Medical Image Fusion Using Combine Approach of DWT and DRT

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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 the ripplet transform can solve the discontinuity in the image. So for improving the image the combination of DWT and DRT can be use.

KEY WORDS: *Image Fusion, CT, MRI, DWT, DRT, PSNR, MSE.*

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 & 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.

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. 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 &MRI images individually have some shortcomings such as MRI images not concentrate on hard tissues & in CT image soft tissues can't be clearly visible.

In this paper image fusion of CT & MRI images has been carried out so that the fused image which is the combination of soft & hard tissues proven as the focused image for doctors & 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.[2]

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.[2]

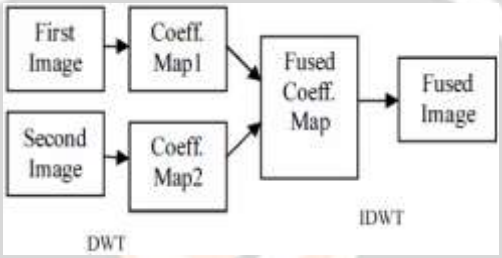

Fig. 1 Discrete Wavelet Transform

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.[6]

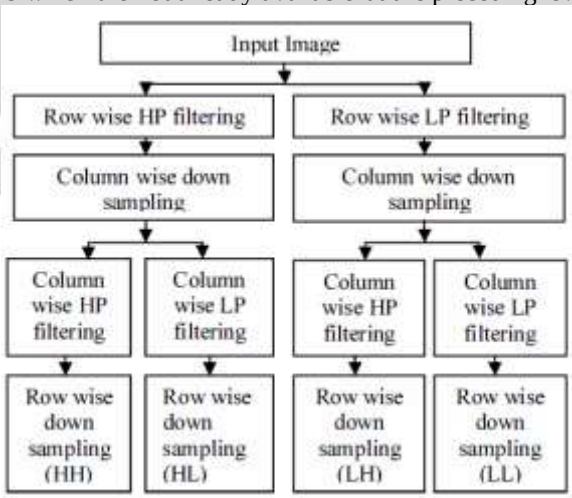

Fig. 2 DWT Decomposition

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.

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.[5]
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, →b_k and Θ_l, which satisfy that $a_j = 2^{-j}$, →$b_k = [c \cdot 2^{-j} \cdot k_1, 2^{-j/d} \cdot k_2]^T$ and $\Theta_l = 2\pi/c.2^{-[j(1-1/d)]}.l$, where →$k=[k_1, k2]^T$, $(.)^T$ 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 $R_{j,\rightarrow k,l}$ 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.

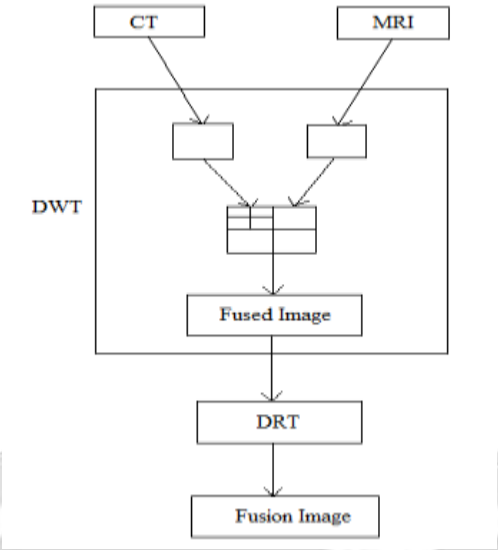

Fig. 3 Proposed Method

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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 & integrate the complementary information from multiple image sensor data & 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.

RESULT

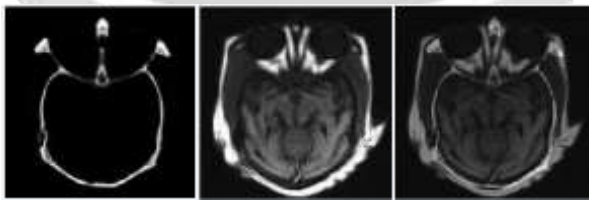

Fig. 4 CT, MRI and Fusion Image of DWT

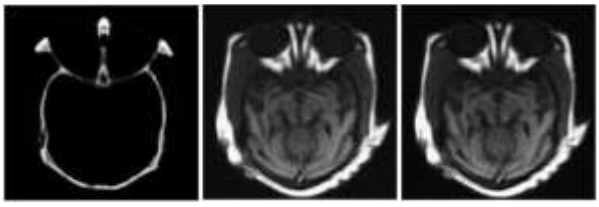

Fig. 5 CT, MRI and Fusion Image of Proposed Method

Table.1 Sharpness Test of DWT & 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

The first table shows that, The DRT has better diagonal representation than the DWT. In second table, the proposed method gives better representation than the DWT method by using the PSNR and MSE parameters.

Table.2 PSNR and MSE Value of DWT & Proposed Method

Method / Parameters	DWT		Proposed Method	
	CT	MRI	CT	MRI
PSNR	16.1075	16.0155	16.6716	16.6293
MSE	1593.4099	1627.5179	1399.3439	1413.0217

PSNR Value

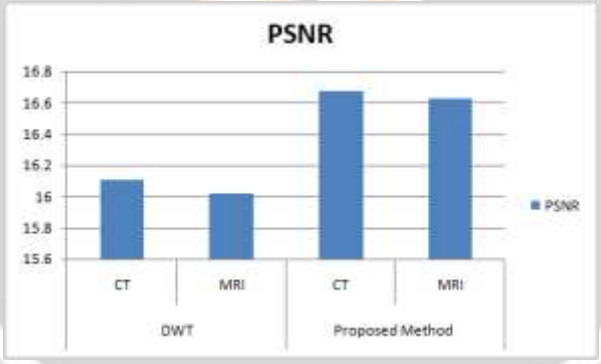

Fig. 6 PSNR Value of the Image

MSE Value

Fig. 7 MSE Value of the Image

CONCLUSION & FUTURE WORK

Result shows that DRT gives better sharpness 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.

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 & CT images to provide useful & precise information for doctor for their clinical treatment in one image.

In the second table, Proposed method shows the better image with the better PSNR and less MSE value.

REFERENCE

[1]Mr. Rajenda Pandit Desale, Prof. Sarita V. Verma," Study and Analysis of PCA, DCT & DWT based Image Fusion Techniques", IEEE,2013.

[2]Yong Yang, Dong Sun Park, Shuying Huang, Nini Rao," Medical Image Fusion via an Effective Wavelet-Based Approach", Springer,2010.

[3]K.P.Indira, Dr.R.Rani Hemamalini," Impact of Co-Efficient Selection Rules on the Performance of DWT Based Fusion on Medical Images", IEEE,2015.

[4]Neetu Mittal, H.P.Singh, Rachana Gupta," Decomposition & Reconstruction of Medical Images in MATLAB using different Wavelet Parameters",IEEE,2015.

[5]C.T.Kavitha, C.Chellamuthu, R.Rajesh," Multimodal medical image fusion using discrete ripplet transform and intersecting cortical model", Science Direct,2014.

[6]Kusum Rani, Reecha Sharma," Study of Image Fusion using Discrete wavelet and Multiwavelet Transform", International Journal of Innovative Research in Computer and Communication Engineering, Vol. 1, Issue 4, 2013.

[7]Deepak Kumar Sahu, M.P.Parsai," Different Fusion Image Techniques-A Critical Review", International Journal of Modern Engineering Research, Vol. 2, Issue 5, 2012.