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Medical Image Fusion Implementation Using FFT Process on FPGA

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Abstract

This paper implements Medical Image fusion using FFT process on FPGA to analyze various diseases. This is obtained by combining CT scan and MRI images. CT (Computed tomography) Scan images provides the more information on denser tissues with less distortion and MRI (Magnetic Resonance Images) provides more information on soft tissues with higher distortion. This experiment shows that combining of images give useful information hence clear images are obtained. FFT is applied on images in MATLAB to obtain pixel format files. In Xilinx system generator, pixel format files are converted into bit streams and downloaded on Spartan3 processing kit to obtain FFT fused images.

Keywords- *FFT, FPGA, Image (MRI), Xilinx.*

I. INTRODUCTION

The motivation for image fusion research is mainly because of the contemporary developments in the fields that are multi-spectral, high resolution, robust and cost-effective image sensor design technology. Since last few decades, with the introduction of these multisensory imaging techniques, image fusion has been an emerging field of research in remote sensing, medical imaging, night vision, military and civilian avionics, autonomous vehicle navigation, remote sensing, concealed weapons detection, various security and surveillance systems applications. There has been a lot of development in dedicated real time imaging systems with the high spatial, spectral resolution as well as faster sensor technology. The solution for large information can be met by a corresponding increase in the number of processing units, using faster Digital Signal Processing (DSP) and larger memory devices. This solution, however, can be quite expensive.

II. LITERATURE SURVEY

Since last few decades, an extensive number of approaches to fuse visual image information. These techniques vary in their complexity, robustness and sophistication. Remote sensing is perhaps one of the leading image fusion applications with a large number of dedicated publications. The main principle of some of the popular image fusion algorithms have been discussed below.[1]

Fusion using Principle Component Analysis (PCA): The PCA image fusion method basically uses the pixel values of all source images at each pixel location, adds a weight factor to each pixel value, and takes an average of the weighted pixel values to produce the result for the fused image at the same pixel location. The optimal weighted factors are determined by the PCA technique. The PCA image fusion method reduces the redundancy of the image data. ϖ Super-resolution image reconstruction: Super-resolution (SR) reconstruction is a branch of image fusion for bandwidth extrapolation beyond the limits of a traditional electronic image system. [2]

Katartzis and Petrou describe the main principles of SR reconstruction and provide an overview of the most representative methodologies in the domain. The general strategy that characterizes super-resolution comprises three major processing steps which are low resolution image acquisition, image

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registration/motion compensation, and high-resolution image reconstruction. Katartzis and Petrou presented a promising new approach based on Normalized Convolution and a robust Bayesian estimation, and perform quantitative and qualitative comparisons using real video sequences. [3]
Image fusion schemes using ICA bases: Mitianoudis and Stathaki demonstrate the efficiency of a transform constructed using Independent Component Analysis (ICA) and Topographic Independent Component Analysis based for image fusion in this study. The bases are trained offline using images of similar context to the observed scene. [3] The images are fused in the transform domain using novel pixel-based or region-based rules. An unsupervised adaption ICA-based fusion scheme is also introduced.

The proposed schemes feature improved performance when compared to approaches based on the wavelet transform and a slightly increased computational complexity. The authors introduced the use of ICA and topographical ICA based for image fusion applications. These bases seem to construct very efficient tools, which can complement common techniques used in image fusion, such as the Dual-Tree Wavelet Transform. The proposed method can outperform the wavelet approaches. The Topographical ICA based method offers a more accurate directional selectivity, thus capturing the salient features of the image more accurately.
Region-based multi-focus image fusion: Li and Yang first describe the principle of region-based image fusion in the spatial domain. Then two region-based fusion methods are introduced. They proposed a spatial domain region-based fusion method using fixed-size blocks. Experimental results from the proposed methods are encouraging. More specifically, in spite of the crudeness of the segmentation methods used, the results obtained from the proposed fusion processes, which consider specific feature information regarding the source images, are excellent in terms of visual perception. [4]
The presented algorithm, spatial domain region-based fusion method using fixed-size blocks, is computationally simple and can be applied in real time. It is also valuable in practical applications. Although the results obtained from a number of experiments are promising, there are more parameters to be considered as compared to an MR-based type of method, such as the wavelet method. Adaptive methods for choosing those parameters should be researched further. In addition, further investigations are necessary for selecting more effective clarity measures.
Image fusion techniques for non-destructive testing and remote sensing application: The authors present several algorithms of fusion based on multi-scale Kalman filtering and computational intelligence methodologies. The proposed algorithms are applied to two kinds of problems: a remote sensing segmentation, classification, and object detection application performed on real data available from experiments and a non-destructive testing/evaluation problem of flaw detection using electro-magnetic and ultrasound recordings. In both problems, the fusion techniques are shown to achieve a modest superior performance with respect to the single-sensor image modality. The joint use of the eddy current and ultrasonic measurements is suggested because of the poor results that are obtained by processing each single recorded type of signal alone. Therefore, both measurements are jointly processed, and the information used to perform the classification has been extracted at three different levels: pixel, feature, and symbol.
The numerical performance of these techniques has been compared by using the probability of detection and probability of false alarm. Experiments performed on real data confirmed the effectiveness of the proposed SL based approach, by maximizing the probability of detection and achieving an acceptable probability of false alarm with respect to the PL and FL fusion techniques.

III. Proposed System

Fusion steps based on FFT can be summarized

- First register the input images (I1 and I2), which are going to be fused and corresponding pixels are aligned.
- The Registered input images (I1 and I2) are decomposed into FFT images respectively.
- K-level decomposition will include one LL band (low-frequency portion) and LH bands, HL bands and HH bands (high-frequency portions).

- The Transform coefficients on different portions are performed using certain fusion rule.
- Then by applying an FFT based on the combined transform coefficients, the fused image (I) is constructed.

  When each FFT coefficient is constructing for the fused image, we have to determine which source image makes this coefficient better. This information will be put in the fusion decision map. The fusion decision map will have the same size as the original image. Each value is the index of the source image which may be more informative on the corresponding FFT coefficient. Thus, we will able to make decision on each coefficient. In order to we make the decision on one of the coefficients of the fused image, there is one way to consider the corresponding coefficients in the source images as illustrated by the red pixels. This is called pixel based fusion rule. The other way is to consider not only the corresponding coefficients, but also consider their close neighbors, these are 3x3 or 5x5 windows. This is called window-based fusion rules. This method considered the fact that there is high correlation between neighboring pixels. [9]

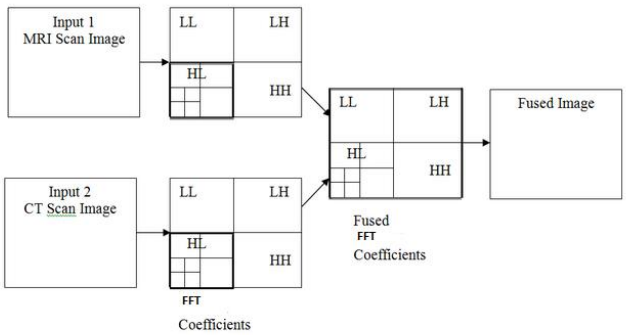

Figure. 1 Proposed System

IV. IMPLEMENTATION

The implementation process can be done with the use of XPS, MATLAB software &Spartan3 FPGA Image Processing Kit. By converting the input images into header files and then converting the FFT and fusion codes added in the source files. By selecting Hardware & Software architectures add source and header files. Then generate net-lists and bit streams for the specified file, then convert it into bit-streams and download into Spartan3 FPGA Image Processing Kit and view the output by using MATLAB. [10]

Figure 2: Spatan3 FPGA Image Processing Kit

V. RESULT AND DISCUSSION

The image fusion process follows by considering System C coding for FFT method to implement fused image using FPGA. Figure below shows the expected fused image taken from the Xilinx platform studio tool. Registered Source images like CT scan and MRI scan images are taken for fusing the both resolution images by considering pixel coefficients of the images by using FFT. After the FFT process by considering the low-resolution sub band of CT scan and MRI scan images, fusion

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will be done using FFT method. Inverse FFT is applied for the image to get final fused image. It is implemented on Spartan-3 kit by using Xilinx tool.

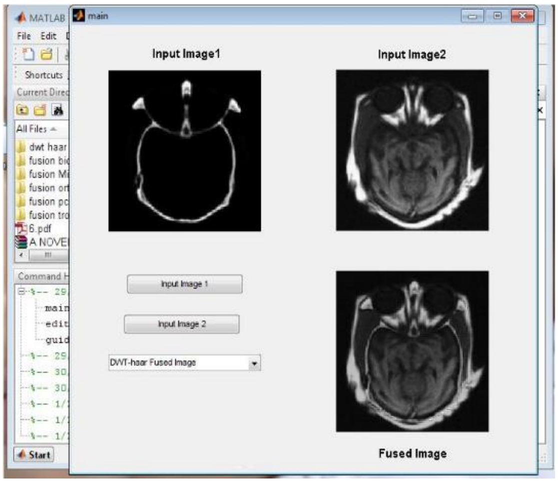

Figure3: Expected Result

VI. Conclusion

The system is to produce fused image using multispectral images for medical application. This is implemented on FPGA using FFT. The Xilinx system generator provides a hardware implementation of the complex techniques used for image fusion with minimum resources and minimum delay and also provides simplicity and easy for Hardware implementation.

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