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RESEARCH ARTICLE

DECOMPOSITION AND RECONSTRUCTION OF MEDICAL IMAGES IN MATLAB

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ABSTRACT

Decomposition and Reconstruction Method provide directional information in decomposition levels and contain unique information at different resolution. The idea behind the concept of image fusion is to improve the image content by fusing two images like MRI and CT images to provide useful and precise information for doctor for their clinical treatment in one image. Discrete Ripplet Transform is a higher directionality and localization of the transform such edges. Discrete Wavelet Transform suffer from discontinuity of the image. So, use combination of DWT and DRT method has better image than DWT. So in future the ripplet transform can solve the discontinuity in the image. So for improving the image the combination of DWT and DRT can be use.

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INTRODUCTION

Image Fusion is a process of combining the relevant information from a set of images, into a single image, where in the resultant fused image will be more informative and complete than any of the input images. 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, research, and treatment. In order to support more accurate clinical information for physicians to deal with medical diagnosis and evaluation, multimodality medical images are needed, such as X-ray, computed tomography (CT), magnetic resonance imaging (MRI), magnetic resonance angiography (MRA), and positron emission tomography (PET) images. However when larger number of sources of medical images are used in clinics, the problem of "Information Overload'' is caused. Image fusion techniques, merge and integrate the complementary information from multiple image sensor data and makes the image more suitable for the visual perception and processing. Image fusion process extracts all the useful information to minimize redundancy and reduce uncertainty from the source images. The image is decomposed into spatial frequency bands at different scales in wavelet transform method, such as low-low, high-high, and high- low and low-high band. The average image information is given by the low-low band.

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Other bands High-high, High-low contain directional information due to spatial orientation. In high bands higher absolute values of wavelet coefficients correspond to salient features such as edges or lines. The common element idea in almost all of them is the use of wavelet transforms to decompose images into a multi resolution scheme. MRI images provide greater contrast of soft tissues of brain than CT images, but the brightness of hard tissues such as bones is higher in CT images. CT andMRI images individually have some shortcomings such as MRI images not concentrate on hard tissues and in CT image soft tissues can't be clearly visible. In this paper image fusion of CT and MRI images has been carried out so that the fused image which is the combination of soft and hard tissues proven as the focused image for doctors and their clinical treatment by using the DWT and DRT.

Related Work

This section gives information about the related work done for the Image Fusion by the Discrete Wavelet Transform and Discrete Ripplet Transform. (Yong Yang *et al*., 2010)

Discrete Wavelet Transform (DWT)

Discrete Wavelet Transform (DWT) is the most commonly used wavelet transform for image fusion which provides spectral as well as increased directional information with three spatial orientations that is vertical, horizontal and diagonal. (Yong Yang *et al*., 2010)

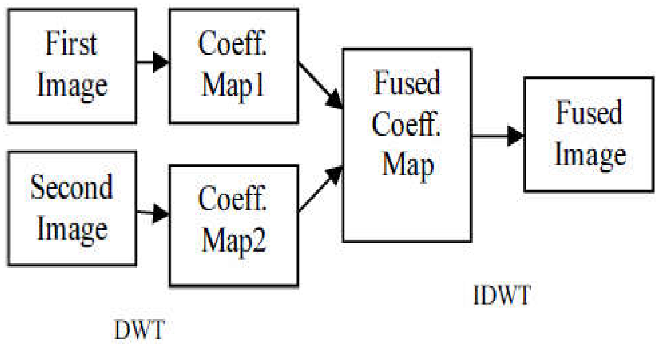

Fig. 1 Discrete Wavelet Transform

The discrete wavelet transform is combination of two processes that is decomposition and reconstruction.

DWT Decomposition

In discrete wavelet transform (DWT) decomposition, the filters are specially designed so that successive layers of the pyramid only include details which are not already available at the preceding levels. (Kusum Rani and Reecha Sharma, 2013) The DWT decomposition uses a cascade of special low-pass and high-pass filters and a sub-sampling operation. The outputs from 2D-DWT are four images having size equal to half the size of the original image. So from first input image we will get HHa, HLa, LHa, LLa images and from second input image we will get HHb, HLb, LHb, LLb images. LH means that low-pass filter is applied along x and followed by high pass filter along y. The LL image contains the approximation coefficients. LH image contains the horizontal detail coefficients. HL image contains the vertical detail coefficients; HH contains the diagonal detail coefficients. The wavelet transform can be performed for multiple levels. The next level of decomposition is performed using only the LL image. The result is four sub-images each of size equal to half the LL image size.

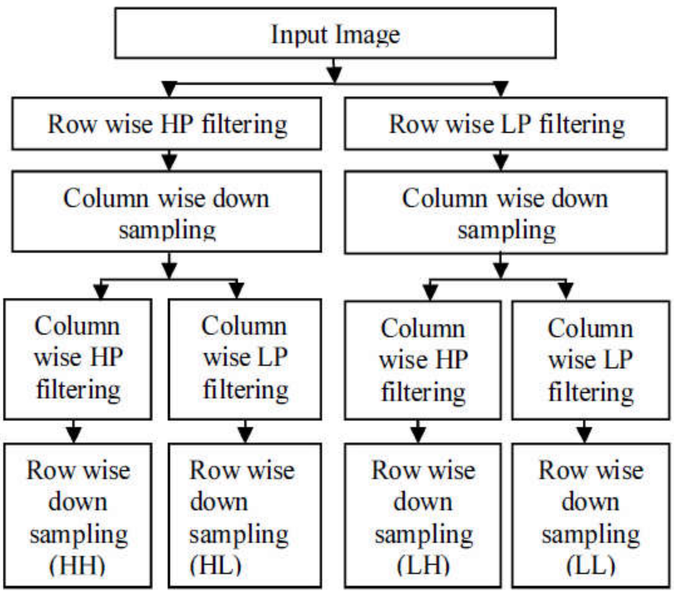

Fig. 2. DWT Decomposition

Discrete Ripplet Transform (DRT)

The ripplet transform overcomes the disadvantages of the wavelet transform. It represents the edges in the images more efficiently. The images are represented at different scales and different directions. (Kavitha *et al.*, 2014) For the scale parameter a, we sample at dyadic intervals. The position parameter b and rotation parameter Θ are sampled at equal-spaced intervals. a, →b and Θ are substituted with discrete parameters a_j, $\to b_k$ and Θ_l, which satisfy that $a_j = 2^{-j}$, $\to b_k = [c \,.\, 2^{-j} \,.\, k_1, 2^{-j/d} \,.\, k_2]^T$ and $\Theta_l = 2\ /c.2^{-\lfloor j(1-1/d)\rfloor}.l$, where $\to k=[k_1, k2]^T$, $(.)^T$ denotes the transpose of a vector and j,k_1, k_2, l € Z. The degree of ripplets can take value from R. Since any real number can be approximated by rational numbers, we can represent d with d = n/m, n,m n≠0 € Z. Usually, we prefer n, m €N and n,m are both primes. In the frequency domain, the corresponding frequency response of ripplet function is in the form

$$\hat{\rho}_j(r,\omega) = \frac{1}{\sqrt{c}} a^{\frac{m+n}{2n}} W(2^{-j}\cdot r) V\left(\frac{1}{c}\cdot 2^{-\lfloor j\frac{m-n}{n}\rfloor}\cdot \omega - l\right),$$

Where W and V satisfy admissibility conditions as below:

$$\sum_{j=0}^{+\infty} |W(2^{-j}\cdot r)|^2 = 1,$$

$$\sum_{l=-\infty}^{+\infty} \left| V\left(\frac{1}{c}\cdot 2^{-\lfloor j(1-1/d)\rfloor}\cdot \omega - l\right)\right|^2 = 1, \text{ given } c,\ d \text{ and } j.$$

The ‘wedge’ corresponding to the ripplet function in the frequency domain is

$$H_{j,l}(r,\theta) = \left\{2^j \leqslant |r| \leqslant 2^{2j}, \left|\theta - \frac{\pi}{c}\cdot 2^{-\lfloor j(1-1/d)\rfloor}\cdot l\right| \leqslant \frac{\pi}{2} 2^{-j}\right\}.$$

In discrete case, we can have better understanding about the parameters c and d. The parameter c controls the number of directions in the high-pass bands. d controls how the number of directions changes across bands. For fixed c, d helps to control the resolution in directions at each high-pass band. Given d, c controls the number of directions at all high-pass bands. C and d determine the final number of directions at each band together. The discrete ripplet transform of an M* N image f (n1, n2) will be in the form of

$$R_{j,\vec{k},l} = \sum_{n_1=0}^{M-1} \sum_{n_2=0}^{N-1} f(n_1, n_2)\overline{\rho_{j,\vec{k},l}(n_1, n_2)},$$

Where $R_{j,\to k,l}$ are the ripplet coefficients.

The image can be reconstructed through inverse discrete ripplet transform

$$\tilde{f}(n_1, n_2) = \sum_j \sum_{\vec{k}} \sum_l R_{j,\vec{k},l}\rho_{j,\vec{k},l}(n_1, n_2).$$

In the Proposed system is that, Combination of DWT and DRT methods will be used for fused the image. First apply the DWT method and then after applying the DWT, DRT method use on this fused image using wavelet transform. The performance will be measures used in this are Peak Signal to Noise Ratio (PSNR) and Mean Square Error (MSE) parameter using the MATLAB Image Fusion tool.

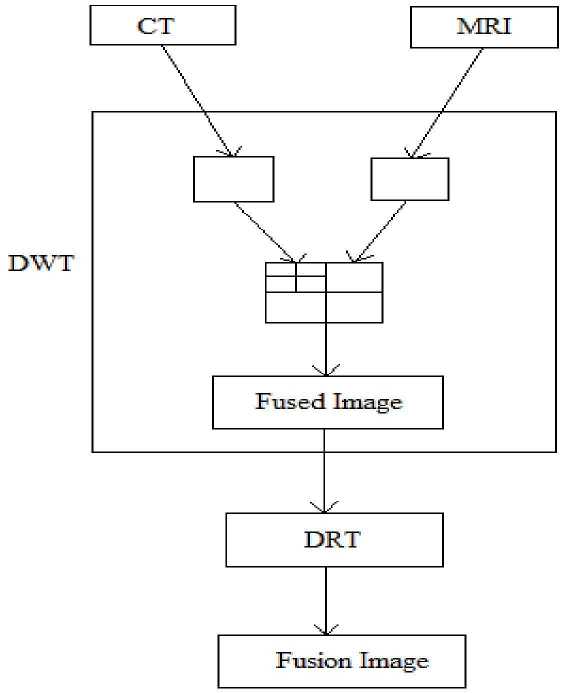

Fig. 3. Proposed Method

Problem Statement

Fourier transform and wavelet transform suffer from discontinuities such as edges in images. In discrete Wavelet Transform, because of its discontinuity, problem may be caused for some applications, like compression and noise removal of audio signal processing. 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. Image fusion techniques, merge and integrate the complementary information from multiple image sensor data and makes the image more suitable for the visual perception and processing. The DWT provide directional information in decomposition levels and contain unique information at different resolution. And the DRT is a higher dimension generalization of the transform. So, use combination of DWT and DRT method has better image than DWT.

RESULTS

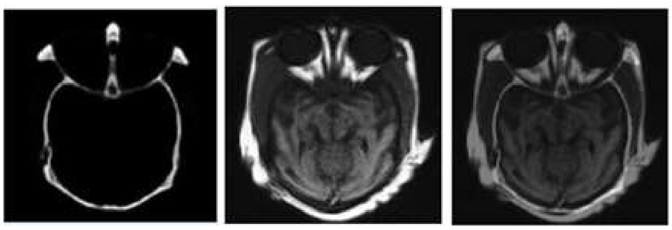

Fig. 4. CT, MRI and Fusion Image of DWT

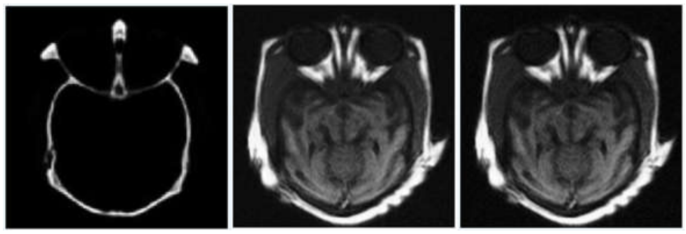

Fig. 5. CT, MRI and Fusion Image of DRT

Table 1. Table for Sharpness Test of DWT and DRT

Kernel size	DWT	DRT
3	4.4048	6.9194
5	3.6734	5.974
7	3.1083	5.2552
9	2.6797	4.6306
11	2.3453	4.0905

Conclusion and Future Work

Result shows that DRT gives better image than DWT. But the wavelet transform provide directional information in decomposition levels and contain unique information at different resolution and ripplet transform holds great potential for image processing such as image restoration, image denoising. Also ripplet transform solve discontinuities such as edges in images. So the combined technical approach of wavelet transform and ripplet transform is used for better resolution. In future the ripplet transform can solve the discontinuity in the image. So for improving the image the combination of DWT and DRT can be use which is the goal of this literature survey. The idea behind the concept of image fusion is to improve the image content by fusing two images like MRI and CT images to provide useful andprecise information for doctor for their clinical treatment in one image.

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