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Trending Technique : Study of DWT in Multimodal Fusion

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Abstract- *Image fusion now a days trending very much. Image fusion is the combination of two or more source images which vary in resolution, instrument modality, or image capture technique into a single composite representation. Thus, the source images are complementary in many ways, with no one input image being an adequate data representation of the scene. Therefore, the goal of an image fusion algorithm is to integrate the redundant and complementary information obtained from the source images in order to form a new image which provides a better description of the scene for human or machine perception. Medical image is a core step of medical diagnosis and has been diffusely applied in modern medical domain. The technology of modern medical image is more and more mature which could be present images in different modes and features. Image fusion has become crucial part of medical diagnosis. Medical image fusion is the technology that could compound two mutual images into one according to certain rules to achieve clear visual effect. By observing medical fusion image, doctor could easily confirm the position of illness. CT scans provide high resolution information on bone structure while MRI scans provide detailed information on tissue types within the body. According to the mutual features of CT scan image and MRI medical image, both the images are fused into one. Therefore, an improved understanding of a patient's condition can be achieved through the use of different imaging modalities. In this paper we are focusing on discrete wavelength technique(DWT) for fusing CT and MRI images.*

Keywords-*Multimodal Image Fusion, Computed Tomography Image, Magnetic resonance Image, Discrete Wavelength Technique(DWT), Fusion Rules.*

I. INTRODUCTION

Image fusion produces a single image by combining information from a set of source images together, using data/ pixel, feature or decision level techniques. The goal of an image fusion algorithm is to integrate the redundant and complementary information obtained from the source images in order to form a new image which provides a better description of the scene for human or machine perception. Image fusion is essential for computer vision and robotics systems in which fusion results can be used to aid further processing steps for a given task. Image fusion techniques are practical and fruitful for many applications, including medical imaging, security, military, remote sensing, digital camera and consumer use[1]. The fused image contains greater information content for the scene than any one of the individual image sources alone. The reliability and overall detail of the image is increased, because of the addition of analogous and complementary information. Image fusion requires that images be registered first before they are fused. Data fusion techniques combine data from different sources together. The main objective of employing fusion is to produce a fused result that provides the most detailed and reliable information possible. Fusing multiple information sources together also produces a more efficient representation of the data.

Multi view Fusion has images of the same modality, taken at the same time but from different places or under different conditions. Multimodal Fusion is in which images of different modalities: PET, CT, MRI, visible, infrared, ultraviolet, etc. are fused together. Multi focus fusion has the original image which can be divided into regions such that every region is in focus in at least one channel. Multi temporal Fusion are images of the same scene taken at different times (usually of the same modality). There are three main categories of fusion: Pixel / Data level fusion is the combination of the raw data from multiple source images into a single image. In pixel level fusion the fused pixel is derived from a set of pixels in the various inputs .The main advantage of pixel level fusion is that the original measured quantities are directly involved in the fusion process. Feature level fusion deals with the fusion of features such as edges or texture while decision level fusion corresponds to combining decisions from several experts. In other word, Feature level fusion requires the extraction of different features from the source data before features are merged together. Decision level fusion involves fusion of sensor information that is preliminary determinate by the sensors[3].

One of the main field of image fusion is in medical. Medical image is a core step of medical diagnosis and has been diffusely applied in modern medical domain. The technology of modern medical image is more and more mature which could be present images in different modes and features. Image fusion has become crucial part of medical diagnosis. Medical image fusion is the technology that could compound two mutual images into one according to certain rules to achieve clear visual effect [4]. By observing medical fusion image, doctor could easily confirm the position of illness.

Medical image fusion is the idea to improve the image content by fusing images taken from different imaging tools like Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET) and single photon emission computed tomography (SPECT). CT scans provide high resolution information on bone structure while MRI scans provide detailed information on tissue types within the body. Therefore, an improved understanding of a patient's condition can be achieved through the use of different imaging modalities. According to the mutual features of CT scan image and MRI medical image, both the images can be fused into one for better understanding [5].

II. MULTIMODAL MEDICAL IMAGING

A. Computed Tomography Scan

A CT scan, also known as a CAT scan, is an imaging test that details the inside of the body. A computed tomography (CT) scan is an imaging method that uses x-rays to capture cross sections of the body. Its image consists of array of picture elements called pixels. Each pixel represents the mean attenuation of an axial column of tissue. CT scans can provide detailed information to diagnose, plan treatment for, and evaluate many conditions in adults and children. Additionally, the detailed images provided by CT scans may eliminate the need for exploratory surgery. CT-Scan image are able to visualize bone , soft tissue and blood vessels. The main feature of CT is it can outline bone inside the body very accurately [2].

B. Magnetic Resonance Image

MRI images demonstrates subtle differences between different kinds of soft tissues .Mainly MRI images are used to detect cancerous tissue , blood clot, tumour etc. The Contrast material is used during MRI to show abnormal tissue more clearly. An MRI scan can be done for the: Head. MRI can look at the brain for tumours, an aneurysm, bleeding in the brain, nerve injury, and other problems, such as damage caused by a stroke. The main feature of an MRI image is to show the soft tissues , soft cell membranes clearly which are covering the skull[3].

Visualization of multiple image modalities is very difficult. Side by side comparisons are often not precise Flipping back and forth helps to pronounce changes but some modalities may have no structural landmarks. Nowadays, with the rapid development in high-technology and modern instrumentations, medical imaging has become a vital component of a large number of applications, including diagnosis, research, and treatment [6].Medical image fusion is the idea to improve the image content by fusing images taken from different imaging tools like Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET) and single photon emission computed tomography (SPECT). According to the mutual features of CT scan image and MRI medical image, both the images are fused into one. Comparison of both the images is shown in Figure 1. CT scans provide high resolution information on bone structure while MRI scans provide detailed information on tissue types within the body. Therefore, an improved understanding of a patient's condition can be achieved through the use of different imaging modalities[7].

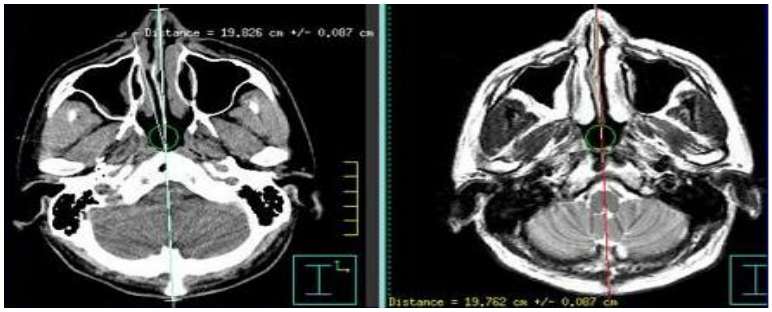

Fig : 1 Comparison of CT and MRI image

III. PREPROCESSING STEPS

The multimodal images which are needed to be fused need to be processed prior to application of fusion algorithm. The pre-processing includes image registration, image resizing and histogram equalization.

1) Image Registration -The images which are obtained by different modalities might be of different orientations and hence are needed to be registered before they are fused.
2) Image Resizing- Also the sizes of the images might vary so before fusion, the images are needed to be resized so that both the images are of the same size. This is done by interpolating the smaller size image by rows and columns duplication.

3) Image Enhancement- If both or any of the images are not of gray scale then it is desired that it is converted to gray scale. The next step which follows this is equalization of the histograms of the images so that the contrast of the image is enhanced and that both the images have similar range of values for wavelet coefficients [8].

IV. APPLICATION OF DWT TO MRI & CT SCAN IMAGE FUSION

The wavelet transform decomposes the image into low-high, high-low, high-high spatial frequency bands at different scales and the low-low band at the coarsest scale which is shown in figure 2. The low image has the smallest spatial resolution and represents the approximation information of the original image. The other sub-images, on the contrary show the detailed information of the original image. There are different levels of decomposition which are shown in Figure 2. After one level of decomposition, there will be four frequency bands, as listed above. The next level decomposition is just applied to the LL band of the current decomposition stage, which forms a recursive decomposition procedure. Thus, N-level decomposition will finally have 3N+1 different frequency bands, which include 3N high frequency bands and just one LL frequency band which is shown in figure 3 in detail [9].

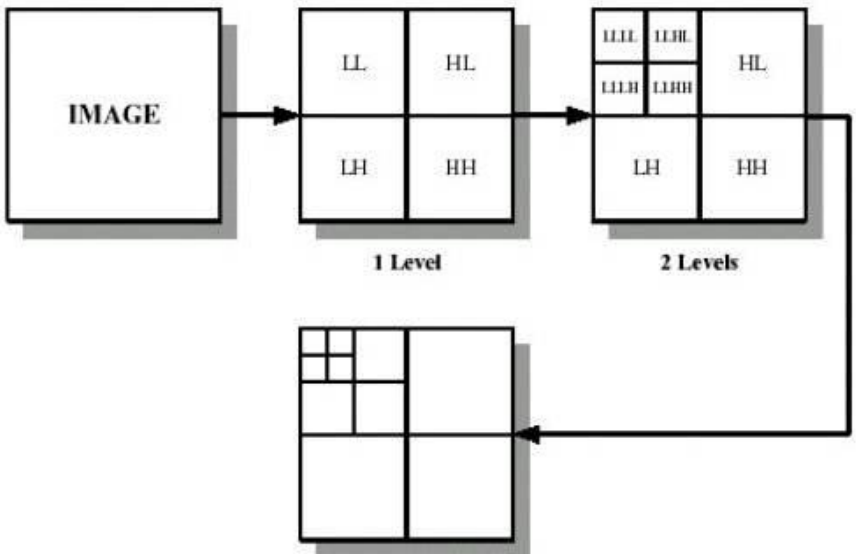

Fig 2 : Wavelet transform (a) Single Level decomposition (b) Two level decomposition (c) three level decomposition

A. Image Fusion Steps

The steps in the algorithm for image fusion using DWT as shown in Figure 3 are as follows: (1) Read the input images (MRI & CT Scanned). (2) Resample and register both these images. (3) Apply 2D-discrete wavelet transform to these images which decompose it into four sub-bands (LL, LH, HL and HH). (4) The Wavelet coefficients obtained from both the images are fused using the rules for fusion. (5) The final fused image is reconstructed by applying inverse discrete wavelet transform to fused image[10].

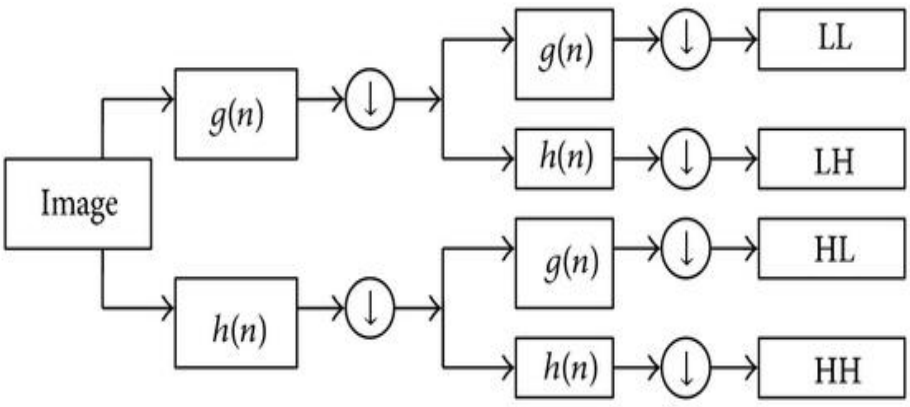

Fig 3 : Discrete wavelength technique

B. Fusion Rules

Selection of fusion rules plays a significant role in image fusion. Most information of the source images is kept in the low-frequency band as it is a smoothed and sub sampled version of original input image. Higher value of wavelet coefficients carries salient information about images such as corners, edges and hence several rules like maximum selection rule, gradient and contrast fusion rule can be used for image fusion[11]The fusion process is shown in figure 4.
Maximum or choose max fusion rule:

Higher value of wavelet coefficients contains most important information about images such as edges, and corners. Therefore, in maximum selection rule for fusion, smaller magnitude complex wavelet coefficients are replaced by means of higher magnitude complex wavelet coefficients. For every corresponding pixel in input images, the pixel with the maximum intensity is chosen and used as the resultant pixel of the fused image. The major steps of the proposed algorithm are summarized as follows

If,
LL1(i,j) > LL2(i,j)
Lout(i,j) = LL1(i,j);
Else
Lout(i,j) = LL2(i,j);

Where, LL=indicates low frequency coefficients, Lout=indicates output image value, LL1=indicates coefficients of 1st input image and LL2=indicates coefficients of 2nd input image [12].

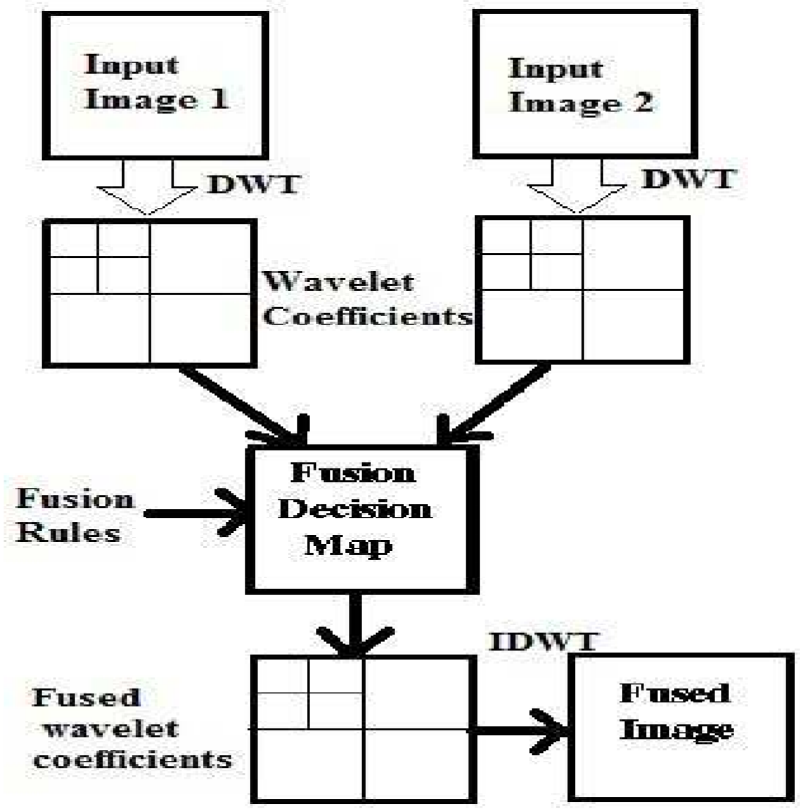

Fig 4 : Block diagram of Image Fusion process using DWT

V. CONCLUSION

Selection of proper fusion technique plays an important role in Multimodal Image fusion. In this paper we have discussed that how discrete wavelet technique (DWT) is used to fuse the two image of different modes which are CT and MRI images. Fusion of these two images will lead to diagnosis of the disease or tumour in a better and particular way. This will lead to a major turn in the medical imaging industry and will be helpful to doctor in diagnosis and treatment of a patient.

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