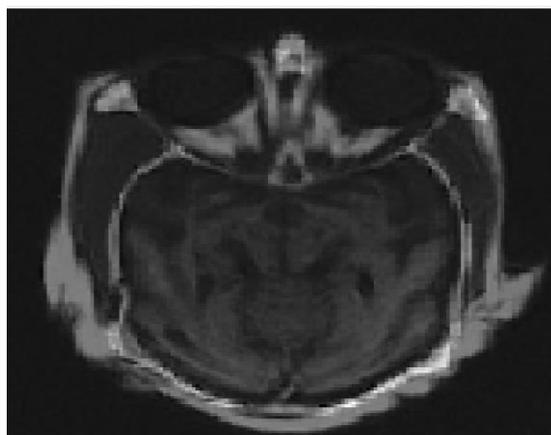
**Fig2.** *MRI scan image*



**Fig3.** *Wavelet decomposition of CT scan image*



**Fig4.** Wavelet decomposition of MRI scan image



**Fig5.** Fused image

### 6. CONCLUSIONS & FUTURE SCOPE

We have combined the wavelet transform and various fusion rules to fuse CT and MRI images. This method gives encouraging results in terms of smaller MSE and higher PSNR values. Among all the fusion rules, the maximum fusion rule performs better as it achieved least MSE and highest PSNR values. Using this method we have fused other head and abdomen images. The images used here are gray scale CT and MRI images. However, the images of other modalities (like PET, SPECT, and X-ray etc) with their true colour nature may also be fused using the same method. Wavelet based image fusion is further implemented in Fusion of Rader and optical data and in the Development of the partial and spectral quality of a fused image.

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