Fusion of CT and MRI images using Discrete Multiwavelet Transform

Kusum Rani[1],Reecha Sharma[2]

[1]*M. Tech Student, UCoE, Punjabi University, Patiala, India.*

[2]*Assistant Professor, UCoE, Punjabi University, Patiala, India.*

***Abstract*—Image fusion is a process of combining the complementary information from two or more images into a single highly informative image. The resulting fused image contains more information than both the input images. In this paper DMWT algorithm for fusing two different modality medical images and different quantitative metrics are calculated. The images obtained from different medical imaging techniques such as Computer Tomography (CT) and Magnetic Resonance (MR) images are fused into a new image to improve the information quality. In the present fusion algorithm, the input images from two different modalities such as CT and MR are initially registered and then transform namely Multi-Wavelet transform is applied on the input images. Finally the resultant images are fused using various fusion techniques. Qualitative metrics for resultant image such as entropy, standard deviation are calculated.**

***Keywords*—Computed Tomography, Magnetic Resonance Imaging, Fusion Technique, Multiwavelet Transform.**

I. INTRODUCTION

Image fusion is a useful technique for combining single sensor and multi-sensor images to enhance the information content of the images. Image fusion technique is a process for fusing the complementary information of multi- source input images in order to produce a new image that is more suitable for human visual system .Image fusion has several applications in various areas such as Medical Imaging, Satellite Imaging, Remote sensing, Robotics, Military applications and so on [3]. Computer Tomography (CT) and Magnetic Resonance (MR) are the most important modalities in Medical Imaging, used for clinical diagnosis and computer-aided surgery. CT gives more information about bone structures and less information about soft tissues. Magnetic Resonance (MR) imaging gives more information about the Soft tissues and less information about the bone structures. A single modality of medical image cannot provide fine and accurate information. By combining two or more medical images a highly informative image is produced which give more and useful information about bones and tissues. Image fusion improves reliability and decreases distortion.

II. IMAGE FUSION: MULTI WAVELETS

Multiwavelets are similar to scalar wavelets but have some important differences. Scalar wavelets, which are used in multiresolution analysis with a single scaling function and a wavelet function, multiwavelets may have two or more scaling and wavelet functions. Goodman and Lee [4] are among the earliest to develop a multiresolution theory of multiwavelets. Strela [5] further extends the theory of multiwavelets. He successfully presented it in terms of perfect reconstruction multifilter banks in both time and frequency domains.

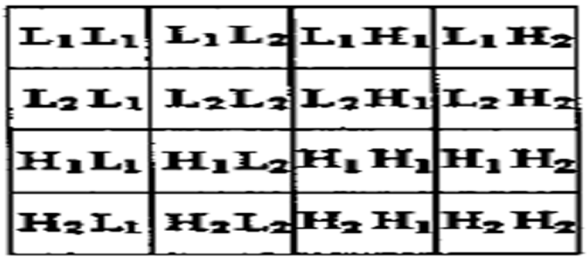

Fig.1Multiwavelet decomposition [2]

We use discrete multiwavelet transform (DMWT) for image fusion to generate a new fused image that have more information than source images, and are more suitable to human visual perception, object detection and target recognition. For DMWT firstly multiwavelet preprocessing and decomposition on both the input images is computed at different level . The source image is decomposed into subbands which can be act as subimages. The pixels of the subimages have corresponding multiwavelet decomposition coefficients. Except for the Low-Low subbands which have all positive transform values and the other subbands contain transform values that are fluctuating around zero. At each level, there are 16 subimages formed and they can be further divided in 4 blocks. The low-low(LL) subbands block indicates image's approximate part. Low-high (LH) subbands block, the high-low(HL) subbands block, and high-high(HH) subbands block give detail parts about horizontal, vertical, and diagonal directions. In next step will decompose the LL subbands further. With the increasing level, the source image can be decomposed further into a serial of subimages, to form a pyramid. Second, a pyramid is formed by selecting multiwavelet decomposition coefficients from the source image pyramids. Larger absolute values of multiwavelet decomposition coefficients are related to sharper brightness changes such as edges, lines and region boundaries. Larger absolute value of the two coefficients at each pixel can be

selected by using some fusion rule. Then IDFT is performed to get fused image.

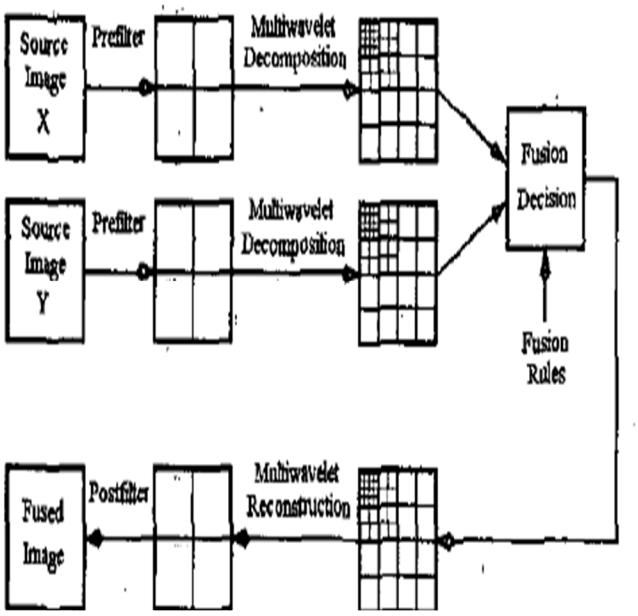

Fig. 2Multiwavelet Based image fusion [2]

III. IMAGE QUALITY METRICS

Image Quality metrics are used to measure image degradation by comparing it with an ideal or perfect image.By using fusion algorithm some distortion or artifacts generated. Image Quality assessment methods can be classified into two categories: Full Reference Methods (FR) and No Reference Method (NR). In FR an image is compared with a reference image. NR methods do not use any reference image.

a) *Entropy :* Entropy is used to calculate the amount of information. Higher value of entropy indicates that the information increases and the fusion performances are improved.

$$E = \sum_{i=0}^{l-1} p_i \log_2 p_i \text{.....(1)}$$

b) *Standard Deviation (SD) :*For a fused image of size $N \times M$, its standard deviation can be estimated by

$$SD = \sqrt{1/NM \left(\sum_{i=1}^{N} \sum_{j=1}^{M} K_f(i,j) - m\right)^2} \text{....(2)}$$

Where $K(i, j)$ is the (i, j)th pixel intensity value and m is the sample mean of all pixel values of the image. It measures the contrast in the fused image. An image with high contrast would have a high standard deviation.

IV. Experimental results

CT and MRI images have been used for evaluation of the DMWT image fusion algorithm presented in this paper. Here we applied DMWT on two CT and MRI pair images and then entropy, standard deviation is calculated. Higher value of entropy gives higher information and by increasing the level of decomposition amount of information also increases. High standard deviation indicates high contrast.

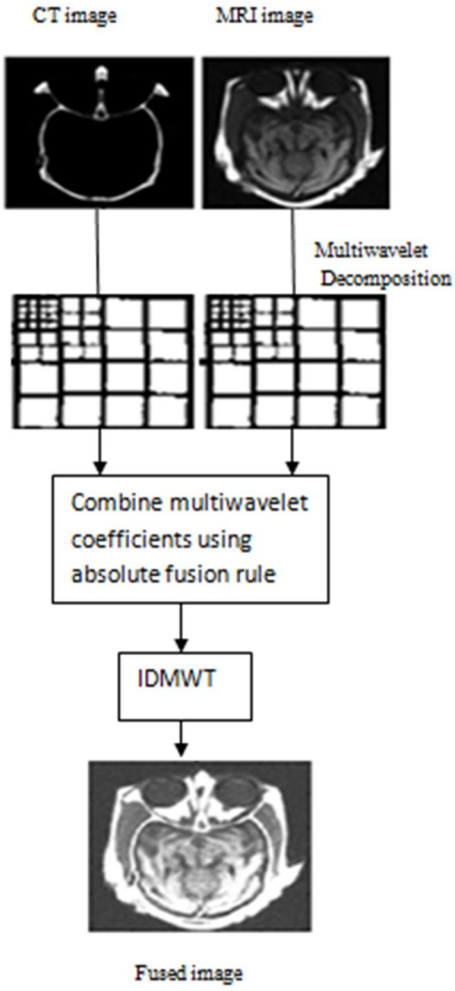

Fig. 3 Fusion of set A images

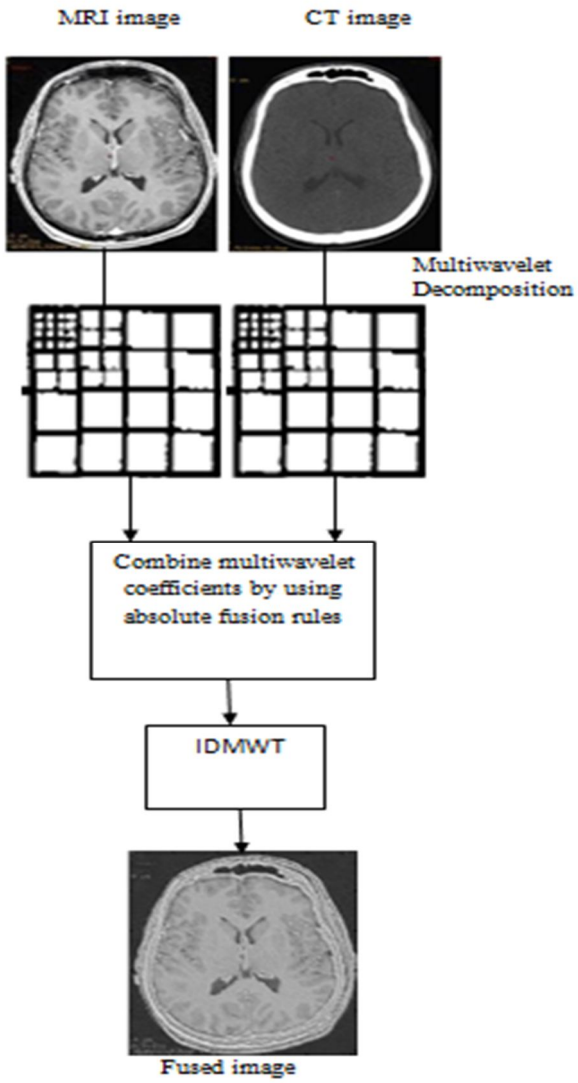

Fig. 4 Fusion of set B images

Table1
Performance Evaluation Indices for multimodality medical images

IMAGES	STANDARD DEVIATION	ENTROPY
Set A	36.3593	6.0054
Set B	12.8498	4.903

V. CONCLUSION AND FUTURE WORK

We have combined the multiwavelet transform and for combining wavelet coefficients we use absolute fusion rules to fuse CT and MRI images. This method gives encouraging results in terms of larger entropy and standard deviation values. Multiwavelet gives fine detail about edges of fused image. However, the images of (like PET, SPECT, X-ray etc) may also be fused using the same method.

REFERENCES

[1] K. Kazemi and H. A. Moghaddam, “Fusion of multifocus images using discrete multiwavelet transform,” IEEE Conf. on Multisensor Fusion and Int. for Int. Systems, pp. 167-172, 2003.

[2] Hai-Wi Wang “Multisensor image fusion by using discrete multiwavelet transform”Third International Conference on Machine Learning and Cybernetics, Shanghai, 26-29 August 2004

[3] M. I. Smith, J. P. Heather, "Fusion Technology Review of Image in 2005," Proceedings of the SPIE, Volume 5782, pp. 29-45, 2005

[4] T. N. T. Goodman and S. L. Lee, “Wavelets of Multiplicity r,” Trans. Of the Amer. Math. Soc., Vol. 342, pp. 307-324, 1994.

[5] V. Strela, “Multiwavelets: Theory and Applications,” Ph.D Thesis, MIT,1996.

[6] LahouariGhouti, Ahmed Bouridane and Mohammad K. Ibrahim “Improved Image Fusion Using Balanced Multiwavelets”,2004

[7] H. Wang, J. Peng, and W. Wu, “Fusion algorithm for multisensor images based on discrete multiwavelet transform,” IEE Proc. Vis. Image Signal Process., Vol. 149, No. 5, pp. 283-289, Oct. 2002.

[8] K. Kazemi, and A. ShikhHassani, “Gray scale imagefusion using DMWT”, 5’h International Student Conference on Electrical engineering, Shiraz, Iran, 2002.

[9] Dr. M. Sumathi , R. Barani “Qualitative Evaluation of Pixel Level Image Fusion Algorithms” IEEE transaction on Pattern Recognition, Informatics and Medical Engineering, March 21-23, 2012