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LIFTING BASED DISCRETE WAVELET TRANSFORM TECHNIQUE FOR IMAGE FUSION

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ABSTRACT:

The motivation behind fusing multimodality, multi-resolution images is to create a single image with improved interpretability. In this paper we analyzed image fusion on medical field. For medical diagnosis, Computed Tomography (CT) provides the best information on denser tissuewithlessdistortion. Magnetic ResonanceImage (MRI) providesbetterinformationonsofttissuewithmoredistortion. With more available multi modality medicalimagesinclinical applications,the idea of combining images from different modalitiesbecome very importantandmedicalimagefusionhasemergedasanewpromisingresearchfield. So, in order to fuse the two images we apply Discrete Wavelet Transform (DWT) for improving quality of the fused image.In this paper, a hardware implementation of a real-time fusion system is proposed. The system is based on an Xilinx Spartan 3 EDK FPGA using CT and MRI scan images using System C language.

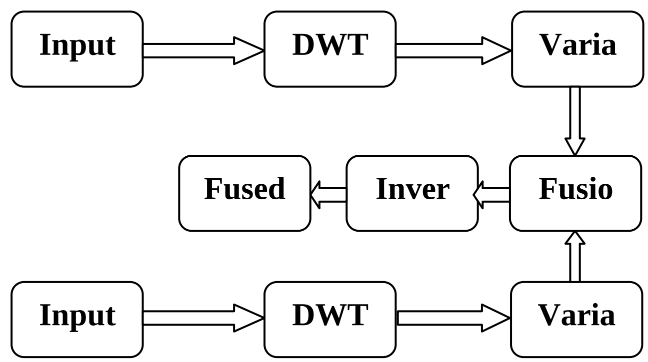
Keywords:Fusion,WaveletsTransform.

1. INTRODUCTION:

With the development of new imaging sensors arises the need of a meaningful combination of all employed imaging sources. The actual fusion process can take place at different levels of information representation; a generic categorization is to consider the different levels as, sorted in ascending order of abstraction: signal, pixel, feature and symbolic level. This site focuses on the so-called pixel level fusion process, where a composite image has to be built of several input images. To date, the result of pixel level image fusion is considered primarily to be presented to the human observer, especially in image sequence fusion (where the input data consists of image sequences). A possible application is the fusion of forward looking infrared (FLIR) and low light visible images (LLTV) obtained by an airborne sensor platform to aid a pilot navigates in poor weather conditions or darkness. In pixel-level image fusion, some generic requirements can be imposed on the fusion result. The fusion process should preserve all relevant information of the input imagery in the composite image (pattern conservation) The fusion scheme should not introduce any artifacts or inconsistencies which would distract the human observer or following processing stages .The fusion process should be shift and rotational invariant, i.e. the fusion result should not depend on the location or orientation of an object the input imagery .In case of image sequence fusion arises the additional problem of temporal stability and consistency of the fused image sequence. The human visual system is primarily sensitive to moving light stimuli, so moving artifacts or time depended contrast changes introduced by the fusion process are highly distracting to the human observer. So, in case of image sequence fusion the two additional requirements apply. Temporal stability: The fused image sequence should be temporal stable, i.e. gray level changes in the fused sequence must only be caused by gray level changes in the input sequences, they must not be introduced by the fusion scheme itself;

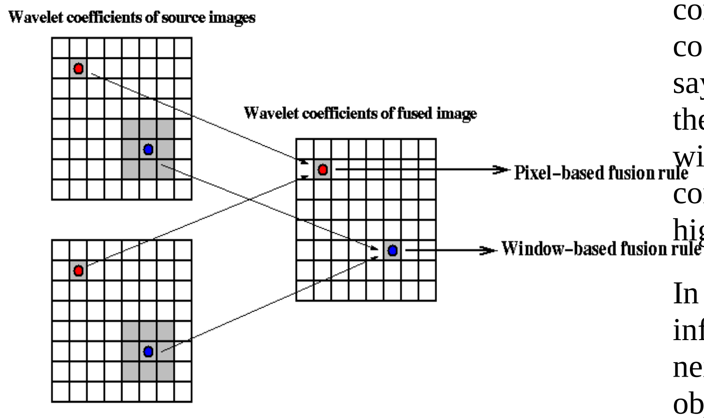
The actual fusion process can be carried out at various levels. Under this, in the pixel-level image fusion the fused images provided all relevant information present in original images with no artifacts or inconsistencies. The pixel-level image fusions were classified into spatial domain fusion and transform domain fusion. Spatial domain fusion is directly applied on the source images which in turn reduce the signal to-noise ratio of the resultant image with simple averaging technique but the spatial distortion still persists in the fused image. To improve on that in transform domain fusion, firstly the input images are decomposed based on transform coefficients. Then the fusion technique is applied and the fusion decision map is obtained. Inverse transformation on this decision map yields the fused image. The fused image carries all the details of the source images and reduces the spatial distortion. So, majority of the earlier fusion techniques were based on wavelet transformation.

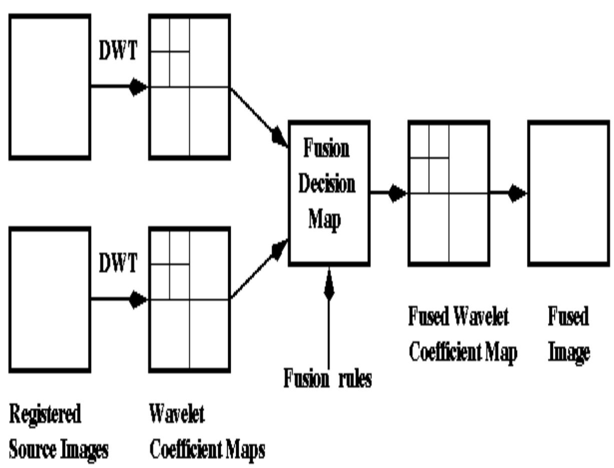
BB Block Diagram:



Wavelet transform is first performed on each source images, then a fusion decision map is generated based on a set of fusion rules. The fused wavelet coefficient map can be constructed from the wavelet coefficients of the source images according to the fusion decision map. Finally the fused image is obtained by performing the inverse wavelet transform.

From the above diagram, we can see that the fusion rules are playing a very important role during the fusion process. Here are some frequently used fusion rules in the previous work:





When constructing each wavelet coefficient for the fused image. We will have to determine which source image describes this coefficient better. This information will be kept in the fusion decision map. The fusion decision map has the same size as the original image. Each value is the index of the source image which may be more informative on the corresponding wavelet coefficient. Thus, we will actually make decision on each coefficient. There are two frequently used methods in the previous research. In order to make the decision on one of the coefficients of the fused image, one way is 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 their close neighbors, say a 3x3 or 5x5 windows, as illustrated by the blue and shadowing pixels. This is called window-based fusion rules. This method considered the fact that there usually has high correlation among neighboring pixels.

In our research, we think objects carry the information of interest, each pixel or small neighboring pixels are just one part of an object. Thus, we proposed a region-based fusion scheme. When make the decision on each coefficient, we consider not only the corresponding coefficients and their closing neighborhood, but also the regions the coefficients are in. We think the regions represent the objects of interest. We will provide more details of the scheme in the following.

Proposed Method:

- 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.
- Lifting 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.
- According to definite standard to fuse images, local area variance is

chose to measure definition for low frequency component.

- Inverse Transformation is taken to get Original Image

II. AVELETBASEDIMAGEFUSION TECHNIQUES

1. Waveletbased imagefusionmethod

Theprocesscanbedividedintofoursteps .

a) Waveletdecomposition
b Detailsinformation combination
c) Inversewavelettransforms

- Usethewavelettransformtodecompose new panchromatic images and different bands of multispectralimage twice, respectively.

- Add the detail images of the decomposed panchromatic images at different levels to the corresponding details of different bands in the multispectral image and obtain the new details component in the different bands of the multispectral image and obtain the new details component in the different bands of the multispectral image.

- Perform the wavelet transform onthe bandsofmulti spectral images, respectivelyandobtainthefusedimage.

2.Integrationofsubstitutionmethod

Theintegrationofsubstitutionmethodisdividedintwoparts.

a.Referstosubstitutionfusionmethod.

b. Refers to thewavelet passedfusion method.

- Theprocessconsistsoffollowingsteps Transform themultispectralimageintothePCAcomponents.
- Apply histogram match betweenpanchromatic image andintensitycomponent and obtain newpanchromaticimage.
- Decompose thehistogrammatched panchromatic imageandintensitycomponenttowaveletplanesrespectively. Replace the LL^P inthepanchromaticdecomposition with the LL^1 of theintensity decomposition, add the detail images inthe panchromaticdecompositiontothecorresponding detailimageinthepanchromaticdecompositionto thecorrespondingdetailimagesoftheintensityandobtain LL^1, LH^P , HH^P and HL.Perform an inverse wavelet transform, and generate a new intensity. Transform the new intensity together with hue, saturation components or PC1, PC2, PC3 back. Into RGB space.

III.IMPLEMENTATION PROCESS

In our project first going to create a header file of the images by using MATLAB. In mat lab we are creating the header files using GUI window. By using that header files as supporting file, fusing the two images by using DWT technique.

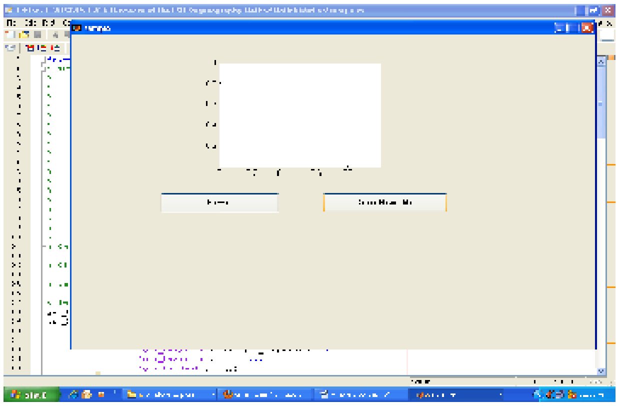


Fig1: Gui window to create header file

IV. RESULTS

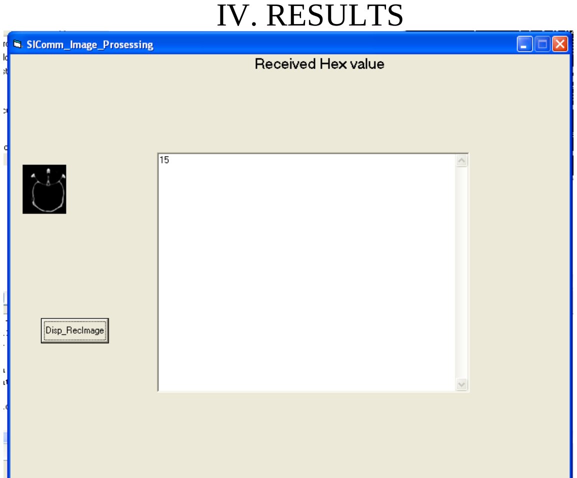


Fig2: MRI Image of Brain

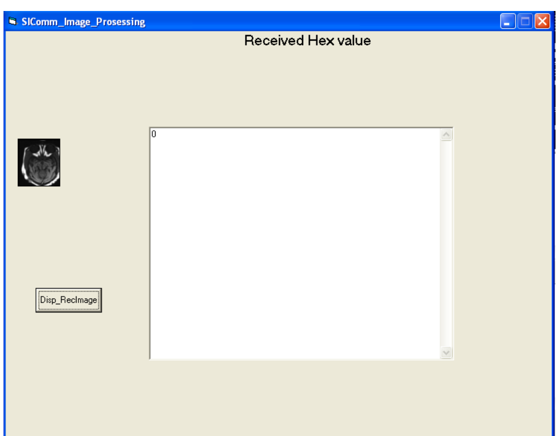


Fig3: CT Image of Brain

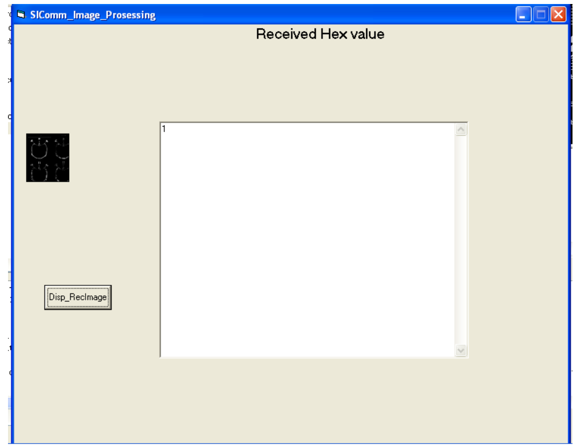


Fig4: DWT MRI Image of Brain

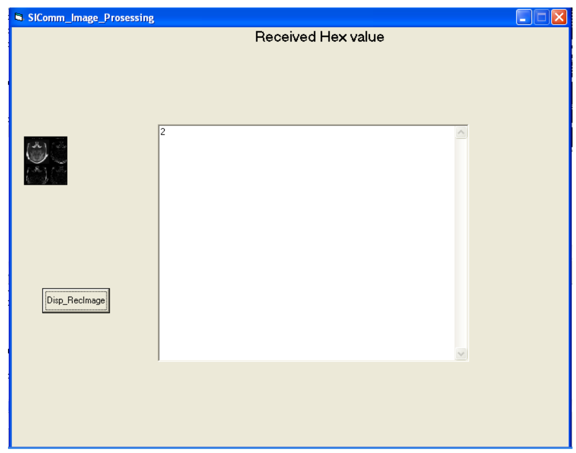


Fig5: DWT CT Image of Brain

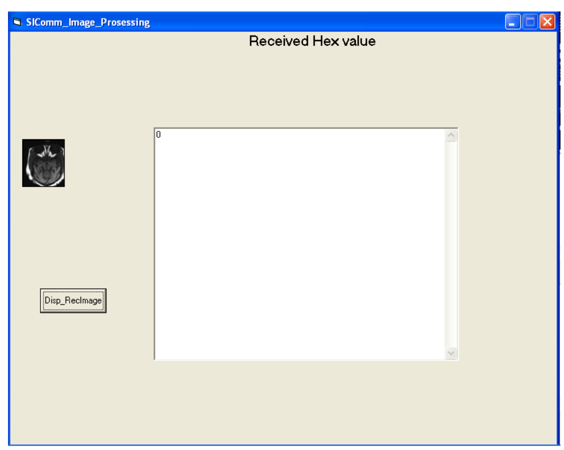


Fig: Fused Image

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Device utilization summary:
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Selected Device : 3s200tq144-4

 Number of Slices:                    1880  out of   1920    97%
 Number of Slice Flip Flops:          2118  out of   3840    55%
 Number of 4 input LUTs:              2971  out of   3840    77%
    Number used as logic:             2418
    Number used as Shift registers:    297
    Number used as RAMs:               256
 Number of IOs:                         62
 Number of bonded IOBs:                 62  out of     97    63%
    IOB Flip Flops:                     64
 Number of BRAMs:                        4  out of     12    33%
 Number of MULT18X18s:                   3  out of     12    25%
 Number of GCLKs:                        4  out of      8    50%
 Number of DCMs:                         1  out of      4    25%

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Fig: Synthesis Report

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Timing Summary:
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Speed Grade: -4

   Minimum period: 15.304ns (Maximum Frequency: 65.342MHz)
   Minimum input arrival time before clock: 6.569ns
   Maximum output required time after clock: 16.181ns
   Maximum combinational path delay: No path found
```

Fig: Timing Summary

V .**Conclusion**

The fusion of multimodality medical images plays an critical and vital role in many clinical applications for they can support more comprehensive and accurate information than any individual source images. A hardware implementation of a CT and MRI fusion system is done based on an Xilinx Spartan 3 EDK FPGA System C language.

In the future, we want to integrate other techniques for fusion and testing it for different types of complementary medical images. We also want to develop methods for registration images from different medical modalities.

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