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MULTI – FOCUS IMAGE DIAGNOSTIC BASED ON SECOND GENERATION CURVELET TRANSFORM COMBINED WITH WAVELET TRANSFORM

k.subasri,E.Ramya ***Ms.R.Sonal@Shaloo***
Mailam Engg. College, Mailam
Tamil Nadu, India
sonalramnivas@gmail.com

ABSTRACT

Image fusion is an important research topic in many related areas such as computer vision, automatic object detection, remote sensing, image processing, robotics, and medical imaging. A variety of techniques have been developed for fuse the images, broadly classified into the spatial and spectral methods. Spatial mostly rely on statistical calculation on the image. These statistical techniques are sensitive to noise and have inefficient number of features. The spectral methods are robust to noise .spectral method of image fusion use multiresolution. But the drawback with these spectral methods is that they do not capture the edge information of an image effectively and complexity. This is the reason for finding better multiresolution spectral approaches, which can capture the edge and orientation information of an image effectively. The mainobjective of image fusion is to obtain a better visual.

Keywords-Depth of field, Multi-focus Image, Image Fusion, Curvelet Transform.

1. INTRODUCTION

The use of image fusion techniques has gained significant popularity over the past decade. It is improved with the development of digital image processing and image analysis technology, and gradually demonstrates its wide range of applications in the automatic target recognition, remote sensing, medical image processing and other fields. In the image fusion research, multifocus image fusion is one of the major categories with representative, which generally refers tothe conditions that due to the limited depth-of-focus of optical lenses in CCD devices, it is often not possible to get an image that contains all relevant objects in focus. Consequently, the image obtained will not be in focus everywhere, i.e., if one object in the scene is in focus, another one will be out of focus [1].

In order to resolve that problem, many fusion techniques have beendeveloped. The simplest image fusion method just takes the pixel-by-pixel average of the sourceimages. The algorithms are rather easy to implement and time efficient [2]. This, however, oftenleads to undesirable side effects such as reduced contrast. In recent years, many researchers recognized that multi-scale transforms are very useful for analyzing the information content ofimages for the purpose of fusion. So, various alternatives based on multi-scale transforms havebeen proposed [3,4], such as Laplacian pyramid-based, gradient pyramid-based, ratio pyramidbased,et al.. The basic idea of multi-scale transform is to perform a multi-resolutiondecomposition on each source image, then integrate all these decompositions to produce acomposite representation [5,6].

The fused image is finally reconstructed by performing aninverse multi-resolution transform. The pyramid-based method is simple and has goodperformance generally. However, in the pyramid reconstruction, it is sometimes unstable,especially when there are multiple significant differences in the source image, the fused image will appear plaques. Wavelet transform is a multi-resolution analysis method, too. It can decompose an image into an approximation and the lowest level of detail in different directions at different scales, and it is one of the most commonly used image fusion methods [9-11]. Wavelets are very effective in representing objects with isolated point singularities,

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while wavelet bases are not the most significant in representing objects with singularities along lines. As a consequence, the method based on the WT can not excavate the edge quality and detail information [12].

To above deficiencies of wavelet transform, Donoho et al. proposed the theory of Curvelet transform [13], which takes edge as the basic description element and is well suitable for the characteristics of image. The research results show that Curvelet transform theory can be better used in image denoising [14], feature extraction [15], image fusion [16], etc., and good results were obtained. But they used the first generation of Curvelet transform. In 2004, Candès, who proposed the theory of second generation of Curvelet transform [17,18], and in 2005 the fastimplementation of second generation Curvelet transform algorithm is given.

Compared withfirst generation Curvelet transform, the second generation can overcome many of the shortcomings, not only has the simple structure, but also greatly reduces the amount of data redundancy, and its fast algorithm is easier to be understood. Therefore, combining with the characteristics of multi-focus images, we discussed the principles of the second generation Curvelet transform and explored a new multi-focus image fusion method based on Curvelet transform in this paper. It is realized by adopting different strategies on low-frequency coefficients and high frequency coefficients to extract the features of the original images. Experimental results show that the algorithm is with satisfactory results.

The rest of this paper is organized as follows. The principle of Curvelet transform is described in section 2. In section 3, a new image fusion approach for multi-focus images based on Curvelet transform is presented; it describes different methods for merging the coefficients obtained during the Curvelet transform process and the main steps of this fusion method. After that, evaluation rules of fused image is proposed, which is followed by the discussion of experiments in section 5. Finally, in section 6, the conclusions are presented.

2. IMAGE FUSION

Image fusion is a data fusion technology which keeps images as main research contents. It refers to the techniques that integrate multi-images of the same scene from multiple image sensor data or integrate multi-images of the same scene at different times from one image sensor. Image fusion combines perfectly registered images from multiple sources to produce a high quality fused image with spatial and spectral information. It integrates complementary information from various modalities based on specific rules to give a better visual picture of a scenario, suitable for processing.This Complementary Fusion is useful in many Medical Applications.Image Fusion can be done in different levels such as pixel Level Fusion, Region Based Fusion, Feature Level Fusion, Entropy Based Fusion, Decision Level Fusion, Contrast Based Fusion.

Medical Image Fusion

Image Fusion also contains various potential applications for medical data collection and diagnosis. It assists physicians in extracting features that may not be normally visible in images produced by different modalities. For example, a MRI-T1 provides greater detail about anatomical structure, whereas a MRI-T2 provides a greater contrast between the normal and abnormal tissues. Other medical image analyses, an image showing functional and metabolic activity such as a single photon emission computed tomography (SPECT), positron emission tomography (PET), and magnetic resonance spectroscopy (MRS), are often registered to an image which shows anatomical structures such as a magnetic resonance image (MRI), computed tomography (CT), and an ultrasound. Thus to extract more information, medical image fusion is performed in such a manner as to combine these contrasting and complimentary features into oneimage. Advantages of these applications are to reduce the difficulty in diagnosing disease and reducing storage cost.

The goal of image fusion is to obtain useful complementary information from multimodality images as much as possible. A number of solutions for image fusion have been introduced in previous literatures.The simplest way to obtain a fused image from two or more medical images is to average them. Although mostly preserving the original meaning of the images, it is prone to reduce the contrast of the fused image. Most of present image fusion methods aim at obtaining as many as information from the different modality images.The fusion criterion is to minimize different error between the fused image and the input images. With respect to the medical diagnosis, the edges and outlines of the interested objects is more important than other information. Therefore, how to preserve the edge-like features is worthy of investigating for medical image fusion.

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Quantitative Evalution

The Image Quality of Fused Image can be evaluated by the following parameters

1) *Entropy*

The entropy of an image is a measure of information content .The estimate assumes a statistically independent source characterized by the relative frequency of occurrence of the elements in X, which is its histogram. For a better fused image, the entropy should have a larger value.

2) *Peak Signal to Noise Ratio*

The Signal-to-noise ratio is defined as the power ratio between a signal (meaningful information) and the background noise (unwanted signal). The PSNR is most commonly used as a measure of quality of reconstruction of lossy compression codecs.

The PSNR is defined as:

$$\begin{aligned} PSNR &= 10 \cdot \log_{10}\left(\frac{MAX_I^2}{MSE}\right) \\ &= 20 \cdot \log_{10}\left(\frac{MAX_I}{\sqrt{MSE}}\right) \end{aligned} \quad (3.1)$$

3) *Root Mean Square Error*

The Root Mean Square Error (RMSE) between the reference image R and fused image F.

$$RMSE = \left(1/MN \sum_{i=1}^{M} \sum_{j=1}^{N} [R(i,j)-F(i,j)]^2\right)^{1/2} \quad (3.2)$$

Proposed Image Fusion Algorithm

Image Fusion is defined as the process of combining information in two or more images of a scene to enhance viewing or understanding of the scene.Image fusion is opposed to strict data fusion, requires data representing every point on a surface or in space so to be fused, rather than selected points of interest. Image fusion can be based on pixel,

Features,Region,Entropy and Contrast based Fusion.In this project we deals with Pixel Level Fusion , Region based Fusion and Feature Level Fusion.Its used to fuse Medical images using Complementary analysis where the CT image and MRI Images are fused together to get all the visual information about the image.

To fuse these images there are many fusion algorithm based on Wavelet.Now we have proposed a new fusion algorithm based on both wavelet and Second generation Curvelet Transform.

Since using Wavelet Transform edge information can't be extacted clearly.In Medical Image Fusion the edge information is most important so we are going to use a new algorithm to fuse the images.Its a combination of Wavelet and Curvelet based algorithm which is used for fusion to extract edge information and the process is simple to analyse the fusion of the images.

3. BLOCK DIAGRAM OF IMAGE FUSION ALGORITHM

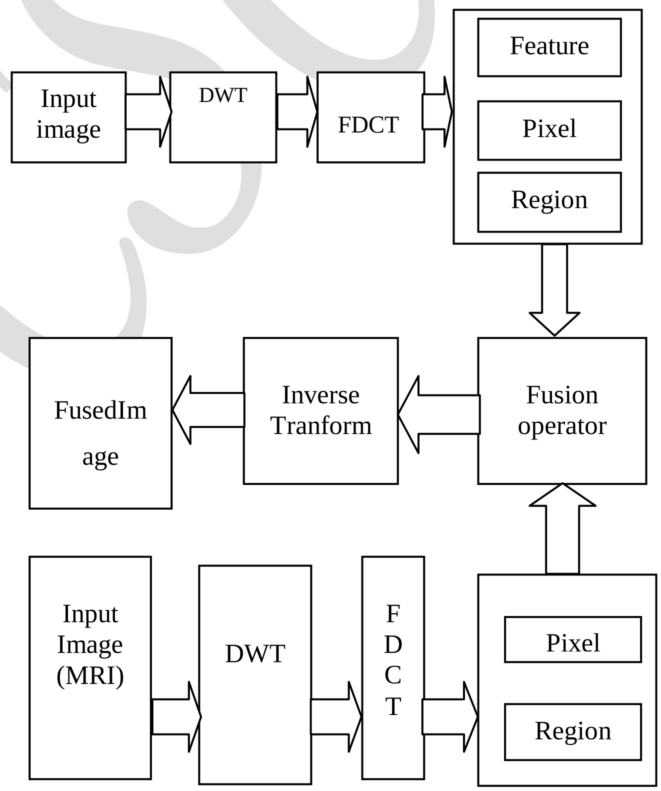

Figure1.Block diagram of Image Fusion Algorithm

Images can be fused in Pixel level fusion ,Region based fusion and Feature level Fusion in this project.Its mainly used in medical applications. We can take operation on pixel directly, and then fused image could be obtained. We can keep as more information as possible from source images. Using Complementary

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Fusion image the image of CT and MRI images has been fused. The steps to fuse two images as follows Using Wavelet Transform to decompose original images into proper levels. One low-frequency approximate component and three high-frequency detail components will be acquired in each level.Curvelet Transform of individual acquired low frequency approximate component and high frequency detail components from both of images,neighborhood interpolation method is used and the details of gray can't be changed.In Pixel level fusion depending on maximum value of pixels is chosen to measure definition for low frequency component. First, divide low-frequency as four sub square blocks and calculate the maximum value of the block.Inverse transformation of coefficients after fusion,the reconstructed images will be fusion images.In Region base fusion the fusion depends upon the region which is segmented and depending on variance the image is fused In the Feature Level Fusion depending on the Entropy and Variance value based on Region based Fusion this fusion occurs. The Performance of the algorithm can be evaluated using Entropy,RMSE and PSNR.

4) CT Image

Cat scans are a specialized type of x-ray. The patient lies down on a couch which slides into a large circular opening. The x-ray tube rotates around the patient and a computer collects the results. These results are translated into images that look like a "slice" of the person. Sometimes a radiologist will decide that contrast agents should be used. Contrast agents are iodine based and are absorbed by abnormal tissues. They make it easier for the doctor to see tumors within the brain tissue.The CT image has been shown in Fig 2 There are some (rare) risks associated with contrast agents and you should make sure that you discuss this with the doctor before arriving for the examination. CT is very good for imaging bone structures.

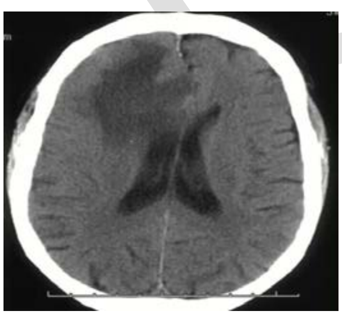

Figure.2 CT image

5) MRI Image

MRI is a completely different, Unlike CT it uses magnets and radio waves to create the images. The patient lies on a couch that looks very similar the ones used for CT. They are then placed in a very long cylinder and asked to remain perfectly still. The cylinder that you are lying in is actually a very large magnet. The computer will send radio waves through your body and collect the signal that is emitted from the hydrogen atoms in your cells.This information is collected by an antenna and fed into a sophisticated computer that produces the images. These images look similar to a CT scan but they have much higher detail in the soft tissues as shown in Fig 3 MRI does not do a very good job with bones.

One of the great advantages of MRI is the ability to change the contrast of the images. Small changes in the radio waves and the magnetic fields can completely change the contrast of the image. Different contrast settings will highlight different types of tissue. Another advantage of MRI is the ability to change the imaging plane without moving the patient. Most MRI machines can produce images in any plane.

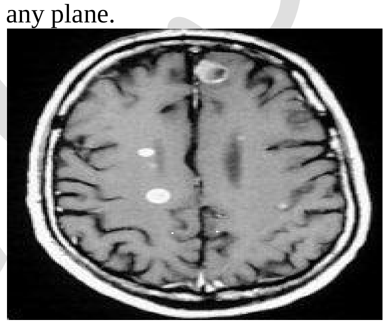

Figure.4 MRI image.

6) Pixel Based Fusion

Pixel based fusion represents fusion of visual information of the same scene, from any number of registered image signals,obtained using different sensors. The goal of pixel-level image fusion can broadly be defined as to represent the visual information present in any number of input images, ina single fused image without the introduction of distortion or loss of information. In simpler terms, the main condition for successful fusion is that "all" visible information in the input images should also appear visible in the fused image. However, although theoretically possible, due to the redundant nature of multisensor information(for example, slightly different

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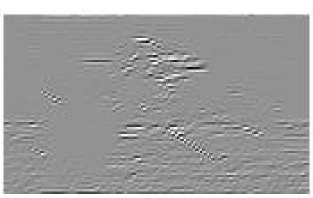
signatures of the same object in different sensor modalities), the complete representation of all of the visual information from a number of input images into a single one is seldomly achieved in practice. Thus, the practical goal of pixel-level image fusion is modified to: the fusion, or preservation in the output fused image, of the "most important" visual information that exists in the input image set.

The main requirement of the fusion process then, is to identify the most significant features in the input images and to transfer them without loss into the fused image.In the fusion process,the distortions into the fused image and the possible loss of useful visual information represent the main problems associated with pixel-level fusion algorithms. Distortion refers to "false" information that is introduced by the fusion algorithm into the fused image. . is the number of input images and the colour characteristics of the input and output images This may be in the form of new features which can not be found in the input images or of additive "noise" superposed over valid features in the fused image. In both cases, distortion reduces the effectiveness of the fusion process. In pixel-level fusion.

4. SIMULATION RESULTS



5. CONCLUSION AND FUTUREWORK

The Wavelet and Fast Discrete Curvelet Transform has been applied to the medical images. This fusion has been used to get all information clearly to diagnosis. This can be used to give the edge information clearly and speed of computation will be high compare to other methods.

The image processed using curvelet transform can be further processed based on Pixel,Region and Feature level Fusion depending on the pixels and comparing each pixel the maximum value the image can fused.Similarly based on the region the images can be fused to extract all the visual information with reduced noise. The Feature Level Fusion depending upon the entropy and variance the images are fused. The Quantitative analysis will be processed comparing the Pixel, Region and Feature Level fusion. The Images can be fused depending upon the Decision Level Fusion.

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