Brain Tumor MR Image Fusion Using Most Dominant Features Extraction from Wavelet and Curvelet Transforms

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Abstract - *The MR medical image Fusion plays a crucial role in medical diagnostics and treatment. Widely used transform domain based image fusion methods like DWT,CVT, CT,NCST suffer from spatial inconsistency and high complexity. Also most existing traditional methods of image fusion like Simple Average, Minimum, Maximum, weighted, PCA,[5] have limitations in fused image like image is not clear, blurring effects, noise effects, Spectral degradation, block discontinuities, etc. While global contrast-enhancement techniques enhance the overall contrast, their dependences on the global content of the image limit their ability to enhance local details. Also due to fluid flow in the brain during acquisition of image will affect the detection of brain boundaries, because of the brain registration not that much accurate so the accuracy of fusion decreases. Therefore to overcome these shortcomings, we have proposed a method using Most Dominant Features which are extracted from wavelet image and curvelet image transforms [2][6] to get fused image which increases the level of fusion.*

Keywords- Brain Tumour MR Image, Image Fusion Technique, Wavelet, Curvelet , Feature Extraction, Most Dominant Features

1. INTRODUCTION

We Propose a method to balance in both spatial and frequency domains using MR image first by applying Wavelet transform, to obtain wavelet decomposition of the input image. Secondly we use Curvelet transform to obtain Most Dominant Features from image. Then fusion is done using extracted features and inverse transformation is carried to get fused image. Then the accuracy of fused image is shown by RMSE and fused PSNR which illustrate its sharpness in better visual analyzing of MR image containing Brain Tumors detection for proper Medical Image Diagnosis applications.

Most of the image fusion algorithm aims at obtaining as much as possible information in the fused image, with keeping the error low as possible between the fused image and input image. The resulting image will be more informative than any of the input images. In case of medical images, contains more contrast and edge-like information, which needs to preserve in fused image. In our paper we have proposed and compared methods to preserve contrast and edge information as much as possible using wavelet transform [2]. The main aim in image fusion for medical images is to preserve the edge information and contrast because recent image fusion algorithm is prone to reduce the contrast of the fused image. One of the simplest methods to obtain the salient features of both the images in to fused image is just averaging [6].

In our paper worked at feature level, by applying fusion technique on Brain Tumour MR images [22]. Image fusion is done by appling wavelet and curvelet transform, the input image resized and first dwt is applied to the image it generates the approximation coefficients matrix and details coefficients matrices (horizontal, vertical, and diagonal, respectively), obtained by wavelet decomposition of the input image. To obtain most dominant features from image curvelet transform is applied to approximation coefficients matrix, mean and average features are extracted from detail coefficients matrix. Then fusion is done using extracted features and inverse transformation is carried to get fused image.

1.1 MR Images of Brain

Magnetic Resonance Image is noninvasive medical test that physicians use to diagnose medical conditions. MRI uses a powerful magnetic field radio frequency pulses and a computer to produce detailed picture of organs, soft tissues , bone and virtually all other internal body structures. MRI does use ionizing radiations , X-rays.

2. RESEARCH GAP

Literature survey has revealed that the fusion of high-spectral but low spatial resolution multispectral and low-spectral but high spatial resolution panchromatic satellite images is a very useful technique in various applications of remote sensing[13] but not using MRI. Recently, some studies showed that wavelet-based image fusion method provides high quality of the spectral content of the fused image. However, most of wavelet-based methods have a spatial resolution of the fused result less than the Brovey, IHS, and PCA [6] fusion methods. A new method based on the curvelet transform which represents edges better than wavelets. Since edges play a fundamental role in image understanding, one good way to enhance spatial resolution is to enhance the edges. Curvelet-[2][3] based image fusion method provides richer information in the spatial and spectral domains simultaneously.

3. IMPLEMENTATION OF PROPOSED METHOD OF WAVELET ANDCURVELET TRANSFORMATIONS TECHNIQUE

3.1 Wavelet Algorithm Description

Our proposed method of image fusion is using Wavelet and Curvelet image Transformations: Discrete Wavelet Transform is used as it separates out the low frequency band and high frequency band and further sub bands (i.e. LL, LH, HL, HH bands). Image fusion is done by appling wavelet and curvelet transform , the input image resized and first dwt is applied to the image , it generates the approximation coefficients matrix and details coefficients matrices (horizontal, vertical, and diagonal, respectively), obtained by wavelet decomposition of the input image. The steps of Discrete Cosine Transforms are as follows:

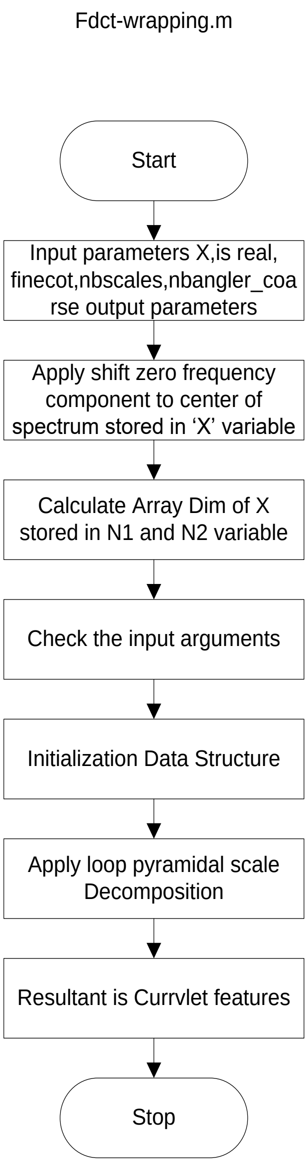

Fig.a: Flow chart of Discrete Cosine Transform

3.2 Curvelet Algorithm

The curvelet transform which represents edges better than wavelets. Since edges play a fundamental role in image understanding, one good way to enhance spatial resolution is to enhance the edges. Curvelet-based image fusion method provides richer information in the spatial and spectral domains simultaneously. The LL band is a Homogeneous feature, on this LL we apply for curvelet coefficient to set Intensity elements. That is to obtain most dominant features from image curvelet transform is applied to approximation coefficients matrix, mean and average features are extracted from detail coefficients matrix. Then fusion is done using extracted features and inverse transformation is carried to get fused image. Curvelet Transform Algorithm's flowchart is as follows:

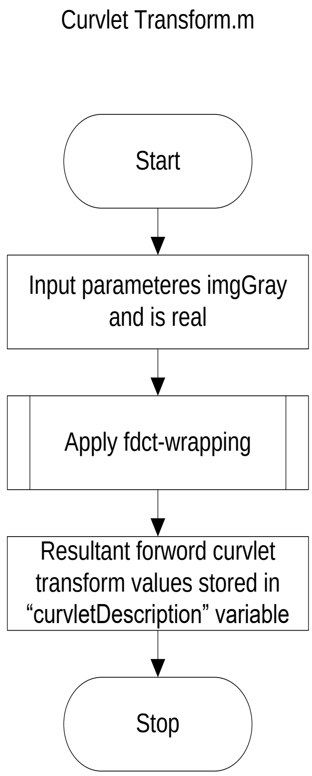

Fig.b : Flow chart of Curvelet Transform

The steps for feature extraction of Intensity based Homogeneity are as follows:

Featuresel.m

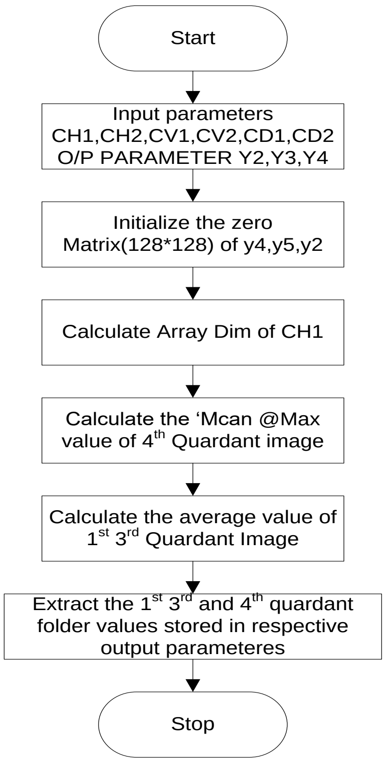

Fig.c: Flow chart of Feature Extraction

4. EXPERIMENT

The Experimentation has been done using 10 synthesized digital MR images of Brain Tumour , which are scanned images of MR machine, and image size is 256X256. The implementation of the Segmentation algorithms is carried out using Intel core i5 system at 2.30GHz and Matlab2010. As mentioned in the above implementation section fdc_wrapping.m, curvelet_Transform.m, Featuresel.m are the separate module and many more required modules are assembled for running the implemented code in MATlab2010. The brief fusion based algorithmic steps are mentioned below:

Algorithm 1: Fusion process of images by combined algorithms of wavelets and curvelet is as follows
Step1: Input parameters m1 and m2
Step2: Compute array dimensions of m1 and m2
Step3: apply Single-level discrete 2DWT
Step4: Display "cc" variables image
Step5: Apply Curvelet Transform()
Step6: Apply ifdct_wrapping()
Step7: Apply feature_select()
Step8: Apply idwt2()
Step9: Stop

The proposed work is image fusion is by applying wavelet and curvelet transform, because due to fluid flow in the brain during acquisition will affect the detection of brain boundaries, because of the brain registration not that much accurate so the accuracy of fusion decreases. In our method we have used most dominant features which are extracted for image fusion using wavelet and curvelet transforms for fusion. So the level of fusion increases. The implementation of the proposed method is as follows, the input image resized and first DWT is applied to the image , it generates the approximation coefficients matrix and details coefficients matrices (horizontal, vertical, and diagonal, respectively), obtained by wavelet decomposition of the input image. The Table1, the input brain images are pre-processed and wavelet transform is applied to both the images. Figure 1 and Figure 3 shows the input images, Figure 2 and Figure 4 shows the filtered images. For both filtered images wavelet transform is applied, it performs a single-level two-dimensional wavelet decomposition with respect to either a particular wavelet decomposition filters. It computes the approximation coefficients matrix and details coefficients matrices, for approximation coefficients matrix curvelet is applied and maximum features are extracted for fusion, similarly for details coefficients matrices average features are extracted for fusion. The following are the steps for calculation of RMSE and PSNR

Rms-error.m

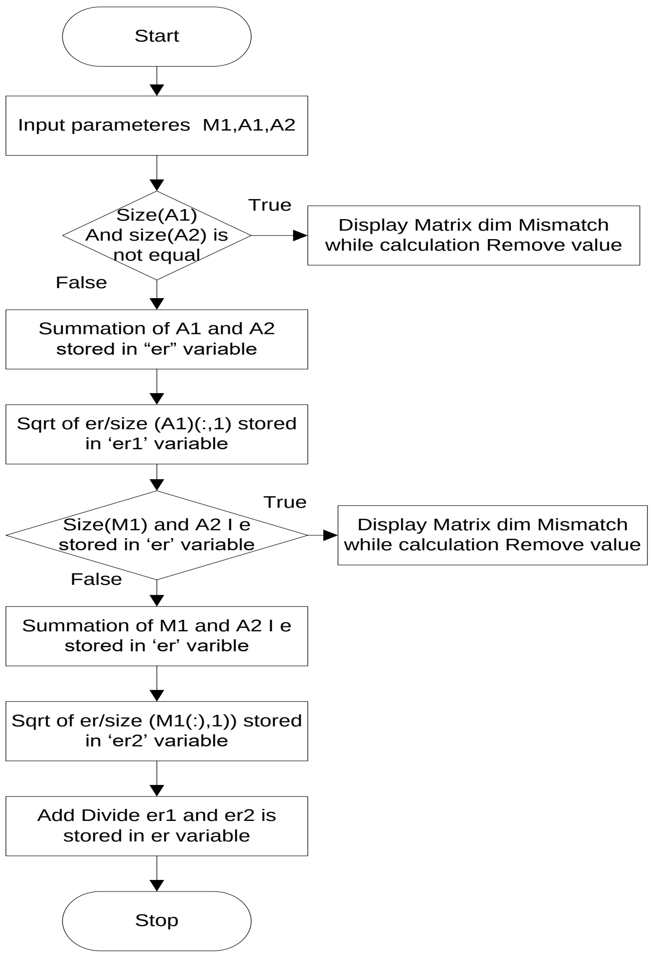

Fig.d:Flow chart of RMSE

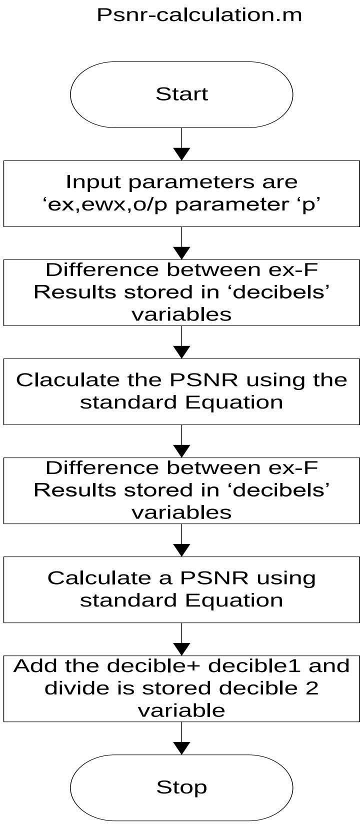

Fig.e: Flow chart of PSNR

$$RMSE = \frac{\sum_{0\le i<M} \sum_{0\le j<N} (f - f^{\wedge})^2}{M \times N}$$

$$PSNR = 10\log_{10} \frac{255}{RMSE}$$

Where as

whereas f and f^ are original and filtered image respectively.

Table 1:

Parameters	Measurement
RMSE	2.2767
Fused PSNR	+42.66 dB

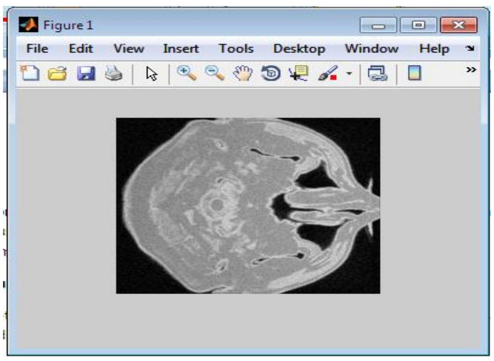

Figure1: Input image1

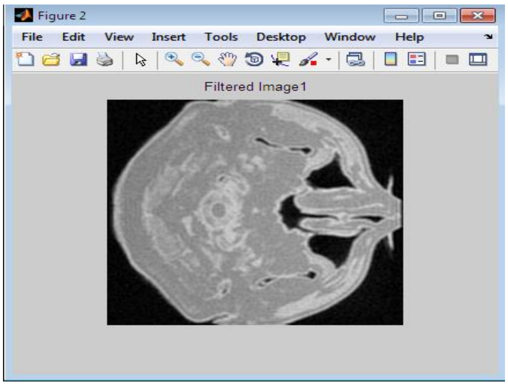

Figure2: Filtered Image1

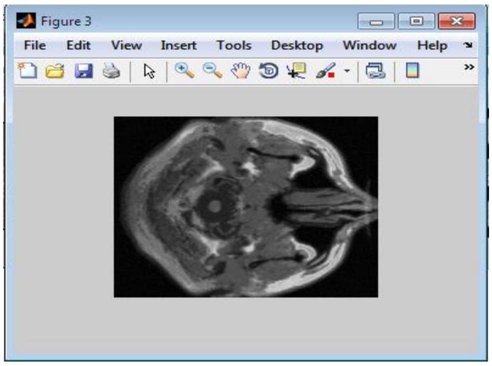

Figure3: Input image2

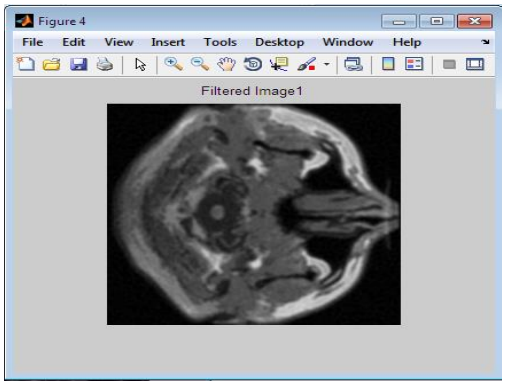

Figure4: Filtered Image2

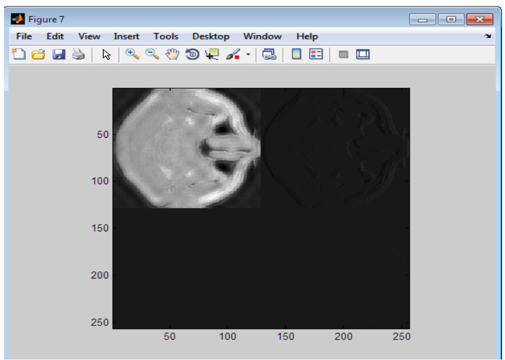

Figure5: Maximum and Average features fused image

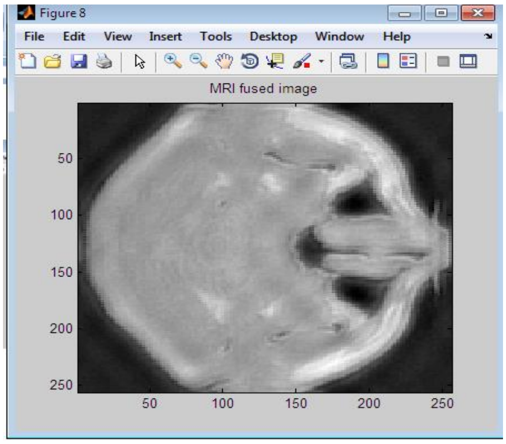

Figure6: Fused Image

Based on the experimental results obtained from this study, the curvlet-based image fusion method is very efficient for fusing.

5. CONCLUSIONS

The conclusion is that with 10 dataset we have used to compare with different MR images, the sharpness is observed as in table1. Figure 1 and Figure 3 shows the input images, Figure 2 and Figure 4 are preprocessed images using wieners filters. For both filtered images wavelet transform is applied, it performs a single-level two-dimensional wavelet decomposition with respect to either a particular wavelet decomposition filters. It computes the approximation coefficients matrix and details coefficients matrices, for approximation coefficients matrix curvelet is applied and maximum features are extracted for fusion, similarly for details coefficients matrices average features are extracted for fusion.

6. FUTURE SCOPE

Due to fluid flow in the brain during acquisition will affect the detection of brain boundaries, the image registration decreases the accuracy of fusion, so in our further research work, brain registration image fusion will be implemented. Then further research work will be focusing on analyzing and testing on T1,T2-weighted[22] MRI images for different types of tumors in brain for a tumor detection using three parameters; edge (*E*), gray (*G*), and contrast (*H*) values will be compared with the standard values It can be extended to work with more medical image datasets, and real-time images, it can also be extended with other tumor types in brain or tumors or cancer in body with other type of imaging technique.

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