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Fusion of CT-PET Lungs Tumour images using Dual Tree Complex Wavelet Transform.

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ABSTRACT

Image fusion is one of the important branches of data fusion. Its purpose is to combine multi-image information in one scene which is more suitable to human vision or more adapt to further image processing such as target identification. In this paper image fusion algorithm based on Dual tree complex wavelet transform (DTCWT) is proposed to improve quality of image and meet the needs of application of vision. Computed tomography (CT) and positron emission tomography (PET) medical image fusion has important clinical significance. The non- subsampled contourlet transform (NSCT) rule is applied on the decomposed images to obtain the low and high frequency coefficients of the fused images. The fused image is obtained by applying inverse DTCWT. The performance measures for evaluating the fused image are Power of signal to noise ratio, Entropy, Mean squared error, Normalized cross correlation.
Keywords: Computed tomography (CT) and positron emission tomography (PET), Dual tree complex wavelet transform (DTCWT), Non- subsampled contourlet transform (NSCT).

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INTRODUCTION

Image fusion integrates multiple images of the same scene from multiple image sensor data. It has acquired an integral role in medical field. In this work, introduces the CT-PET image fusion based on transform domain image processing [1].Wavelet and Curvelet transform techniques are used for fusion of medical images scanned via different modalities. This method performs efficiently and effectively may identify the anomalies exists in an objects to detect and analyzed for radiological purpose. CT -PET provide data conditioned by the different technical, anatomical and functional properties of the organ or tissue being studied, with values of sensitivity, specificity and diagnostic accuracy variations between them. Their fusion enables the "unification" of the various technique-dependent data, thus "summing" the diagnostic potential of each individual technique. Because of the image fusion technology which can effectively integrate the image information, the fusion images are more intelligible and readable and have more information than the images that are got through single channel, and this technology has been concentrated very much, and has had a great development. A general wavelet based image fusion technique can be described in fig 1.In this work dual tree complex wavelet transform [2].

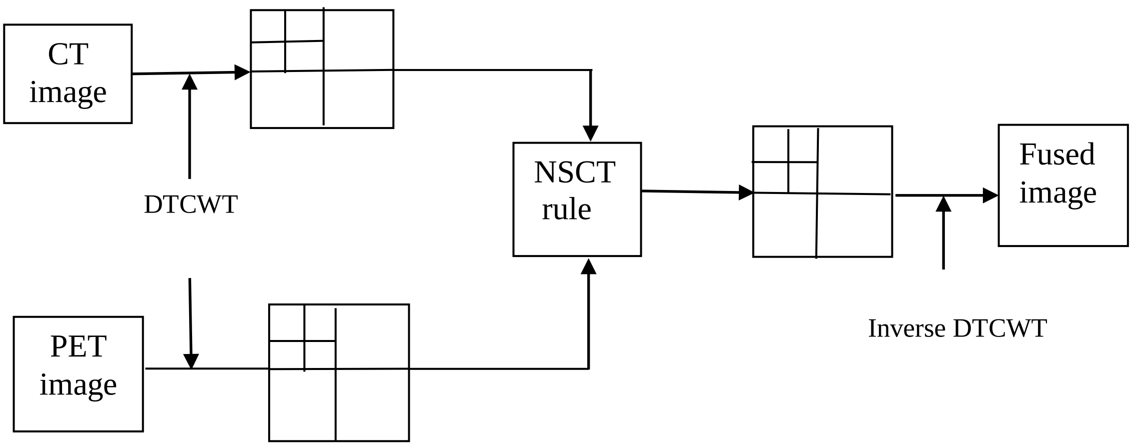

Figure 1: General Wavelet Based Image Fusion Technique

The major drawback of DWT are shift sensitivity, poor directionality and lack of phase information.

a. Shift sensitivity: A transform is shift-sensitive if an input signal shift causes an unpredictable change in the transform coefficients. Shift sensitivity arises in DWT by using down sampling in the implementation of DWT. This is undesirable as DWT failed to distinguish input signal shifts.

b. Poor Directionality: An m-dimensional transform suffers from poor directionality when the transform coefficients reveal only a few feature orientations in the spatial domain. Two dimensional DWT provides only three spatial orientations: Vertical, Horizontal and Diagonal. Thus DWT leads to a poor representation of images.

c. Lack of phase information: The use of real filters in DWT fails to provide any phase information. It has been found that phase information is very useful in image processing tasks such as edge detection and corner detection. Also phase information is not affected by noise. Hence it should be provided by wavelet transform. The drawbacks of DWT i.e. shift sensitivity; poor directionality and lack of phase information are removed with the use of Dual Tree Complex Wavelet Transform.

LITERATURE REVIEW

Anuyogam Venkataraman et al., [3] presented a image fusion algorithm which is the hybrid of Orthogonal Matching Pursuit (OMP) and Principal Component Analysis (PCA) is proposed to properly utilize the advantages and to overcome the disadvantages of both OMP and PCA methods. Lei Wang et al., [4] presented a Traditional two-dimensional (2-D) fusion frame work usually suffers from the loss of the between-slice information of the third dimension. Manpreet Kaur et al., [5] presented a medical image fusion contain the complementary and relevant information from multiple source images that used for identify the diseases and better treatment In this paper complete functional survey of all techniques for fusion has been described and work done using Discrete Wavelet Transform due to low cost and less overhead also important feature of this transform are locality, multi resolution analysis, edge detection , decor relation and energy compaction. Deron Ray Rodrigues [6] Presented an image fusion integrates multiple images of the same scene from multiple image sensor data. This paper introduces the various means image fusion based on transform domain image processing. Wavelet and Curvelet transform techniques are used for fusion of medical images scanned via different modalities. Each of the methods is evaluated under a performance evaluation criterion. NayeraNahvi et al., [7] presented a image Fusion of DWT technique on different images to make a fused image having more information content. In our paper, other methods such as Principal Component Analysis (PCA) based fusion, Intensity hue Saturation (IHS) Transform based fusion and high pass filtering methods are also discussed. A new algorithm is proposed using Discrete Wavelet transform and different fusion techniques including pixel averaging, min-max and max-min methods for medical image fusion. C. H. Seng et al., [8] in this paper, we propose a new technique for image fusion in multi-view through-the-wall radar imaging system. As most existing image fusion methods for through-the-wall radar imaging only consider a global fusion operator, it is desirable to consider the differences between each pixel using a local operator. Here, we present a fuzzy logic-based method for pixel-wise image fusion.

METHODOLOGY

The proposed method uses DTCWT [9] for multimodal medical image fusion. Initially input images are decomposed into low pass and high pass wavelet coefficients using DTCWT. High directionality, shift invariance and availability of phase information in DTCWT provide better fusion process through merging of wavelet coefficients. In this paper NSCT fusion rule is used.

A. Procedure for Image Fusion based on Dual tree complex wavelet Transform

1. Read two input images and resize both to same size.
2. Apply dual tree complex wavelet transform to decompose source images into low pass and high pass sub images.
3. At each level, we get four sub images. One low pass sub image, three high pass sub images (Horizontal, Vertical, Diagonal).
4. Apply NSCT coefficients rule to find fused coefficients.

The main property of NSCT [11] is providing a multidirectional, multiscale, shift invariant image decomposition that can be efficiently implemented by means of the fusion techniques or algorithms.

NSCT is a shift-invariant version of CT (Contourlet transform) and has some excellent properties including multilevel and multidirectional properties. NSCT provides a better representation of the contours. CT employs the Laplacian pyramid for multiscale decomposition and the DFB for directional decomposition. To reduce the frequency aliasing of CT and to reach the shift invariance, NSCT eliminates the down samplers and the up samplers during the decomposition and the reconstruction of the image; it is built upon the non-subsampled pyramid filter banks and the non-subsampled Directional filter banks, by applying this transform we will get low and high frequency component of input image.

5. Apply dual tree complex wavelet transform for construction from fused low pass and high pass coefficients. The fused image is obtained.
6. Calculate Entropy, Correlation Coefficient, Mean values and Root Mean Square (RMS).
7. Compare with other existing wavelets. fig2 shows the image fusion based on wavelet transform

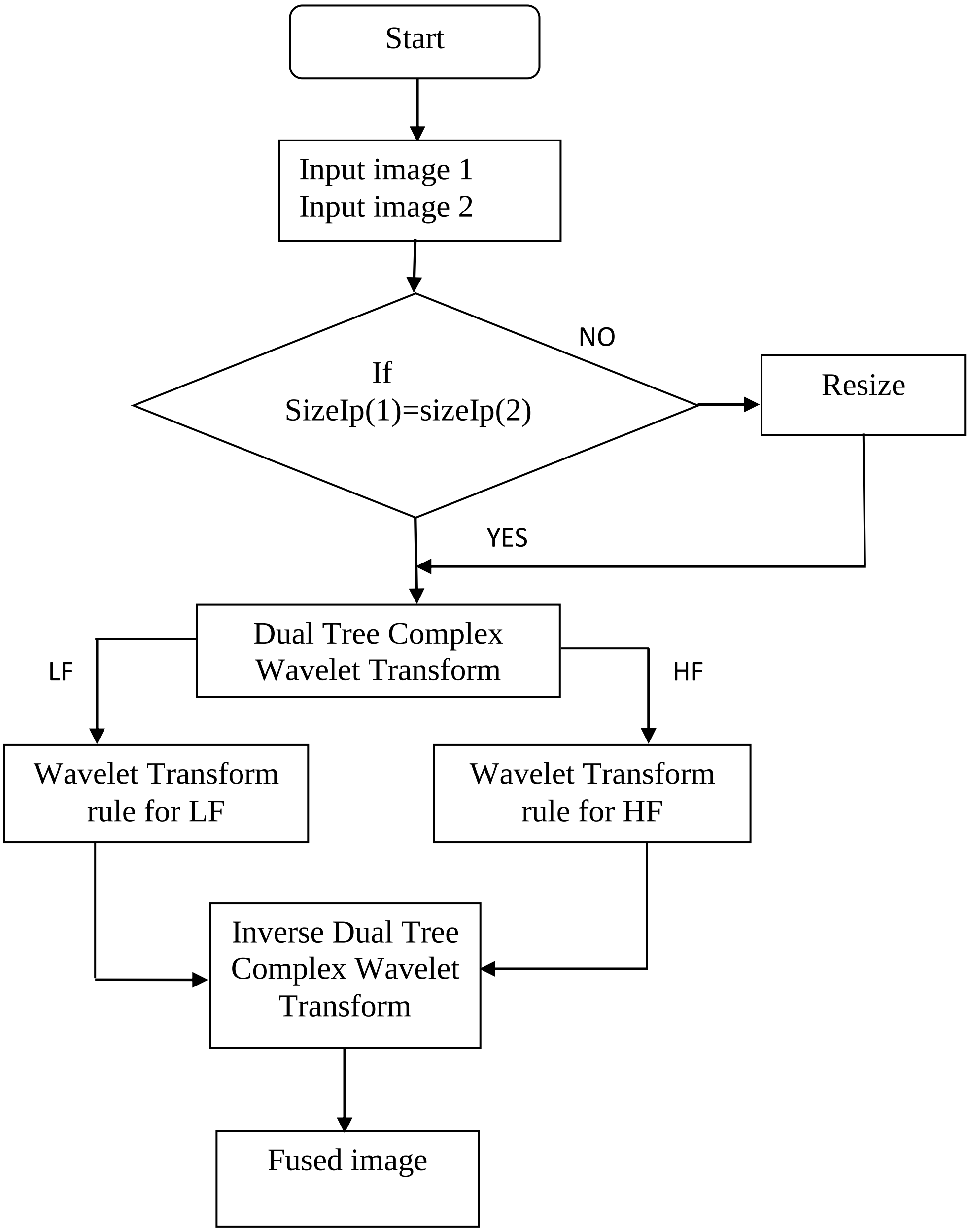

Figure 2: Image fusion based on wavelet transform

RESULT AND DISCUSSION

PERFORMANCE PARAMETERS:

The performance measures used in this paper provide some quantitative comparison among different fusion are measuring the definition of an image [10].

PSNR:

PSNR is the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. The PSNR measure is given by the equation

$$PSNR = 10 \log_{10}\left(\frac{R^2}{MSE}\right)$$

R is the maximum fluctuation in the input image data type.

ENTROPY:

Entropy is defined as the information quantity contained in an image. If the value of entropy becomes higher after fusing, the performances are improved. The equation is given by

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

Where L is the total of grey levels

p = [p0, p1......pL-1} is the probability distribution of each level.

MEAN SQUARED ERROR (MSE):

The mathematical equation of MSE is giver by the equation

$$MSE = \frac{\sum_{M,N}[I_1(m,n) - I_2(m,n)]^2}{M * N}$$

Where,

I_1 - the perfect image
I_2 - the fused image to be assessed
i - Pixel row index
j - Pixel column index
m,n - No. of row and column .

NORMALIZED CROSS CORRELATION (NCC):

Normalized cross correlation are used to find out similarities between fused image and registered image is given by the following equation

$$NCC = \frac{\sum_{i=1}^{m}\sum_{j=1}^{n}(A_{ij} * B_{ij})}{\sum_{i=1}^{m}\sum_{j=1}^{n}(A_{ij})^2}$$

In this work five lungs tumor CT-PET images are used. In fig3 first column shows CT images, second column shows the PET images and third column shows the fused images. The fused image's PSNR, Entropy, MSE, Normalised cross correlation values are tabulated in table1.

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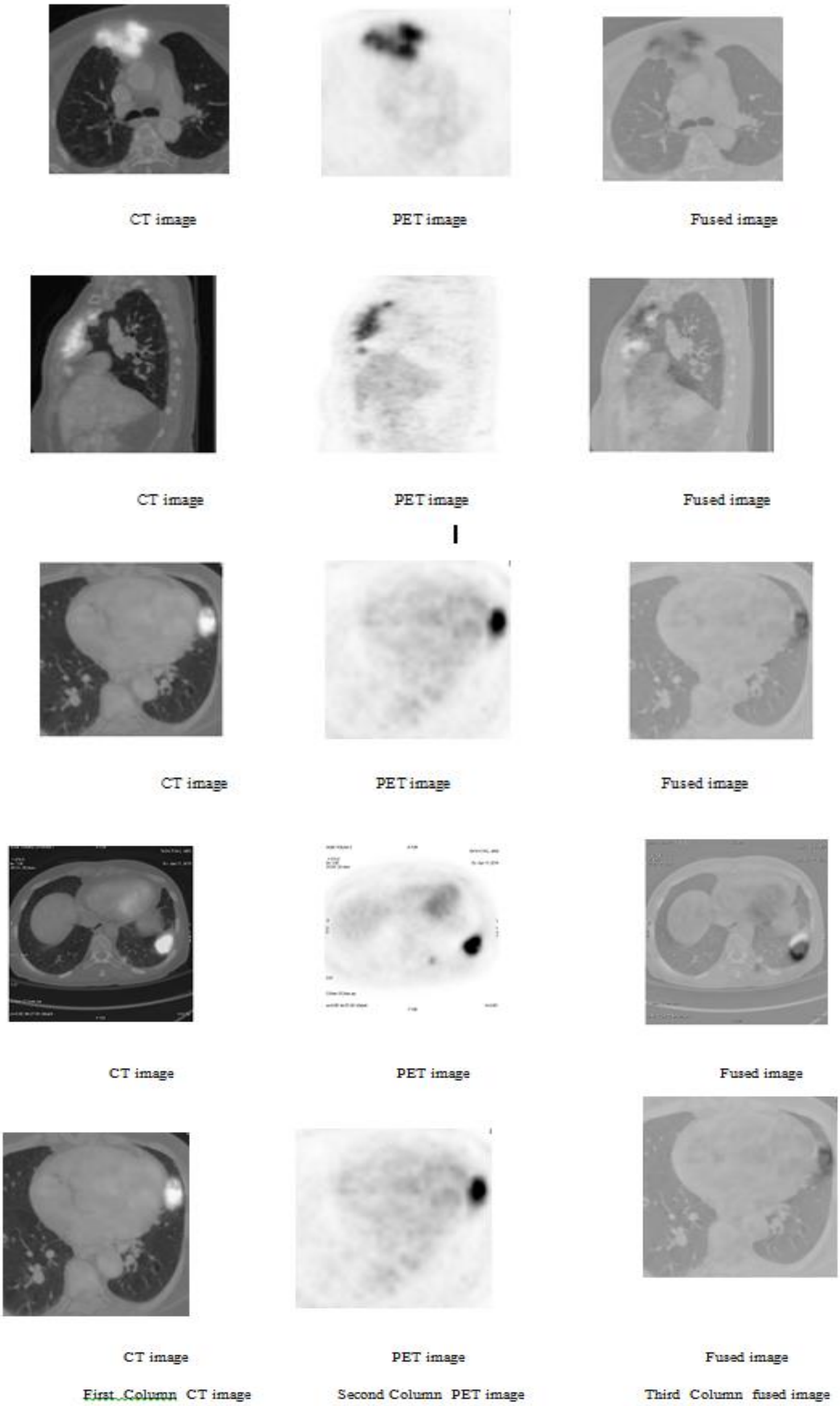

Figure 3: CT ,PET and Fused image

TABLE I : EVALUATION INDICES FOR FUSED MEDICAL IMAGES

S.NO	PSNR(dB)		RMSE		SIMILARITY INDEX	ENTROPY	CORRELATION CO EFFICIENT
	CT	PET	CT	PET			
1.	44.97	24.14	0.0158	0.1582	0.53035	2.467	0.23
2.	38.26	24.27	0.0311	0.1559	0.38192	2.56	0.24
3.	44.13	24.14	0.0158	0.1582	0.3962	2.39	0.22
4.	42.98	24.22	0.0181	0.1568	0.29328	3.10	0.25
5.	43.04	24.19	0.0180	0.1574	0.58536	2.99	0.23

CONCLUSION

This paper presents an image fusion technique based on Dual code tree complex wavelet transform. It leads to accuracy which is far more improved and leads to extraction of maximum information. From the experimental results, we observe that fusion image has more details and information is clearly.so the algorithm proposed in this paper is an effective method for the fusion of medical images. The fusion of CT-PET images can make medical diagnosis much easier and accurate.

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