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MEDICAL IMAGE FUSION BASED ON DISCRETE WAVELET TRANSFORM

Saradiya Kishore Parija[1], Sukanth Behera[1]

[1]Assistant Professor, Department of ECE, Gandhi Institute for Technology (GIFT), Bhubaneswar, India

Abstract

Image fusion is a technique in which useful information from two or more recorded medical images is integrated into a new image. It can be used to make clinical diagnosis and treatment more accurate. Wavelet transform fusion considers the wavelet transforms of the two registered source images together with the fusion rule. The fused image is reconstructed when the inverse wavelet transform is computed. Usually, if only a wavelet transformation is applied, the outcomes are not so helpful for analysis. But, better fusion results may be attained if a wavelet transform and a traditional transform such as Principal Component Analysis (PCA) transform is integrated. Hence a new novel approach is introduced in this work to improve the fusion method by integrating with PCA transforms. Haar wavelet decomposes a signal into frequency sub-band at different scale from which registered image can be perfectly reconstructed. As stated above, the Hardware support results show that the scheme can preserve all useful information from primal images in addition the clarity and the contrast of the fused image are improved.

Keywords— Fusion, Wavelets, PCA Transform,Haar transform.

1. INTRODUCTION

Image fusion is the process which fuses multiple images. It aims to improve the quality of image. Firstly, images are decomposed using wavelet transform. Then, images in approximate channel and detail channel are fused according to proposed assumption. Finally, decomposed are synthesized to form fused image. [2] In the pixel-level image fusion, the fusion takes place directly at the pixel level. Medical Image Fusion is a sort of data fusion and developed from that into a new data fusion technology. Computed tomography (CT), and positron emission tomography (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[4].

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[6]. PET and CT fusion on the same machine is a typical representative of the multimodal medical image fusion technology. One image can get PET and the corresponding parts of CT. It combines the advantages of both and provides a reliable basis for diagnosis. PET/CT image fusion has become a research hotspot at present[7].

There are many multimodal medical image fusion methods. Because of the good sub-frequency features in the transform domain, the wavelet transform has been widely used. Multi wavelet is an extension from wavelet theory, and has several particular advantages in comparison with scalar wavelets on image processing.It can simultaneously posses many desired properties such as short support, symmetry and

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smoothness. The purpose of image fusion is to reduce the ambiguities and maximize the fusion information. Medical image fusion is to collect the information of multimodality image together to express information got multi-modal images in one image at the same time to highlight their respective advantages, to carry out complementary information and to provide comprehensive morphology and functional information which reflects physiological and pathological changes. In order to obtain good fusion images , the pixel level fusion algorithms have been improved from the weighted average method, principal component analysis and pyramid image fusion algorithm to the wavelet transform. However, wavelet transform has its own short comings, such as shift sensitivity and lack of orientation selectivity.

2. IMAGE FUSION BASED ON DIFFERENT WAVELET TRANSFORMS

In this research paper fusion of two images (i.e. MRI and CT) has been carried out using wavelet toolbox. Wavelet toolbox provides various tools related to the different functions which can be performed on digital images. The Wavelet Toolbox provides two categories of tools:

- Graphical interactive tools
- Command-line functions

The Graphical interactive tools are a collection that affords access to extensive functionality. The command-line functions are MATLAB programs that can call directly from the command line or from the applications. This toolbox, with the power of MATLAB software, allows writing complex and powerful applications[3,4] and provides a way to introduce, learn, and apply the methods.

Types of Wavelets – MATLAB has different types of wavelets as follows –

- **Haar**- Haar wavelet, is the first and simplest type of Wavelet. Haar wavelet is discontinuous, and resembles a step function.
- **Daubechies**- Ingrid Daubechies, one of the brightest stars in the world of wavelet research, and called as compactly supported orthonormal wavelets — thus making discrete wavelet analysis practicable. The names of the Daubechies family wavelets are written dbN, where N is the order, and db the "surname" of the wavelet. The db1 wavelet is the same as Haar wavelet.
- **Biorthogonal**- Biorthogonal wavelet family exhibits the property of linear phase, needed for signal and image reconstruction. It uses two wavelets, one for decomposition (on the left side) and the other for reconstruction (on the right side) instead of the same single one.
- **Coiflets**- The wavelet function has 2N moments equal to 0 and the scaling function has 2N-1 moments equal to 0. The two functions have a support of length 6N-1.

3. PROCESS OF IMAGE FUSION

Figure 1 explained that how image fusion performs firstly load image 1 then load image 2 after that use wavelet transform, after that apply the fusion rules and then take inverse discrete wavelet transform to get the fused image with better quality and reliability and also for the clear vision.

3.1 Discrete Wavelet Transform

Wavelet transform provides a framework in which a signal is decomposed, with each level corresponding to a coarser resolution or lower frequency band, and higher frequency bands. There are two main groups of transforms, continuous and discrete. Of particular interest in DWT, which applies a two channel filter bank (with down sampling) iteratively to the low pass band (initially the original signal). The wavelet

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representation then consists of the low pass band at the lowest resolution and the high pass band obtained at each step. This transform is invertible and non redundant. The DWT is a spatial domain decomposition that provides a flexible multi resolution analysis of an image. In a 2-D DWT, a 1-D DWT is first performed on the rows and then columns of the data by separately filtering and down sampling, this result in one set of approximation coefficients.In the language of filter theory, these four sub images correspond to outputs of low-low (Ia), low-high (Ib), high-low(Ic), and high-high (Id) bands. By recursively applying the scheme to the LL sub band multi resolution decomposition with a desire level can be achieved.

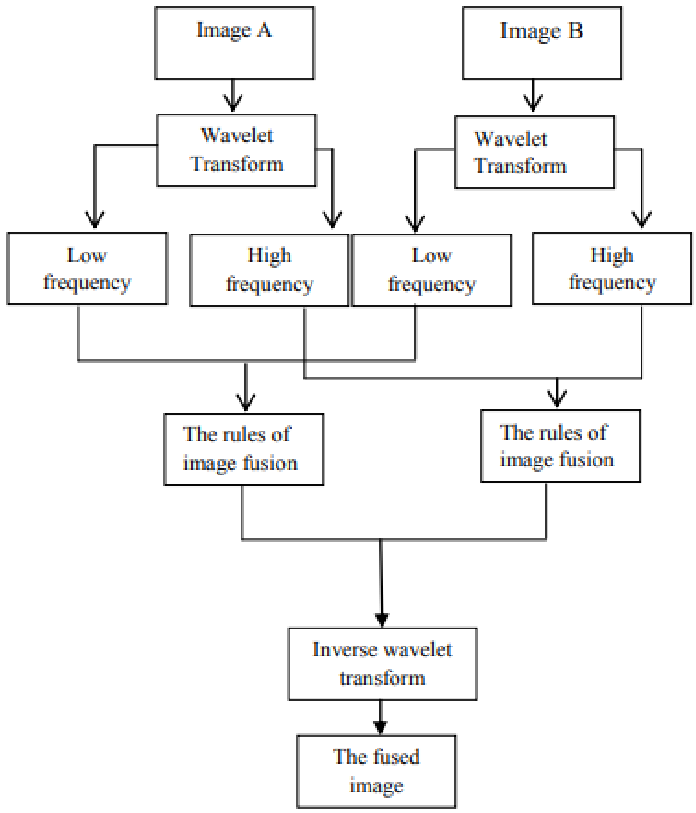

Figure 1: Process of image fusion.

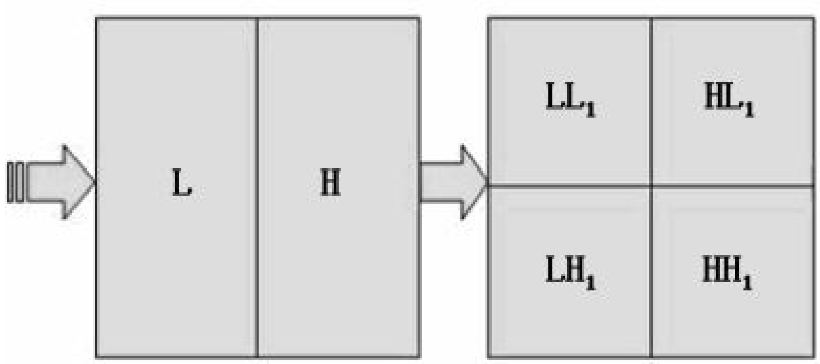

Figure 2: structure of 2D-DWT

4. Experimental Result

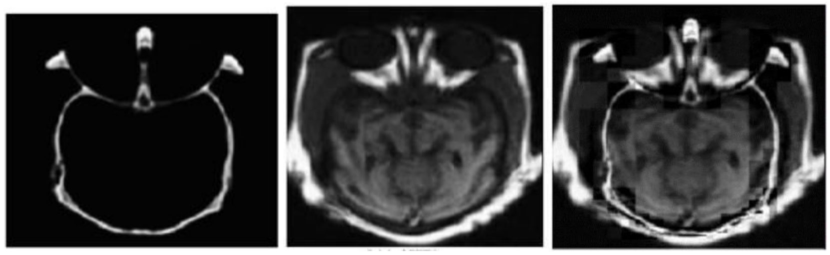

Figure 3: CT image (left). MR image (center). used image (right).

5. CONCLUSION

Fusion imaging is one of the most modern, accurate and useful diagnostic techniques in medical imaging today. In this paper, the integration of wavelets and PCA for the fusion of magnetic resonance and computed tomography medical images has been proposed. Haar wavelet transform is applied to decimate each source image. The resulting coefficients are fused and reconstructed using inverse wavelet transforms. From the statistical analysis, it is proved that the harr wavelet is more suitable for medical image fusion, since it provides less MSE and high SNR than Orthogonal, Biorthogonal, Trous and PCA wavelets. From the simulation results, it is obvious that the resultant fused image consists of information about both soft and dense tissues and free from undesirable effects. The proposed technique is going to implement on the processor based kit or show the hardware support.

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