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COMBINATION OF WAVELET AND SECOND GENERATION CURVELET BASED IMAGE FUSION FOR MEDICAL APPLICATIONS

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Abstract- This paper analyzes the characteristics of the Second Generation Curvelet Transform and put forward an image fusion algorithm based on Wavelet Transform and the Second Generation Curvelet Transform. We looked at the selection principles about low and high frequency coefficients according to different frequency domain after Wavelet and the Second Generation Curvelet Transform. In choosing the low-frequency coefficients, the concept of local area variance was chosen to measuring criteria. In choosing the high frequency coefficients, the window property and local characteristics of pixels were analyzed. Finally, the proposed algorithm in this article was applied to experiments of multi-focus image fusion and complementary image fusion.

Index Terms- Curvelet, Image Fusion, Wavelet.

I.INTRODUCTION

An image is a rectangular grid of pixels. It has a definite height and a definite width counted in pixels. Each pixel is square and has a fixed size on a given display. It is represented as a two dimensional function f(x, y) where x and y are spatial co-ordinates and the amplitude of 'f' at any pair of coordinates (x, y) is called the intensity of the image at that point. The growth in the use of sensor technology has led to the demand for image fusion: signal processing techniques that can combine information received from different sensors into a single composite image in an efficient and reliable manner. The theme fusion deals with combining different sources of information for intelligent systems. The information are signals delivered by different sensors and images from various modalities.

The fusion concepts and methods gather tools like weighted average, neural networks, sub-band filtering, and rules based knowledge. Image fusion produces a single image from a set of input images. The fused image should have more complete information which is more useful for human or machine perception. In computer vision, multisensor image fusion is the process of combining relevant information from two or more images into a single image. The resulting image will be more informative than any of the input images. In remote sensing applications, the increasing availability of space borne sensors gives a motivation for different image fusion algorithms. Several situations in image processing require high spatial and high spectral resolution in a single image. Most of the available equipment is not capable of providing such data convincingly.

The image fusion techniques allow the integration of different information sources. The fused image can have complementary spatial and spectral resolution characteristics. However, the standard image fusion techniques can distort the spectral information of the multispectral data while merging.

II.LITERATURE SURVEY

Image fusion is a tool to combine multimodal images by using image processing techniques. Specifically it aims at the integration of disparate and complementary data in order to enhance the information apparent in the images, as well as to increase the reliability of the interpretation [1],[2]. Due to the advent of new diseases complementary information are required from different modalities. When sensitive organs like brain are scanned, both magnetic resonance imaging and computed tomography scans are preferred. CT provides best information about denser tissue and MRI offers better information on soft tissue [2],[3],[4]. Bharat and E.S Karthik Kumar [5] proposed implementation of 2-G curvelet transform for image fusion which is fast and simpler than 1-G curvelet transform. Researchers have made lot of work on wavelet and curvelet transform for image denoising, image contrast enhancement, fusion of satellite images, image retrieval, texture analysis and object recognition.

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III. Proposed Work

An image is a combination of high-contrast region like edges and low-contrast areas which have a smooth appearance. When an image is captured by CCD device, only the objects at focus plane would appear sharp. A practicable way to get an image with all objects in focus is to fuse images acquired with different focus levels of the scene. In this paper, we propose an image fusion algorithm based on combination of wavelet and curvelet transform. Although the fused results obtained by wavelet or curvelet transform individually are encouraging, there is still large room for further improvement. Wavelets have dominated this field for the past few years but they failed to smoothly restore the edges, which is necessary for better perception of an image. The curvelet transform finds an advantage over wavelets in that, it requires fewer coefficients to represent edges and gives a better perception. But at the same time it suffers from occurrence of visual artifacts in the low-contrast region. Thus for two different areas (edges/smooth) in an image two different fusion methods can be employed so that combined attributes of both the transforms give better results. So in the proposed method, these two methods are combined together. Each of the registered images is decomposed using Wavelet transform firstly. Then the coefficients are fused using Curvelet based image fusion method. Finally, the fused image is reconstructed by performing the inverse wavelet and curvelet transform. The experimental results on several images show that the combined fusion algorithm exhibits clear advantages over any individual transform alone.

First, we need pre-processing, and then cut the same scale from awaiting fused images according to selected region. Subsequently, we divide images into sub-images which are different scales by Wavelet Transform. Afterwards, local Curvelet Transform of every sub-image should be taken, its sub-blocks are different from each others on account of scales' change. The steps of using Curvelet Transform to fuse two images are as follows:

i. Resample and registration of original images, we can correct original images and distortion so that both of them have similar probability distribution. Then Wavelet coefficient of similar component will stay in the same magnitude.
ii. 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.
iii. 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.
iv. According to definite standard to fuse images, local area variance is chose to measure definition for low frequency component. First, divide low-frequency frequency $C_{j_0}(k_1,k_2)$
into individual foursquare sub-blocks which are 1 1 N ×M (3×3 or 5× 5), then calculate local area variance of the current sub-block:

$$STD=\sqrt{\frac{\sum_{i=-(N_1-1)/2}^{(N_1-1)/2}\sum_{j=-(M_1-1)/2}^{(M_1-1)/2}[C_{j_0}(k_1+i,k_2+j)-\overline{C}_{j_0}(k_1,k_2)]^2}{N_1\times M_1}}$$

Here, $\overline{C}_{j_0}(k_1,k_2)$ stands for low-frequency coefficient mean of original images. If variance is bigger, it shows that the local contrast of original image is bigger, that means clearer definition. It is expressed as follows:

$$C_{j_0}^F(k_1,k_2)=C_{j_0}^A(k_1,k_2),\quad STD^A\geq STD^B$$

$$C_{j_0}^B(k_1,k_2),\quad STD^A\geq STD^B$$

Regional activity $E_{j,l}(k_{1,}k_2)$ is defined as a fusion standard of high-frequency components. First, divide high-frequency sub-band into sub-blocks, then calculate regional activity of sub-blocks.

$$E_{j,l}(k_1,k_2)=\sum_{i=-(N_1-1)/2}^{(N_1-1)/2}\sum_{j=-(M_1-1)/2}^{(M_1-1)/2}[C_{j,l}(k_1+i,k_2+j)]^2$$

In which, N_1xM_1 means 3×3,5×5 and so on.

Inverse transformation of coefficients after fusion, the reconstructed images will be fusion images.

IV. Results and discussion

Two complementary images (medical images) i.e. MRI and CT scan images are given as input images to the different fusion methods. Firstly Wavelet Transform and Curvelet Transform are executed individually and its results are compared with that of our proposed method i.e. Combination of Wavelet and Second Generation Curvelet Transforms. For the evaluation of performance of the fusion algorithms, the visual quality of the obtained fusion result as well as the quantitative analysis are used

PSNR and MSE

The peak signal-to-noise ratio (PSNR) is the ratio of a signal's maximum power to the power of the signal's noise. PSNR is commonly used to measure the quality of reconstructed images that have been compressed. Each picture element (pixel) has a color value that can change when an image is compressed and then uncompressed. Signals can have a wide dynamic range, so PSNR is usually expressed in decibels, which is

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a logarithmic scale.

PSNR = 20 * log10 (255 / sqrt(MSE))

The higher the PSNR value, the better the performance of the fusion algorithm. Acceptable values for wireless transmission quality loss are considered to be about 20dB to 25dB. PSNR is most commonly used as a measure of the quality of reconstruction of lossy compression codecs. Although PSNR is regarded as a quality measure, in some cases a reconstruction may appear to be closer to the original than another, even though it has a lower PSNR. It is most easily defined via the Mean Squared Error (MSE) or RMSE which for two m×n monochrome images I and K where one of the images is considered a noisy approximation of the other is defined as

$$RMSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

The root-mean-square deviation (RMSD) or root-mean-square error (RMSE) is a frequently used measure of the differences between values predicted by a model or an estimator and the values actually observed. RMSD is a good measure of accuracy. The smaller the RMSE value, the better the performance of the fusion algorithm..

V.CONCLUSION

This paper puts forward an image fusion algorithm based on Wavelet Transform and the Second Generation Curvelet Transform. 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. This method could better describe the edge direction of images, and analyzes feature of images better. According to it, this paper uses Wavelet and the Second Generation Curvelet Transform into fusion images, then makes deep research on fusion standards and puts forward corresponding fusion projects. At last, these fusion methods are used in simulation experiments of multi-focus and complementary fusion images. In vision, the fusion algorithm proposed in this paper acquires better fusion result. In objective evaluation criteria, its fusion characteristic is superior to traditional DWT and FCT's.

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