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# Fusion of MRI and PET Images using DWT

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*Abstract* – **The objective of this paper is to implement an innovative image fusion system for the detection of brain tumours. Fusing images obtained from MRI and PET can accurately access the tumor response. Key step in multi-resolution fusion technique is selection of fusion rule because it will decide how to merge coefficients in appropriate way so that high quality fused image can be obtained. Image fusion technique integrates suitable information from various modalities of input images into a fused distinct image where the resultant image provides better information in comparison with the input images which are used for fusion and is more appropriate for visual perception. This work presents an image fusion method which performs wavelet decomposition for both PET and MRI images with different activity levels. This method generates promising fusion results by varying the structural information in the gray matter area and the spectral information in the white matter area to have better color preservation. Moreover, to produce good spectral resolution, smoothing filters is applied to the low frequency region.**

*Keywords* – **Medical Images, Discrete Wavelet Transform, PET, MRI, Image Fusion.**

## I. Introduction

Medical images from various modalities frequently contain complementary information which will be highly required in clinical diagnosis. For example, MRI images shows evidently the extent of a tumor in relation to other soft tissues but not describes whether the tumor has invaded any of the bony structures, while CT images shows clearly the bone involvement but gives poor images of the soft tissue extent of the tumor [1], Positron Emission Tomography (PET) image reveals actual information of flow of blood but lacks boundary information and so on. Image fusion can form a single composite image from the different modalities of images and then provide reliable source to further investigation and diagnosis. But it is necessary to align two images accurately before they can be fused. The resolution of MRI image in gray intensity is high compared to PET image, while PET images gives detailed information of the biochemical changes such fluid flow etc. In medical field, it is highly desired to have both the image characteristics for effective diagnosis and treatment. Thus, fusing two different medical images into a single image with both anatomical structural and spectral information is highly required [2].The objective of this work is to integrate these processes and to produce satisfactory and promising fusion results. This paper is formed as follows Section II presents the Review of existing fusion techniques, Section III presents the methodology, Section IV shows the synthesis and simulation results and they are discussed clearly, finally the paper is concluded with Section V.

## II. Review Of Existing Fusion Techniques

Image fusion technique integrates appropriate information from various modalities of input images into a fused distinct image of the same prospect that contains vital information features of the unique image where a human can use it with more convenience [3]. In many medical applications, image fusion is used as the most significant tool for the interpretation of the quality of images and to verify whether the data acquired through this is either functional or having high spatial resolution. Typically, MRI image shows structural information of the brain without any functional data, where as PET image describes functional information of the brain but with less spatial resolution. Therefore, image fusion is conceded to improve functional image’s spatial resolution through which original functional characteristics is preserved [4] with no spatial distortion.

Wavelet based fusion scheme satisfies the requirement quite well due to the advantages of wavelet analysis. A technique for fusing PET- MRI image using wavelet and spatial frequency method is proposed which eliminate the influence of image imbalance [5]. This method reduced blur effect, improved the clarity which is useful for clinical diagnosis. The result analysis indicated that this method is comparatively better than the conventional algorithm based on PCA in terms of good visual & quantitative fusion results. It is necessary to preserve the prominent features in source images and should not initiate for any artifacts which would distract the human observer.

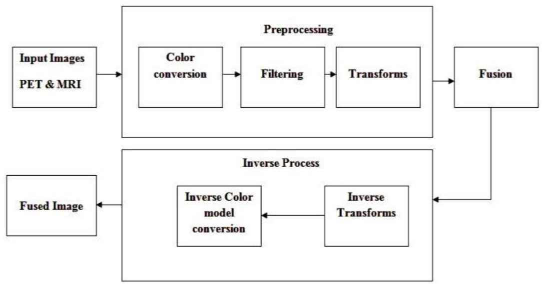


Fig. 1. System Architecture

## III. Methodology

The system architecture of the proposed method is shown in Fig.1.Here, MRI and PET images are taken as its input for preprocessing and fusion. PET image is firstly

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decomposed into its Intensity Hue Saturation (IHS) transform and thus the information of high activity region is differentiated from the low activity region of PET image by making use of "hue angle" obtained from the IHS transform. After preprocessing, the quality of the input PET image is enhanced by Gaussian filters. The enhanced image is then fused based on Discrete Wavelet Transform (DWT) for brain regions with different activity levels[7].Then we combine low frequency coefficients of MRI and PET images and perform the inverse DWT to obtain the fused result for the fused low frequency output. Similarly by combining high frequency coefficients of PET and MRI images into a complete set of wavelet coefficients and performing the inverse DWT, we can obtain the fused result for the high activity region.

This work is executed in MATLAB which provides an easy-to-use platform for a wide range of computational problems. Graphic User Interface (GUI) is developed which helps the user to interact with the system .GUI will ask for the default parameters in a message box for the corresponding modules chosen by the user.GUI displays the input PET and MRI images, various processes including filtering, color conversion, wavelet transform. GUI also enables to identify all four performance indices such as Mean Square Error (MSE), Peak signal to noise ratio (PSNR).

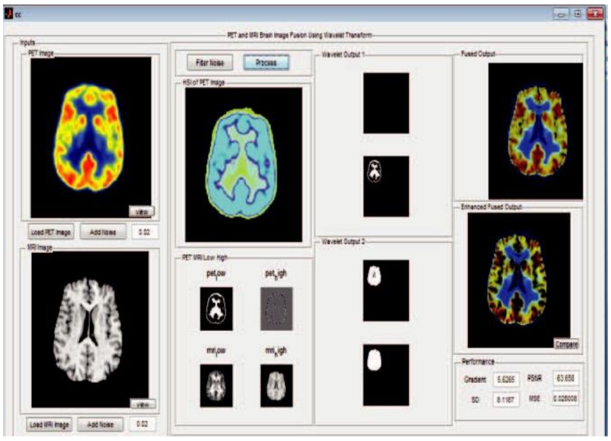

Fig. 3. GUI performing various processes to analyze the high contrast fused output for Normal Axial Brain Disease

## IV. Experimental Results and Analysis

The demonstrated application has been experimented with various inputs and the results are analyzed for its performance indices like Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR. The experimental dataset includes PET and MRI images taken from the website [8] www.med.harvard.edu for pre-processing and fusion. A total of 2 set of brain diseases like Normal Axial and Normal Coronal disease are used as the experimental datasets for fusion.

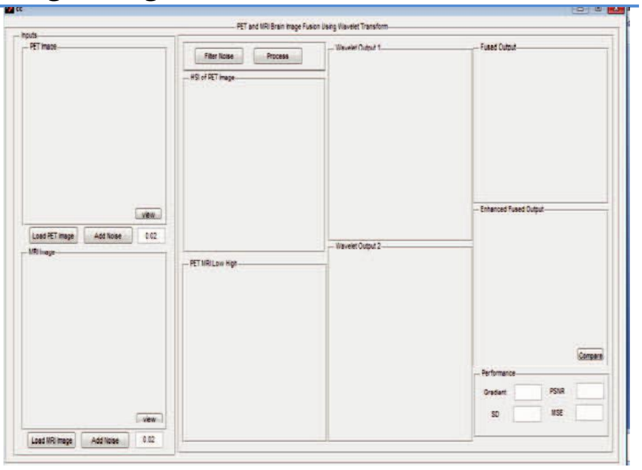

Fig. 2. GUI when the application is started

Fig. 3 and Fig. 4 shows the GUI performing various processes such as color conversion, wavelet transform, inverse wavelet transform and to analyze various performance indices such as PSNR, MSE for Normal Axial and Normal Coronal brain diseases.

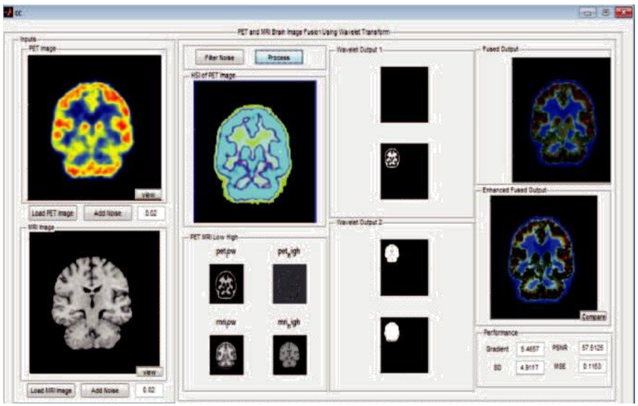

Fig. 4. GUI performing various processes to analyze the high contrast fused output for Normal Coronal Brain Disease

Fig. 5 and Fig. 6 shows the comparison of input PET and MRI images with the fused output for Normal Axial and Normal Coronal Brain Disease.

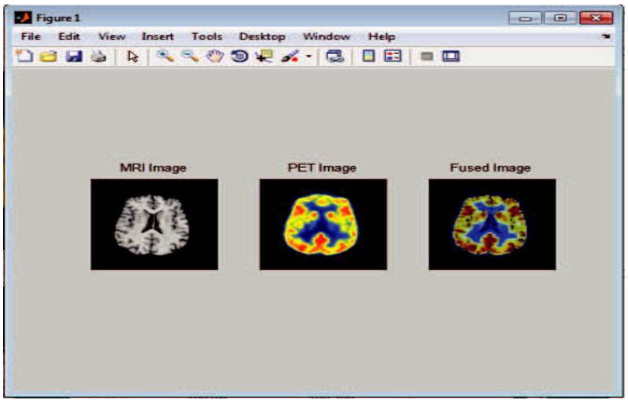


Fig. 5. GUI comparing input PET and MRI images with the fused output for Normal Axial Brain Disease

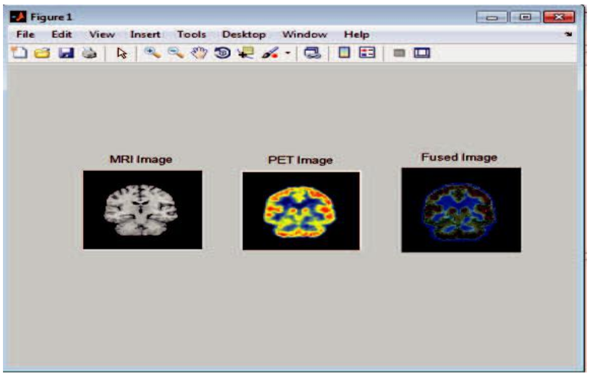


Fig. 6. GUI comparing input PET and MRI images with the fused output for Normal Coronal Brain Disease

Table I. Performance indices evaluation for normal axial brain disease

| IMAGES | PSNR | MSE | METHOD |
|---|---|---|---|
| MRI/PET | 10.1901 | 2.5814e-008 | DWT |
| MRI/PET | 10.1942 | 2.5863e-008 | IHS |

TABLE I represents the performance metrics comparison of the proposed method with the existing IHS+DWT Model for normal axial and normal coronal brain diseases.

Experimental results demonstrated that our fused results for PET and MRI normal axial & PET and MRI normal coronal brain images have less color distortion and richer anatomical structural information than those obtained from the existing method visually.

## V. Conclusion and Future Scope

In this paper, a new fusion method based on wavelet transform with MRI and PET brain images is proposed with less color distortion. Experimental results reveal that the fused image for normal axial and normal coronal disease brain images have very good structural information and less color distortion. The research can be further extended by using other multi-modality medical images with color and gray scale information and using an integration of complex wavelets for fusion to preserve the edge information.

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