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"SURVEY PAPER ON MEDICAL IMAGE FUSION USING HYBRID WAVELET AND CURVELET TRANSFORM"

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ABSTRACT

This research work proposes an improved fusion technique for medical images using Discrete Wavelet Transform (DWT). The proposed approach is based on two processes, namely, image enhancement and image fusion to obtain more information on the fused image. The low resolution Positron Emission Tomography (PET) image is enhanced using Lagrange interpolation technique and then combined with the Magnetic Resonance Image (MRI) using proposed image fusion. By adopting the proposed interpolation the edge preservation is achieved, the spectral and spatial qualities are improved. The comparative study has been made among Intensity-Hue-Saturation (IHS), Principal Component Analysis (PCA), DWT, Curvelet and proposed image fusion algorithm. Experimental results show that the application of proposed fusion has higher Peak Signal to Noise Ratio (PSNR) values with good visual perception. Comparing with other fusion methods, the proposed method has higher average gradient lower discrepancy and less Mean Square Error (MSE). Therefore the method proposed exhibits better image quality and proved to be advantageous.

Key Words: *Image Fusion, Principal Component Analysis (PCA), Discrete Wavelet Transform (DWT), Curvelet Transform.*

I. INTRODUCTION

The concept of image fusion has been widely used in many applications like medicine, machine vision, automatic change detection, biometrics etc. Medical image fusion is one of the modern and accurate diagnostic techniques in medical field. Imaging in medical field help the doctors to see the interior portions of the body for easy diagnosis and make keyhole surgeries for reaching the interior parts without really opening too much portion of the body. The images that are handled through image processing contain variety of problems such as low resolution, high level of noise, low contrast, geometric deformation, presence of imaging artifacts, simulation etc. While handling the image, these problems make the image imperfect for accurate diagnosis of disease. There are numerous situations that require high spatial and high spectral resolution simultaneously in a single image. However, in most cases, instruments are not able to provide such data either by design or by observational constraints. For accurate diagnosis, radiologists must integrate information from multiple images of a patient. Multiple images are registered in different formats and are overlaid or combined to provide additional information. The idea of integrating images from different modalities becomes very important and medical image fusion has emerged as a new promising medical research field. Image fusion is a process of combining multiple images into composite products, through which more information than that of individual input images can be revealed. Image fusion is used to form clear, complete and accurate description of target. Efficient information is extracted to achieve significant benefits from a variety of fused image received by multiple sensors with different spectra in different bands or different time. In image fusion, the fused image can effectively remove the

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contradiction and redundancy between information and improve the clarity of the image.

II. LITERATURE REVIEW

Much of the research and work has been done in the field of image fusion using wavelet and curvelet fusion technique.

H. Hariharan, A. Koschan and M. Abidi described the Direct Use of Curvelets in Multifocus Fusion. In this effort, a data-driven and application independent technique to combine focal information from different focal planes is presented. Fusion is performed on medial and peripheral curvelets by relevant fusion rules and the fused image combines information from different focal planes, while extending the depth of field of the scene. The main contribution in this effort is the direct use of curvelets in combining multifocal images. And it is concluded that direct curvelet fusion method exhibits improved global sharpness.

Xuelong HU1, Huimin LU and Lifeng ZHANG, Seiichi SERIKAWA describes A New Type of Multi-focus Image Fusion Method Based on Curvelet Transforms. In this after analyzing the classical multi-focus image fusion method, they use the maximum local energy method to calculate the energy of two images. Firstly, coefficients of two different focus images by curvelet transform; secondly, select the low- frequency coefficients by maximum local energy, and through a sliding window, obtained output the Maximum energy pixel information. Then the high-frequency coefficients are gotten by absolute maximum method; finally, the fused image was obtained by performing an inverse curvelet transform. Compared with wavelet transform, it exhibits high directional sensitivity and is highly anisotropic.

Jianwei Ma and Gerlind Plonka describes about Curvelet Transform in this paper. The curvelet transform is a multiscale directional transform that allows an almost optimal non adaptive sparse representation of objects with edges. In this article, a review on the curvelet transform is presented, including its history beginning from wavelets, its logical relationship to other multiresolution multidirectional methods like contourlets and shearlets, its basic theory and discrete algorithm The multiresolution geometric analysis technique with curvelets as basic functions is verified as being effective in many fields.

GUO Chao-feng and LI Mei-lian presented An Improved Image Denoising Algorithm Based on Wavelet Transform Modulus Maximum This paper proposes an improved image denoising algorithm, which uses a piecewise cubic spline interpolation algorithm to reconstruct wavelet coefficients after de noising based on Modulus Maximum Principle first, and then recompose the image using the mallet algorithm. . Using the piecewise cubic spline interpolation algorithm to de- noise image, the image obtains higher SNRP and smaller MAE. In addition, the piecewise cubic spline interpolation algorithm is simple and convenient. The experiment proves that the piecewise cubic spline interpolation algorithm is effective.

Deepak Kumar Sahu, M.P.Parsai presented paper on Different Image Fusion Technique This paper presents a literature review on some of the image fusion techniques for image fusion like, primitive fusion (Averaging Method, Select Maximum, and Select Minimum), Discrete Wavelet transform based fusion, Principal component analysis (PCA) based fusion etc. Comparison of all the techniques concludes the better approach for its future research. this review results that spatial domain provide high spatial resolution. But spatial domain have image blurring problem. The Wavelet transforms is the very good technique for the image fusion provide a high quality spectral content. Finally this review concludes that a image fusion algorithm based on combination of DWT and PCA with morphological processing will improve the image fusion quality.

Vyas, Sandip B. Chotaliya Manthan S. Manavadaria described An Image Fusion Based On Wavelet And Curvelet Transform. In this paper it has been put forward an image fusion algorithm based on wavelet transform and second generation curvelet transform. The wavelet transform does not represent the edges and singularities well. So the second generation curvelet transform is performed along with the wavelet transform and the image fusion is done. It includes multiresolution analysis ability in Wavelet Transform, also has better direction identification ability for the edge feature of awaiting describing images in the Second Generation Curvelet Transform

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Pure, Neelesh Gupta, Meha Shrivastava described A New Image Fusion Method based on Integration of Wavelet and Fast Discrete Curvelet Transform this paper describes the curved shapes of images and analyses feature of images better. This paper uses MRI and CT images for fusion which contains complementary information helpful for diagnosis of disease. The fusion results obtained from proposed method are analyzed and compared visually and statistically with different types of wavelets used in image fusion. The results of proposed method are efficient and improve the Entropy, PSNR, Mean, STD and MSE. The proposed method can be helpful for better medical diagnosis.

Sweta K. Shah and Prof. D.U. Shah have presented the Comparative Study of Image Fusion Techniques based on Spatial and Transform Domain. This paper presents two approaches to image fusion, namely Spatial Fusion and Transform Fusion. This paper describes Techniques such as Principal Component Analysis which is spatial domain technique and Discrete Wavelet Transform, Stationary Wavelet Transform which are Transform domain techniques. Performance metrics without reference image are implemented to evaluate the performance of image fusion algorithm. Experimental results show that image fusion method based on Stationary Wavelet Transform is remarkably better than Principal.

III. METHODOLOGY

Principal Component Analysis

The Principal Component Analysis (PCA) is a statistical technique widely used in signal processing, statistics, and many other applications. Chavez et al. [1991] used principal component analysis; the color distortion in the fusion is less than the Intensity-Hue-Saturation (IHS) fusion method. The main advantage of PCA method is that it can process unlimited multispectral bands and distortions less severe. The first Principal Component (PC) contains the spatial information. The first principal component (red) will exhibit a high degree of contrast, the second (green) will display only limited available brightness value and the third one (blue) will demonstrate an even smaller range. The RGB correlation coefficients depend on the scenes depicted in the images. In PCA, the redundant information can be organized in such a way that each output band is uncorrelated with others. The PCA fusion scheme can be applied to all bands in the MS image simultaneously (Krista Amolins et al. 2007). The disadvantage is that this method is sensitive to dead pixels, noise and other unwanted artifacts.

Wavelet analysis

The wavelets have the potential to separate the desired information and the undesired information from an image. Since it has many advantages such as multi-resolution representation, good energy compaction and decorrelation, the Discrete Wavelet Transform (DWT) has become the most important technique in image processing applications. Stephane G Mallat (1989) explained the extraction of difference of information between successive resolutions as wavelet representation by decomposing the original signal. Wavelet analysis is the process of decomposing a signal into shifted and scaled versions of a mother (initial) wavelet. An important property of wavelet analysis is perfect reconstruction that is the process of reassembling a decomposed signal or image into its original form without any loss of information. Decomposition of an image from a low frequency approximation image and a set of high frequency detailed image by performing thresholding have been used to reconstruct the image. DWT preserves the edge details of the image and reduces the noise effectively. There is no redundancy in the DWT and the original signal can be reconstructed from these components. To optimize the coding by the wavelet representation, the sensitivity of the human visual system as well as the statistical properties of the image are used. The wavelet representation is well suited for data compression, texture discrimination and fractal analysis. The applications extend to computer vision applications, pattern recognition, speech recognition applications, quantum mechanics and applied mathematics (Stephane G Mallat 1989).

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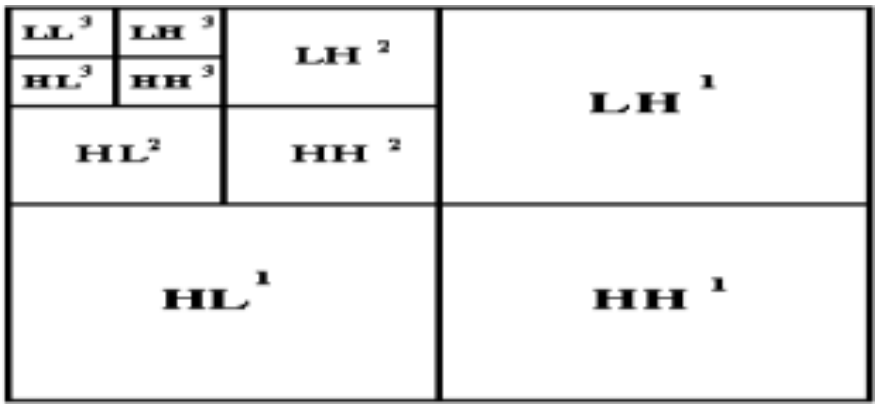

Figure 1: Wavelet Decomposition

Curvelet Transform

Mapper Plus PAN and MS image. The curvelet transform is a multi-resolution transform with frame elements indexed by scale and location parameters. This method is based on the principal that extracting the detailed spatial information from a PAN image and injecting into the MS image in a multi-resolution framework. To evaluate whether the amount of information injected is the detailed spatial information, the PAN 19 and fused images are filtered by a Laplacian filter. This method provides richer information in the spatial and spectral domain. It gives better visual and quantitative results for remote sensing fusion.

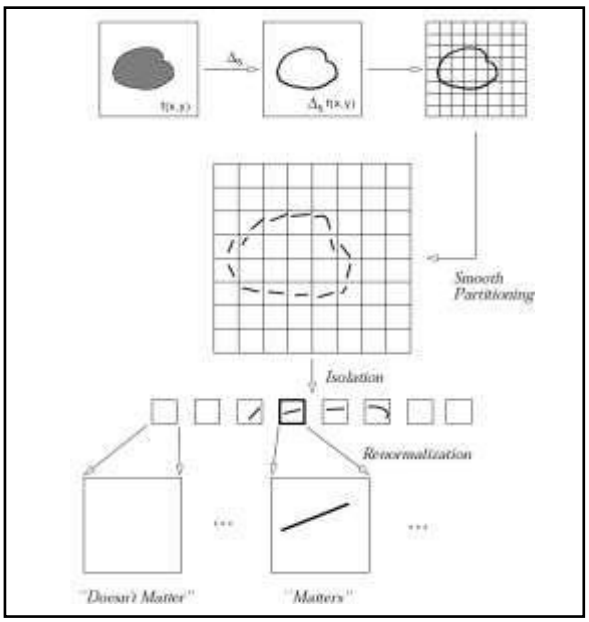

Figure 2: Overview of Organization of the Curvelet Transform

IV. CONCLUSION

With the growing technological advancements in the medical arena, it is necessary to keep up the research on medical image fusion standards to handle a host of problems such as integrating multiple images on common workspace and computational complexities in fusing image without jeopardizing quality. Handling problems of such mammoth proportion has been an arduous task, which is to some extent addressed by available image fusion techniques. Still, it requires a lot of energy and research in addressing improved fusion technique and more suitable hardware architecture

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catering more efficient functionalities in terms of reduced computational complexity and without sacrificing image quality. In this background, present research study has designed and implemented certain fusion technique with specific hardware architecture and has arrived at the following conclusions. In this research, an improved fusion technique for medical images using Discrete Wavelet Transform (DWT) is proposed. This new approach to fuse two medical images with DWT technique is better than other techniques in terms of spatial and spectral quality. The presented fusion rules are based on image enhancement.

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