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Image Fusion Technique for Multi-Resolution Medical Images Using Directional Contourlet Transform

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Abstract: Among the accessibility of multi-detector information in numerous fields, image fusion has received growing consideration in the researchers for a extensive spectrum of applications. Image fusion is the procedure to merges statistics from various images of the identical view. These pictures perhaps taken from various detectors, obtained at dissimilar times. In this paper, an image fusion technique rely on Directional Contourlet transform is proposed to improve the quality of image and meet the needs of application of vision. Two or more images to be fused should be decomposed using Contourlet with multi-resolution frequencies. The resulting sub-images are fused using Directive Contrast rule to obtain the combined image. As the wavelet packet transform has several special features in evaluation with scalar wavelets on image processing, but it flushes it to keep the inherent information. The efficacy of the proposed scheme has been explained using various image sets such as the multi-focus pictures, multi-detector satellite image. The proposed Directional Contourlet transform based fusion method has compared with wavelet transform image fusion method qualitatively and quantitatively. Experimental results concluded that the proposed scheme performs superior for image fusion in comparison with wavelet packet transform.

Key words: Directional Contourlet transform, MRI Images, wavelet packet transform, Image fusion.

INTRODUCTION

Image Fusion is a method of integrating the significant data from a set of pictures of the same sight into an exclusive image and the ensuing fused image is more revealing and inclusive than the input images. Input images could be the multi-sensor, multimodal or multi-focal point [1]. The fused image is supposed to keep all significant facts from the input images. The image fusion avoid introducing artifacts that contribute to an incorrect analysis. One of the imperative basic steps of the fusion process is image registration. Image registration is the procedure of transforming various sets of data into one organize system. Image fusion finds application in the field of navigation guidance, target detection and recognition, medical diagnosis, satellite imagery for remote sensing, military and civilian surveillance, etc [2]. Image fusion techniques are classified into pixel, feature and decision points.

Pixel fusion works straight on the pixels of source images while feature fusion techniques function on features taken out from the source images. The wavelet grasp the phantom and time, where the former system failed. Wavelet Packet Transform (WPT) is unrivaled of the extensively applied tools [3]. The WPT fusion strategy is selecting the maximum sub-bands in every elevated enormity. The demerits of wavelet is sensitive in the vicinity of the information. In this work, the Multi-Resolution Analysis (MRA) is achieved by directional non-subsampled Contourlet transform.

From the literature, it is inferred that pixel level fusion leads to unwanted side effects such as reduced contrast. In the recent years, many image fusion techniques have been proposed, such as arithmetical and numerical methods, hue-saturation- intensity (HSI) method, principal component analysis (PCA) method, image gradient pyramid and multiresolution methods. These methods involve huge computation using floating point arithmetic and hence these are time and memory consuming. In the recent years, fusion methods based on pyramid and multiresolution analysis turn out to be most popular. Li et al. also used DWT for decomposition area based activity measure and maximum selection rule for fusion [3]. Hence in this paper, Directional Contourlet transform is implemented for decomposition.

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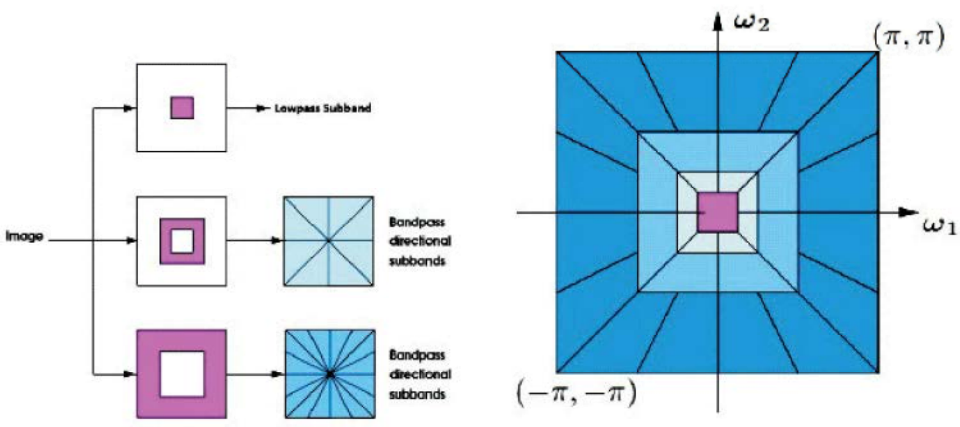
In this paper, the fusion scheme based on Directive Contrast using Directional and Nonsubsampled Contourlet transform (CT) domain. The Directive contrast method integrates with the sum-modified-Laplacian to get more accurate salient features [4]. Hence, the Directive contrast method is implemented for fusion in this projected work. The work is structured as follows. The CT and image fusion are explained in Section 2 and 3. In Section 4, proposed directive contrast fusion rule is presented. The simulation results are presented in section 5. Finally, the conclusion is given in Section 6.

Directional Contourlet Transform: Directional Contourlet transform is a multidirectional Nonsubsampled renovation technique used in image investigation for capturing contours and superior details in images. The CT is a collection of basis task leaning in dissimilar ways in numerous scales with stretchy feature ratios. This framework should form a foundation with little idleness unlike other transform proficiencies in image analysis. Contourlet representation contains basic elements leaning in an assortment of directions that are provided by other separable transform technique [4].

Among this imminent, it is able to create a double filter bank arrangement shown in Fig. 1, filter is employed to get the spot break, followed by a Directional Filter Bank (DFB). The whole effect is extension of image using elements like contours, so called contourlet transform.

Image Fusion: Image fusion is combining pertinent information from two or more source images into a single image such that it contains most of the data from all the source images [5]. In this work, Image fusion is employed for integrating an MRI and PET shows bones and soft tissue information in human body. The resulting fused image contains both the bone details and soft tissues data. A Directive contrast, fusion process with CT approach is done.

The block diagram of a generic Contourlet-based image fusion system is presented in Fig. 2. MRI is considered as Image 1 and PET is taken as Image 2. Directional Nonsubsampled Contourlet Transform is applied on Image 1 as well as applied on Image 2 separately. Eight sub-bands are generated in each output of Image 1 and Image 2. In this eight sub-band coefficients, one is a low pass approximation coefficient



(a) NSDFB Structure (b) Idealized Frequency Partitioning

Fig. 1: Contourlet filter bank

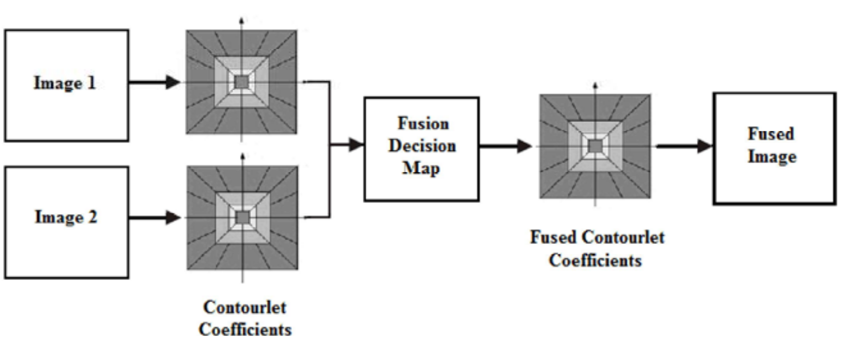


Fig. 2: Systematic process of Contourlet based Image fusion

and remaining seven subsets are high pass detail coefficients. The Directive Contrast Fusion rule is used on each seven detail sub-sets [6]. For the fusion of low-frequency approximation coefficient, the mean is applied to two pictures. Finally, fused Contourlet coefficients image is obtained and inverse CT is done to get the fused image as shown in Fig.2.

Directive Contrast Fusion Rule:

- For the fusion of low-frequency approximation coefficient, mean is applied to blend instead of averaging [7].

$$A_i(new)=mean(A_1, A_2) \tag{1}$$

- For fusing high-frequency detail coefficients of corresponding pixels in all source images,

$$H_i(new)=\begin{cases} H_i^1 & if\ \left|C_iH^1\right| \geq \left|C_iH^2\right| \\ H_i^2 & otherwise \end{cases} \tag{2}$$

$$V_i(new)=\begin{cases} V_i^1 & if\ \left|C_iV^1\right| \geq \left|C_iV^2\right| \\ V_i^2 & otherwise \end{cases} \tag{3}$$

$$D_i(new)=\begin{cases} D_i^1 & if\ \left|C_iD^1\right| \geq \left|C_iD^2\right| \\ D_i^2 & otherwise \end{cases} \tag{4}$$

Where
C_iH is Horizontal contrast
C_iV is a Vertical contrast
D_iV is Diagonal contrast

RESULTS AND DISCUSSIONS

The RGB of MRI of size 256x256 highlights the bone and soft tissues in human body is considered as Image 1 and PET of size 256x256 indicate the organ and tissue functions in human body is taken as Image 2 and as shown in Fig. 3 and in Fig. 4. Image 1 and Image 2 is converted to YUV components and Y component is considered for fusion. The Y component of MRI and PET are shown in Fig. 5 and in Fig. 6, respectively. MRI and PET images are decomposed to two levels using Directional Nonsubsampled Contourlet transform. The resulting sub-bands are shown in Fig. 7 and in Fig. 8. The Contourlet transform decomposes the image in a multidirectional way and generates more directional sub-bands whereas wavelets are directionally sensitive.

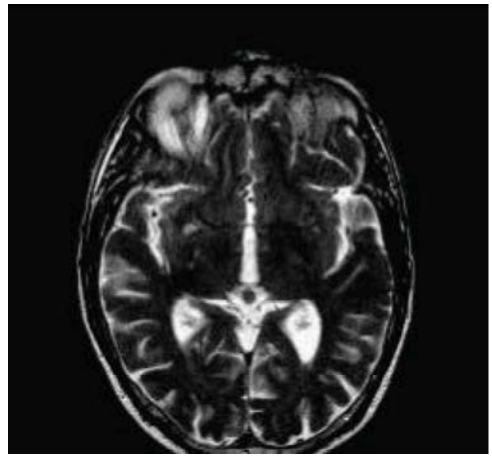


Fig. 3: Image1 (MRI)

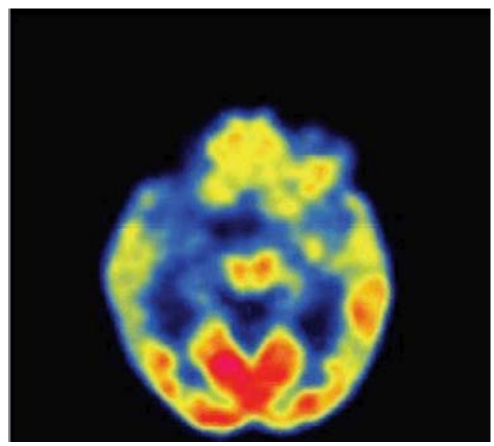


Fig. 4: Image2 (PET)

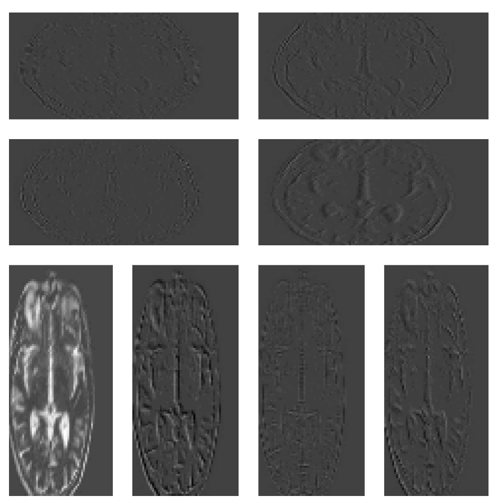


Fig. 5: Two level Contourlet transform decomposition for Image 1

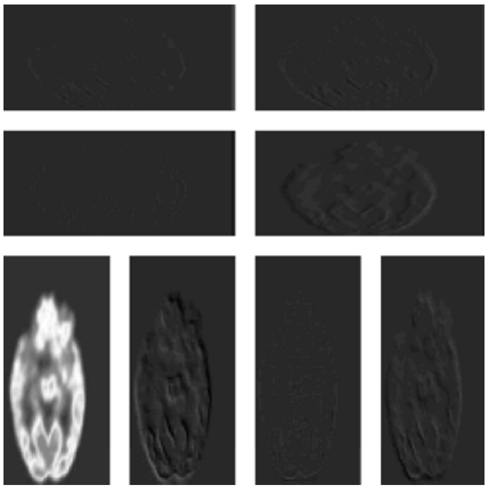


Fig. 6: Two level Contourlet transform decomposition for Image 2

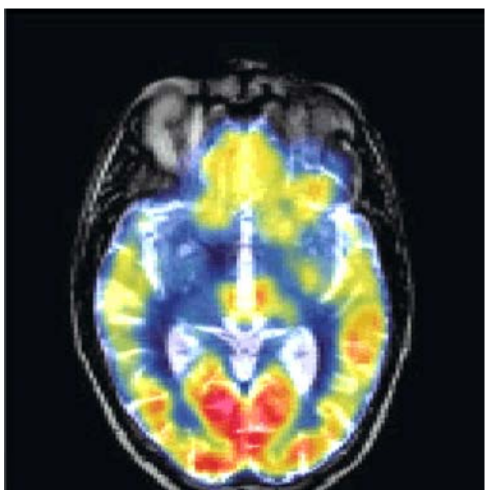


Fig. 7: Fused image using proposed CT

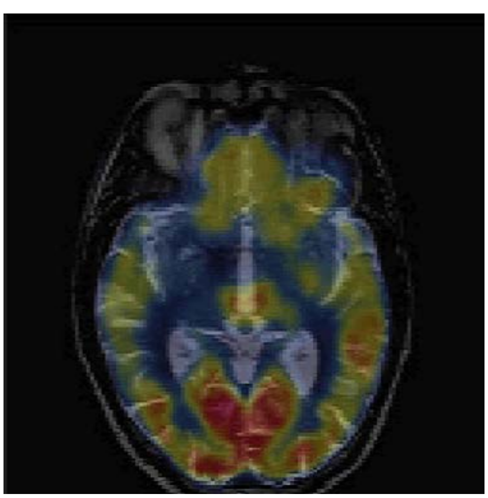


Fig. 8: Fused image using WPT

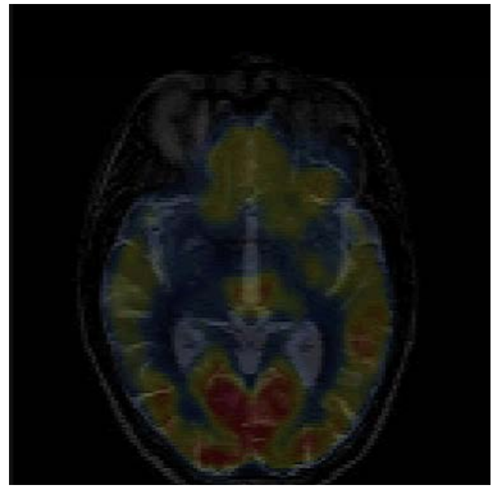


Fig. 9: Fused image using DWT

Second set MRI - PET Images:

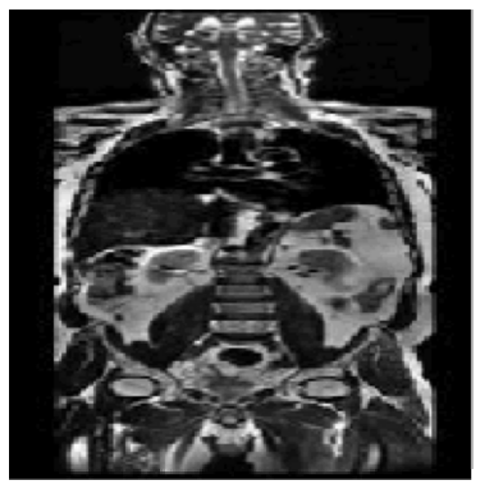


Fig. 10: Image 1(MRI)

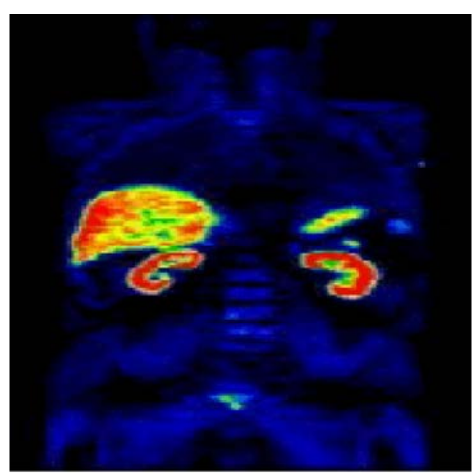


Fig. 11: Image 2 (PET)

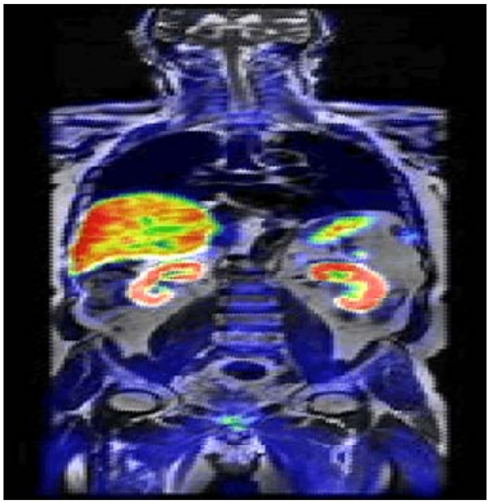


Fig. 12: Fused image using proposed

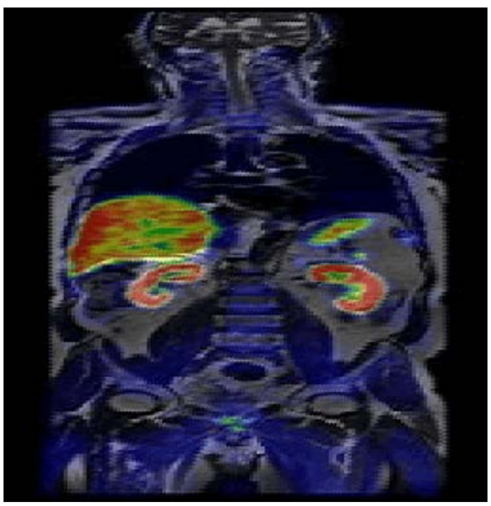


Fig. 13: Fused image using WPT

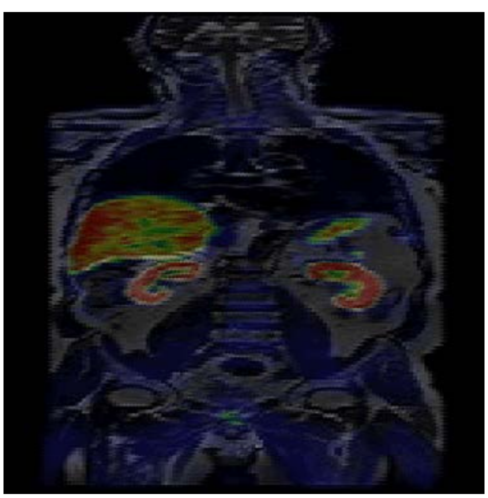


Fig. 14: Fused image using DWT

Third set- MRI and CT Images:

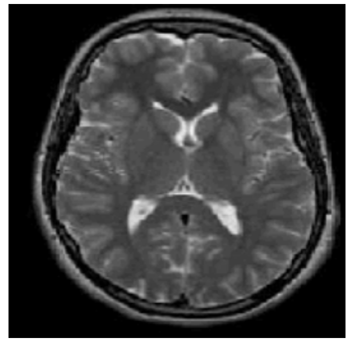


Fig. 15: Image 1(MRI)

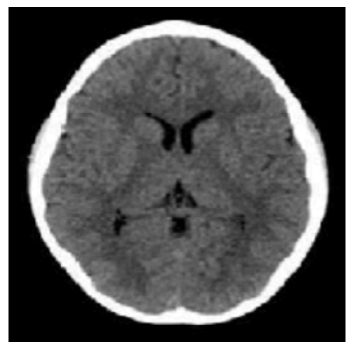


Fig. 16: Image 2 (CT)

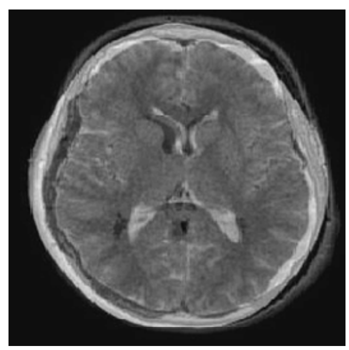


Fig. 17: Fused image using proposed Contourlet transform

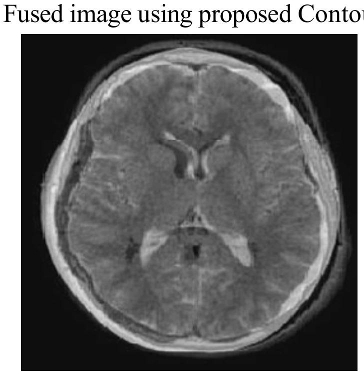


Fig. 18: Fused image using WPT

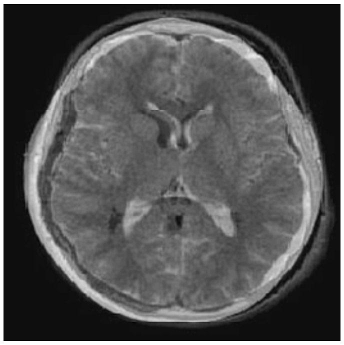


Fig. 19: Fused image using DWT

The Directive Contrast Fusion rule is used on each seven detail sub-sets in two images. For the fusion of approximation coefficient, the mean is calculated between low-frequency components in two images. After fusing, fused Contourlet coefficients image is obtained and inverse CT is called for to get Y component of the merged image as depicted in Fig. 9. Then this Y component fused image is changed into an RGB fused image as depicted in Fig. 10.

Table 1: Evaluation indices of PSNR for DWT, WPT and Contourlet transform.

Images	Wavelet Transform	Wavelet Packet Transform	Contourlet Transform
MRI-PET Image (Set1)	39.7456	43.9712	47.28195
MRI-PET Image (Set2)	38.2904	42.1893	46.2815
MRI- CT Image	39.2874	43.9872	46.3925

Table 2: Evaluation indices of Normalized Correlation for DWT, WPT and Contourlet transform.

Images	Wavelet Transform	Wavelet Packet Transform	Contourlet Transform
MRI-PET Image (Set1)	0.9167	0.9487	0.9709
MRI-PET Image (Set2)	0.9024	0.9311	0.9621
MRI- CT Image	0.9183	0.9423	0.9665

CONCLUSION

The paper has presented a Directional Contourlet Transform based MRI and PET colour images Directive contrast fusion method. This method maintains both MRI and PET details of medical pictures of bones and soft tissues. Simulation results confessed the pre-eminence of the proposed Contourlet method to wavelet and wavelet packet based Medical image fusion techniques. The proposed method shown to be effective for the fusion in the existence of interference.

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