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A Review Article of Image Fusion Technique Using Wavelet Transform

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***Abstract*- In this thesis various methods for lossless Image fusion of source image data are analyzed andDiscussed. The main focus in this work is lossless Image fusion algorithms based on context modeling using tree structure. The central aspect in context modeling is different context templates, which are based on discrete Cosine transform coefficients, local gradients and intensity of samples in the image. This work includes research on how to use DDCT context tree structure, prediction modeling and probability assignment in lossless image fusion based on context modeling technique. The main advantage over current methods is increasing effectiveness of image fusion and developing new lossless Image fusion methods based on context modeling for different type grayscale images: medical, astronomical, noisy natural images.Due to the increasing requirements for transmission of images in computer, mobile environments, the research in the field of image fusion has increased significantly. Image fusion plays a crucial role in digital image processing, it is also very important for efficient transmission and storage of images. When we compute the number of bits per image resulting from typical sampling rates and quantization methods, we find that Image fusion is needed. Therefore development of efficient techniques for image fusion has become necessary .This paper is a survey for lossy image fusion using Discrete Cosine Transform, it covers JPEG all format of image fusion algorithm which is used for full-color still image applications and describes all the components of it.**

***Keywords*- DWT,DDCT,ANN,PSO**

I. INTRODUCTION

The proliferation of digital technology has not only accelerated the pace of development of many image processing software and multimedia applications, but also motivated the need for better Image fusion algorithms. Imagefusion plays a critical role in telemetric applications. It is desired that either single images or sequences of images be transmitted over computer networks at large distances so as that they could be used for a multitude of purposes.

For instance, it is necessary that medical images be transmitted so as that reliable, improved and fast medical diagnosis performed by many centers could be facilitated. To this end, image fusion is an important research issue. The difficulty, however, in several applications lies on the fact that, while high Image fusion rates are desired, the applicability of the reconstructed images depends on whether some significant characteristics of the original images are preserved after the Image fusion process has been finished[1].

Image fusion is a fast paced and dynamically changing field with many different varieties of Image fusion methods available. Images contain large amount of data hidden in them, which is highly correlated. A common characteristic of most images is that the neighboring pixels are correlated and therefore contain redundant information. Research advances in wavelet theory have created a surge of interest in applications like image fusion. The investigation and design of computationally efficient and effective software algorithms for lossy image fusion forms the primary objective of this thesis.

II. IMAGE FUSION

Image processing is one kind of signal processing for this image acts as input, it may be either photo or video frame and the outcome of image processing may be either an image or a set of characteristics related to the image. Most of the image- processing techniques, image of two dimensional signal is treated as input and standard signal-processing techniques are applied to it. Image and video compression is an active application area in image processing.

In the field of Image processing, image fusion has received a significant attention for remote sensing, medical imaging, machine vision and the military applications. A hierarchical idea of image fusion has been proposed for combining significant information from several images into one image. The aim of image fusion is

to achieve improved situation assessment and/or more fast and accurate completion of a pre-defined task than would be possible using any of the sensors individually. Mainly image fusion requires precise techniques and also good understanding of input data. The final output of image fusion is expecting to provide more information than any of the single images by reducing the Mean Square Error (MSE).

Image fusion is the process that combines information from multiple images of the same scene. These images may be captured from different sensors, acquired at different times, or having different spatial and spectral characteristics. The object of the image fusion is to retain the most desirable characteristics of each image. With the availability of multi sensor data in many fields, image fusion has been receiving increasing attention in the researches for a wide spectrum of applications [1].

III. LITERATURE REVIEW

Heba M. El-Hoseny,El-Sayed M. El.Rabaie: "Medical Image Fusion Techniques Based on Combined Discrete Transform Domains" This paper investigates some of medical image fusion techniques and discusses the most important advantages and disadvantages of these techniques to develop hybrid techniques that enhance the fused image quality. Both traditional and hybrid fusion algorithms are evaluated using several quality metrics including average gradient, local contrast, standard deviation, edge intensity, entropy, structure similarity index, universal image quality index, feature similarity index, Peak Signal-to-Noise Ratio (PSNR), mutual information, Qab/f, and processing time. Experimental results prove that the hybrid technique of Additive Wavelet Transform (AWT) and Dual Tree complex wavelet transform (DT-CWT) with high pass sharpening filter provides the best fused images of highest quality, highest details, shortest processing time, and best visualization. This is favorable, especially for helping in accurate diagnosis and optimal therapy applications.

Medical image fusion is the most up growing field for medical diagnosis that merges the essential features from different source images into a single one with extended information content and reduced redundant data and artifacts that may exist in the source images [1].Image fusion process can be performed in spatial or transform domains. Spatial domain fusion techniques include simple averaging, simple maximum fusion, PCA, and Intensity Hue Saturation (IHS). These techniques have some advantages and disadvantages [2]. Simple averaging fusion technique is the simplest algorithm, but it does not introduce clear objects from the set of images. Simple maximum fusion produces highly focused images, but blurring is the main disadvantage that affects the local contrast, greatly. PCA fusion produces spectral degradation, and IHS is not suitable for medical image fusion as it mainly deals with color images [3]. Transform domain fusion techniques include DWT, DT-CWT, curvelet transform. All transform domain techniques convert images into multi-resolution or multi-scale image representations before fusion, and then apply inverse transforms to obtain the fused images [4]. Despite the good performance of transform domain fusion techniques, they still have some disadvantages. DWT fusion poorly handles long curved edges, has poor directionality, is shift sensitive, destroys phase information, and provides less spatial resolution. Curvelet fusion is more efficient in handling curved shapes, but more complex and consumes longer time. DT-CWT can increase directionality, achieve better edge representation, and has an approximate shift invariance property compared to DWT [4-5].

Yuri Levin-Schwartz, Vince D. Calhoun: "Two models for fusion of imaging data: comparison and connections" Exploitation of complementary information is the principal reason for collecting data from multiple neurological sensors. Since little is known about the latent processes underlying neural function, it is important to minimize the assumptions placed on the data when performing a joint analysis. This motivates the use of data-driven fusion methods, such as independent vector analysis (IVA), for the analysis of neurological data. For neural datasets, the complementary Information exploited by fusion methods may be in the form of similar spatial activation across datasets, the spatial IV A (sIVA) model, or similar subject relations across datasets, the Transposed IVA (tIVA) model. Despite the potential power of these two models, no study has investigated how the differences in the modeling assumptions of sIVA and tIVA inform the fusion of real neuro imaging data. In this paper, we utilize unique set of multitask functional magnetic resonance imaging data from 271 subjects to directly compare the sIV A and tIVA models and visualize their differences using a novel technique, global difference maps. Through this application, we note important similarities between the results from the two methods that increase our confidence in their overall performance, though differences in modeling assumptions result in certain differences in the decompositions.

Gagandeep kaur, Anand Kumar Mittal: "A New Hybrid Wavelet Based Approach for Image Fusion"With the availability of multi -sensor data in many fields, image fusion has been receiving increasing attention in the researches for a wide spectrum of applications. Image fusion is the process that combines information from multiple images of the same scene. These images may be captured from different sensors, acquired at different times,or having different spatial and spectral characteristics. Discrete wavelet transform (DWT) was performed on source image. Because DWT is the basic and simplest transform among numerous multi-scale transform and other type of wavelet based fusion schemes are usually similar to the DWT fusion scheme. In this

paper, hybrid method for image fusion is proposed. The method used is combination of DCT (Discrete Cosine Transform) and Variance and compared it with Hybrid DWT.

Image fusion is the process that combines information from multiple images of the same scene. These images may be captured from different sensors, acquired at different times, or having different spatial and spectral characteristics. The object of the image fusion is to retain the most desirable characteristics of each image. It is basically a process of combining the relevant information from a set of images into a single image, where the resultant fused image will be more informative and complete than any of the input images. Image fusion techniques can improve the quality and increase the application of these data. Image fusion is a useful technique for merging single sensor and multi-sensor images to enhance the information. The objective of image fusion is to combine information from multiple images in order to produce an image that deliver only the useful information. The discrete cosine transformation (DCT) based methods of image fusion are more suitable and time-saving in real-time systems. In this paper an efficient approach for fusion of multifocal images is presented which is based on variance calculated in dct domain.

Zhang Ning, Zhu Jinfu: "Study on image compression and fusion based on the wavelet transform technology" The development of information technology, the rapid development of microelectronics technology, image information acquisition and use is also increasing, sensor technology also unceasingly to reform. A single sensor information obtained is limited, often cannot meet the actual needs, in addition, different sensors have the advantage of the imaging principle and its unique, as in color, shape characteristics, band access, spatial resolution from the aspects of all have their own characteristics. Registration algorithm is proposed in this paper has better robustness to image noise, and can achieve sub-pixel accuracy; the registration time has also been greatly improved. In terms of image fusion, the images to be fused through wavelet transform of different resolution sub image, using a new image fusion method based on energy and correlation coefficient. The high frequency image decomposed using new energy pixels of the window to window energy contribution rate of fusion rules, the low frequency part by using the correlation coefficient of the fusion strategy, finally has carried on the registration of simulation experiments in the Matlab environment, through the simulation experiments of fusion method in this paper can get the image fusion speed and high quality fast fusion image.

Periyavattam Shanmugam Gomathi, Bhuvanesh Kalaavathi: "Multimodal Medical Image Fusion in Non-Subsampled Contourlet Transform Domain"Multimodal medical image fusion is a powerful tool for diagnosing diseases in medical field. The main objective is to capture the relevant information from input images into a single output image, which plays an important role in clinical applications. In this paper, an image fusion technique for the fusion of multimodal medical images is proposed based on Non-Subsample Contourlet Transform. The proposed technique uses the Non-Subsample Contourlet Transform (NSCT) to decompose the images into low pass and high pass sub bands. The low pass and high pass sub bands are fused by using mean based and variance based fusion rules. The reconstructed image is obtained by taking Inverse Non-Subsample Contourlet Transform (INSCT) on fused sub bands. The experimental results on six pairs of medical images are compared in terms of entropy, mean, standard deviation, QAB/Fas performance parameters. It reveals that the proposed image fusion technique outperforms the existing image fusion techniques in terms of quantitative and qualitative outcomes of the images. The percentage improvement in entropy is 0%- 40%, mean is 3%- 42%, standard deviation is 1%- 42%, QAB/Fis 0.4%- 48% in proposed method comparing to conventional methods for six pairs of medical images.

Yu Tian, Yibing Li, Fang Ye: "Multimodal Medical Image Fusion Based on Nonsubsampled Contourlet Transform Using Improved PCNN" Multimodal medical image fusion is an indispensable branch in the field of image fusion. In order to obtain a more complete and more reliable medical image, this paper presents a novel approach for multimodal medical image fusion using an improved pulse-coupled neural network (IPCNN)in non sub sampled contourlet transform (NSCT) domain. First, the image is decomposed into sub-bands with different scales and different directions by NSP and NSDFB. Next, local area singular value is introduced to determine the structural informationfactor which will be the linking strength parameter of PCNN. After the fire process we can get the fire mapping images that can reflect the characteristics of single pixel and its neighborhood. Then, we extract the objects with salient features of the fire mapping images by compare-selection operator. Finally, deconstruct the fused image by inverse NSCT. Our proposed algorithm in multimodal medical image fusion is proved to perform better in robustness and reliability over the existing methods, meeting the requirement of human vision.

IV. DISCRETE WAVELET TRANSFORM

The requirement for the successful image fusion is that images have to be correctly aligned on a pixel-by-pixel basis. In this project, the images to be combined are assumed to be already perfectly registered [1] [2]. The Figure shows the top level block diagram of image fusion using wavelet transform. The two input images image1and image 2 that are captured from visible and infrared camera respectively are taken as inputs. The wavelet transform

decomposes the image into low-low, low-high, high-low, high-high frequency bands. The wavelet coefficients are generated by applying the wavelet transform on input images. Wavelet coefficients of the input images are fused by taking the average of input images. The resultant fused image is obtained by applying the inverse wavelet transform [3].

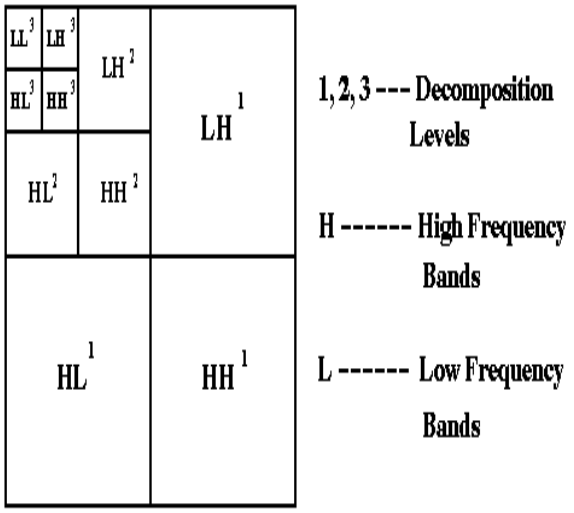

Fig 1. Composition and Decomposition of DWT.

The designing and modeling of fusion two images by averaging and 2-D DWT with different filters like Haar filters in MATLAB. The results of all fusion techniques for three different set of images has been carried out. The PSNR of different set of images for different fusion techniques has been tabulated.

The Discrete Wavelet Transform (DWT) is frequently encountered in numerous applications involving image and video compression, pattern, recognition, bioinformatics, and so on. Due to its incredible advantage over the discrete cosine transform (DCT), 2-D DWT has been adopted for designing of image fusion technique. High PSNR and clear fused image is achieved by 2-D DWT with 9/7 filter [2].

1. Detailed block diagram of DWT based image fusion:
DWT- IDWT plays a vital role in image fusion technique. In this project, the registered images have been considered for fusion process, since it is necessary that the images have to be correctly aligned on a pixel-by-pixel basis to achieve successful image fusion. DWT has been modeled at the transmitter and IDWT has been modeled at the receiver. The wavelet transforms of the images has been computed. The registered images have been passed as input signals through Two different one dimensional digital filters H0 and H1 respectively. H0and H1digital filters perform high pass and low pass filtering operations respectively for both the input images. The output of each filters are followed by sub-sampling by a factor of 2. This step is referred as the Row compression and resultant is called as L-low frequency component and H-high frequency component. The down sampled outputs have been further passed to two one dimensional digital filters in order to achieve Column compression.

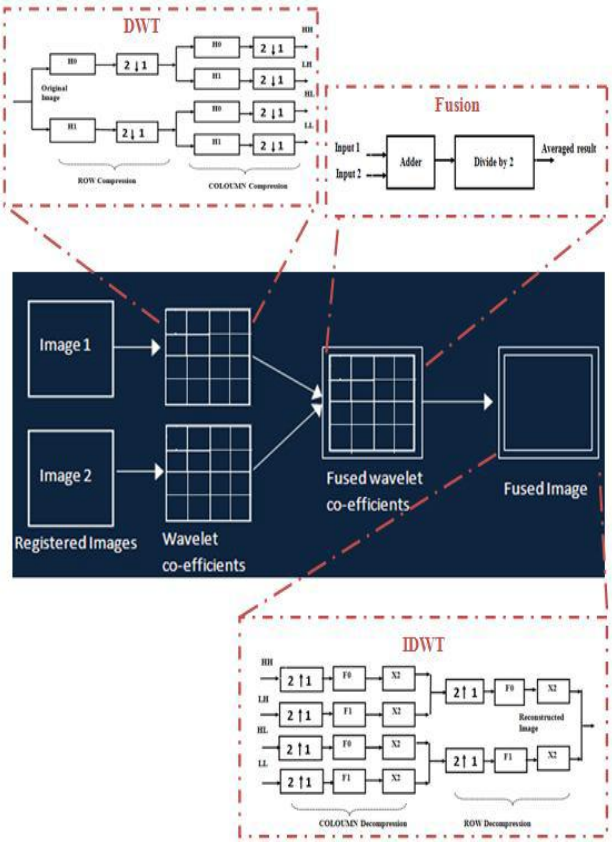

Fig 2. Block Diagram of Image Fusion.

V.CONCLUSION

A new image fusion scheme based on discrete wavelet transform is proposed in this research which provides sufficient high Image fusion ratios with no appreciable degradation of image quality. The effectiveness and robustness of this approach has been justified using a set of real images. The images are taken with a digital camera (OLYMPUS LI-40C). To demonstrate the performance of the proposed method, a comparison between the proposed technique and other common Image fusion techniques has been revealed.

From the experimental results it is evident that, the proposed Image fusion technique gives better performance compared to other traditional techniques. Wavelets are better suited to time-limited data and wavelet based Image fusion technique maintains better image quality by reducing errors. The future direction of this research is to implement a Image fusion technique using neural network.

Comparisons of results for DCT and DWT based on various performance parameters: Mean Squared Error (MSE) is defined as the square of differences in the pixel values between the corresponding pixels of the two images.

Graph of shows that for DCT based image fusion, as the window size increases MSE increases proportionately whereas for DWT based image fusion shows that MSE first decreases with increase in window size and then starts to increase slowly with finally attaining a constant value. and plot show required for compressing image with change in window size for DCT and DWT respectively and indicate Image fusion ratio with change in window size for DCT and DWT based image fusion techniques respectively. Image fusion increases with increase in window size for DCT and decreases with increase in window size for DCT+PCA. a very simple, fast and efficient DCT based multifocal image fusion scheme is proposed which outperforms other DCT based fusion methods as verified in our extensive experiments. Since the fusion rule does not involve any complex arithmetic floating point operations like mean or variance calculations, it is extremely simple and energy efficient, making it more suitable for real time applications and resource constrained battery powered sensors for energy efficient fusion and subsequent Fusion. In future it is planned to validate our approach on a sensor network tested.

In this work, we proposed a new hybrid method for Image fusion, The Method we use have combination of DCT (Discrete Cosine Transform) and Variance then we compare it with Hybrid DWT (Discrete Wavelet Transform). Our proposed technique has much better results in terms of PSNR and MSE comparison to all other existing techniques. This Modified Method has very efficient to use for many Applications in image processing areas.

Till now, we are clear with the idea that we have built a new hybrid technique for the image fusion which clearly works only on two images. But in future, fusion can be done on two videos or even on one video and one image or on an audio and one image

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