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Fusion of Medical Images in Matlab Using Different Wavelet Parameters

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Abstract:
Fusion of Medical images derives useful information from medical images containing the data which has important clinical significance for doctors during their analysis. The idea behind the concept of image fusion is to improve the image content by fusing two images like MRI (Magnetic resonance imaging) & CT (Computer tomography)images to provide useful &precise information for doctor for their clinical treatment. In this paper Discrete Wavelet Transforms (DWT) method has been used to fuse two medical images to decompose the functional & anatomical images. The fused image contains both functional information and more spatial characteristics with no color distortion. In the proposed work different fusion experiments are performed on Medical images by using seven wavelet transform methods- Bior, coif, db, dmey, haar, rbio and sym. Further explores the comparision between all fused image using the measuring parameters Entropy & standard deviation. Experimental results show the best fusion performance is given by the Symlets (sym) wavelet transform.

Keywords:
Image fusion, Frequency, CT, MRI, Entropy, 2-D Discrete wavelet transform Fusion metrics, Phase information.

I.INTRODUCTION:

I. In Image fusion process a fused better visualized image is formed by combining two or more images to retrieve the vital information from these images [1]. Image fusion techniques, merge& integrate the complementary information from multiple image sensor data & makes the image more suitable for the visual perception and processing. Image fusion process extracts all the useful information to minimize redundancy & reduce uncertainty from the source images . Image fusion can combine information from two or more images into a single composite image which become more informative and more suitable for computer processing & visual perception.

II. For further analysis and diagnosis. But it is necessary to align two images accurately before they fused [3].Before fusing images, all features should be preserve in the images and should not introduce any inconsistency or artifacts,so that it could not distract the observer. The advantages of image fusion are improved capability and reliability. The fused image should not have any undesired feature. The idea behind the image fusion concept is that the fused image after image fusion method should posses all relevant information[2] .The fusion of multi-modality imaging increasingly plays an important role in medical imaging field as the extension of clinical use of various medical imaging systems .Different medical imaging techniques may provide scans with complementary and occasionally redundant information. The fusion of medical images can lead to additional clinical information not apparent in the single images. However, it is diffic algorithms of image. The Mexican Hat,Morlet and Meyer, ult to simulate the surgicalability of image fusion when algorithms of image.

III. The Mexican Hat,Morlet and Meyer, wavelets are symmetric in shape,processing are piled up merely.

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So many solutions to medical diagnostic image fusion have been proposed today. Registered medical MRI and CT images of the same people and same spatial part are used for fusion.

II.IMAGE FUSION BASED ON DIFFERENT WAVELET TRANSFORMS:

The original concept and theory of wavelet-based multi resolution analysis gave by mallat. Wavelet transform has increasingly important in image fusion since wavelet allows both time & frequency analysis simultaneously. The wavelet transform is nothing but a mathematical tool. It can detect local features in a signal process and also can be used for multi resolution analysis to decompose two-dimension (2-D) signal such as 2-D gray scale image signals into different resolution levels. At first compute the wavelet transforms of images, then decompose the image into various sub images based on local frequency content and by choosing the salient wavelet coefficients; a composite multi-scale representation is built [4].The common integration rule is that the coefficients whose absolute values are higher being selected at every point in the transform domain. The larger absolute wavelet transform coefficients correspond to sharper brightness changes. In this way the fusion takes place in all the resolution levels and the more dominant features at each scale are preserved in the new multi resolution representation. Anew image has been constructed with the help of specific rules of decision or weighting by performing an inverse wavelet transformation. In wavelet transformation, at each level of decomposition process, the image size is halved which lead to a multi-resolution signal representation, in both spatial directions. Different types of wavelet methods has been used in image fusion process such as Biorsplines (bior), coiflets (coif), daubechies (db), dmeyer (dmey), Haar (haar),reverse bior (rbio) and symlets (sym). Daubechies wavelets are the most popular wavelets among all of them[5].Daubechies wavelet used in many applications & are supposed to be the foundation signal processing. Coiflets, Haar, Symlets Transform measuring the & Daubechies, are capable ofperfect reconstruction &compactly supported orthogonal wavelets. The Mexican Hat, Morlet and Meyer, wavelets are symmetric in shape. Bi orthogonal wavelet exhibits the property of linear phase &needed for image reconstruction and signal processing. These wavelets are chosen in a particular application based on their ability and their shape to analyze the signal the wavelets. Wavelet transforms has two groups i.e. DWT (discrete wavelet transforms) & CWT (continuous wavelet transforms).DWT has the features of fast operational speed and occupies less memory & also maintains the characteristics of wavelet. The continuous function transforms into a highly redundant function of two continuous variables; translation & scale in CWT.[5] In this paper, image fusion process is carried out in MATLAB using DWT method. The concept and procedure of the wavelet based fusion technique has been presented

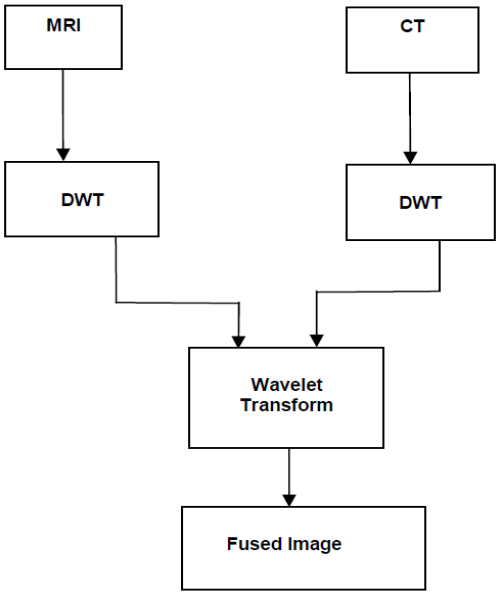

Fig.1 Block Diagram

The discrete wavelet transform (DWT) is the one of The most commonly used and simplest wavelet transform for image fusion. Wavelet theory improves spatial resolution and spectral characteristics. A signal is decomposed, with each level corresponding to a coarser resolution or lower frequency band, and higher frequency bands by Wavelet transform.

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Using the Matlab Image Fusion tool, the fusion has been carried out to give a fused & detailed image.

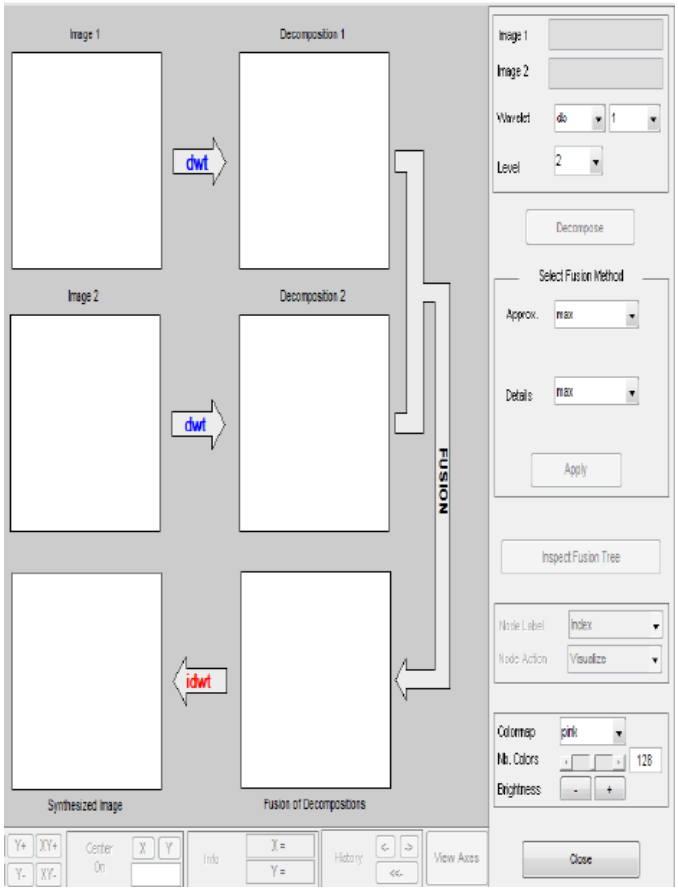

Fig.2 Matlab Image Fusion Tool For Fusion Of Medical Images

The wavelet series expansion maps the function of a continuous variable into a sequence of coefficients [22]. If the function being expanded is a sequence of numbers, such as samples of a continuous function the resulting coefficients are called the discrete wavelet transform (DWT)of .The series expansion becomes the DWT transform pair For j ≥ jo and Here and are functions of the discrete variables = 0, 1, 2……., N-1. The 'sand 's in equation (1, 2, 3) correspond to the cj0(k)'s and dj(k)'s of the wavelet series expansion . The integrations in the series expansion have been replaced by summations, and a normalizing factor.

III.PERFORMANCE ASSESSMENT:

Although wavelets share some common properties, fusion results varies because of their unique image Reconstruction and decompression characteristics.

The general requirement is to preserve all valid and useful pattern information from the source images and also it should introduce artifacts that could interfere with subsequent analyses simultaneously. The performance measures used in this paper are SD (Standard Deviation)& EN (entropy). It provides quantitative comparison among different fusion schemes. It focuses mainly at measuring the definition of an image[6].

Standard Deviation (SD):

The standard deviation (SD) is the among the most commonly used assessment measure of statistical dispersion, SDevaluate how widely spread the gray values in an image and measures the fused image contrast. SD denotes the deviation degree of the estimation and the average of the random variable. SD produces best results in the absence of noise. An image with high contrast would have a high standard deviation. For better results SD should be at the higher end histogram formulation. An image with high standard deviation having the high contrast for an image. Where is the normalized histogram of the fused image and L is number of frequency bins in histogram.

Entropy (EN):Shannon was the first person to introduce entropy to quantify the information. Entropy is a quantitative measure. Entropy defined as the amount of information contained in a signal. The concept of EN has been employed in many scientific fields as well as in image processing methods and it contains the information content of an image[7]. Entropy is an parameter to evaluate the information quantity contained in an image. Entropy defines the information in the digital numbers in images as a frequency of change .Entropy reflects an average information content of an image. When each gray level has the same frequency, then the Entropy has

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$$\sum_{i=1}^{G} P(i)\ log_2\ (P(d_1))$$

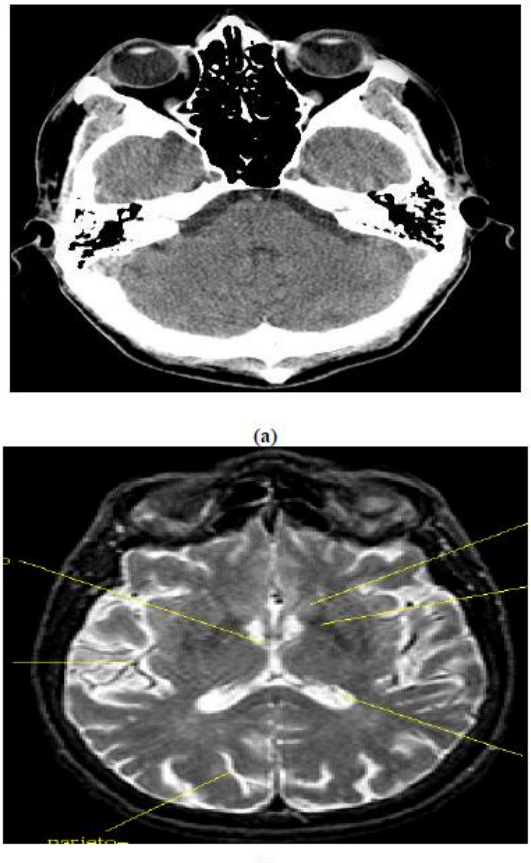
Where G is the number of possible gray levels, P (di) is probability of occurrence of a particular gray level di.The fused image contains abundant information if the entropy value is large. Information entropy is used for comparing the difference of image details. Entropy is defined as

$$E = -\sum_{i=0}^{L-1} p_i \log_2 p_i$$

Where L is the total of grey levels, $p = \{p_0, p_1 \ldots p_{L-1}\}$ is the probability distribution of each level.

IV.EXPERIMENTAL RESULTS:

The MRI& CT medical images (Fig. 3) are used in this fusion experiment. The simulations are performed on these CT scan and MRI Medical images for 7 different wavelet transform methods (Bior, coif, db, dmey, haar, rbio and sym) Fig. 4.In the whole work the LR Fusion – Max wavelet coefficient is used. The comparison of all fusion results (TABLE 1) clearly show that fused images have minimum /maximum Entropy 2.5719/2.5969 for Dmeyer (dmey) and Symlets (sym) Wavelet Transforms respectively. The minimum/ maximum values of In this context, sampling means taking measurements of the continuous image signal at different instants of time. Each measurement can be thought of as a single stationary image. A common problem associated with image digitization is aliasing. The sampling theorem states that for a signal to be completely reconstructed able, it must satisfy the following equation: In an 8 bit sampling and quantization process, for example, the interval of voltage signals is divided into 256 sub intervals of equal length. In the quantization process, All wavelet transforms may be considered forms of time-frequency representation for continuous-time (analog) signals and so are related to harmonic analysis.



(a)

(b)

Fig.3 Original Medical Images To Be Fused (a) CT Image (b) MRI Image

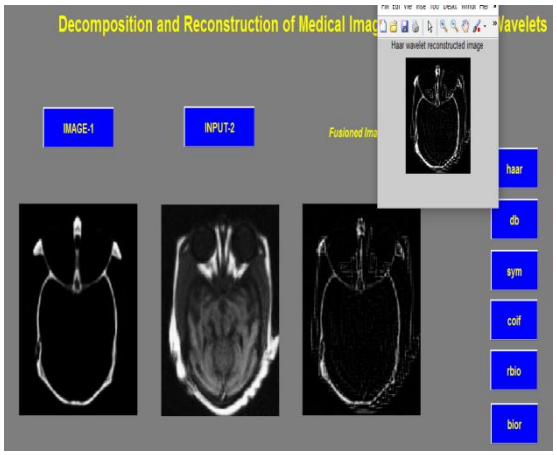


Fig.4 Fused Image

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In formal terms, this representation is a wavelet series representation of a square-integrable function with respect to either a complete, ortho normal set of basic functions, or an over complete set or frame of a vector space extract information from many images

V.CONCLUSIONS:

In this paper, the image fusion of MRI &CT medical images is done using fully automated wavelet transforms in MATLAB environment. The synthesized image has the qualities of both MRI &CT fused images. The different fusion methods used are - Bior, coif, db, dmey, haar, rbio and sym. Further the comparative analysis of a number of image fusion techniques helps in selecting the best fusion method and therefore one can obtain better visualization of the fused image. The worst entropy & Standard Deviation are obtained for Dmeyer (dmey) &Coiflets (coif) wavelet transforms respectively. The Symlets (sym) wavelet transform gives best Entropy & Standard Deviation[8] .Thus the Symlets (sym) fusion method with LR Fusion – Max wavelet coefficients outperforms other fusion methods.

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