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FPGA Implementation of Brain Tumor Detection Using Lifting Based DWT Architectures

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ABSTRACT

Now-a-days, almost all areas of medical diagnosis are impacted by the digital image processing. When an image is processed for visual interpretation, the human eye is the judge of how well a particular method works. Clinical application demanding Radiotherapy plan, for instance, often benefits from the complementary information in images of different modalities. For medical diagnosis, Computed Tomography (CT) provides the best information on denser tissue with less distortion. Magnetic Resonance Image (MRI) provides better information on soft tissue with more distortion. With more available multimodality medical images in clinical applications,his idea of combining images from different modalities become very important and medical image fusion has emerged as a new promising research.

This paper analyzes the characteristics of the Second Generation Wavelet Transform and put forward an image fusion algorithm based on Wavelet Transform. We looked at the selection principles about low and high frequency coefficients according to different frequency domain after wavelet. Then the proposed fused image used to segment the optic disc from the optic region. And then we are implementing the algorithm based on the method of Compensation factor method which is to be usually segmenting the optic discs from the blood vessels. This segmentation process could be effective in the bio-medical applications. 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 and implements a configurable linear pixel level algorithm which is able to result in color fused images using System C language.

Keywords: Brain Tumor, DWT, FPGA.

1. INTRODUCTION

Image fusion is a technique used to integrate a high resolution panchromatic image with low-resolution multispectral image to produce a high-resolution multispectral image, which contains both the high-resolution spatial information of the panchromatic image and the colour information of the multispectral image [4]. Although an increasing numbers of high-resolution images are available along with sensor technology development, image fusion is still a popular and important method to interpret the image data for obtaining a more suitable image for a variety of applications, such as visual interpretation and digital classification [3].

The main objective of medical imaging is to obtain a high resolution image with as much details as possible for the sake of diagnosis [7]. MR and CT imaging are of main concern for diagnostic purposes [6]. Both techniques give special sophisticated characteristics of the organ to be imaged. So, it is expected that fusion of MR and CT images of the same organ would result in an integrated image of much more details [10].Wavelet transform fusion is defined as considering the wavelet transforms of the two registered input images together with the fusion rule .Then, the inverse wavelet transform is computed, and the fused image is reconstructed.

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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 artefacts 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.

Image fusion is the procedure of extracting important visual information from images and merging them to create new image. Image fusion is vital in many fields like medical imaging, remote sensing and satellite imaging. Data fusion is subdivided into three levels which are pixel-level fusion. feature-level fusion and decision-level fusion. The different types of image fusion are nonlinear methods, linear superposition, artificialneural networks, optimization approaches, wavelet transform, image pyramids and generic multi-resolution fusion scheme.

2. EXISTING SYSTEM

This paper proposes an improved version of lifting-based Discrete Wavelet Transform (DWT). The lifting based DWT architecture has the advantage of lower computational complexities transforming signals with extension and regular data flow. The main feature of the lifting based DWT scheme is to break up the high pass and low pass filters into a sequence of upper and lower triangular matrices and convert the filter implementation into banded matrix multiplications. Such a scheme has several advantages, including "in-place" computation of the DWT, integer-to-integer wavelet transform (IWT), symmetric forward and inverse transform, etc. This project designs the VLSI architecture for image compression.

The lifting transform at its highest level is very simple. The lifting transform can be performed via two operations: Predict and Update. Suppose we have the one dimensional signal a0.Lifting is done by performing the following sequence ofoperations:

- Split a0 into Even-1 and Odd-1
- d-1 = Odd-1 – Predict (Even-1)
- a-1 = Even-1 + Update(d-1)

These steps are repeated to construct multiple scales of the transform. The inverse transformation is simple as well. We only reverse the order of operations and change the signs.

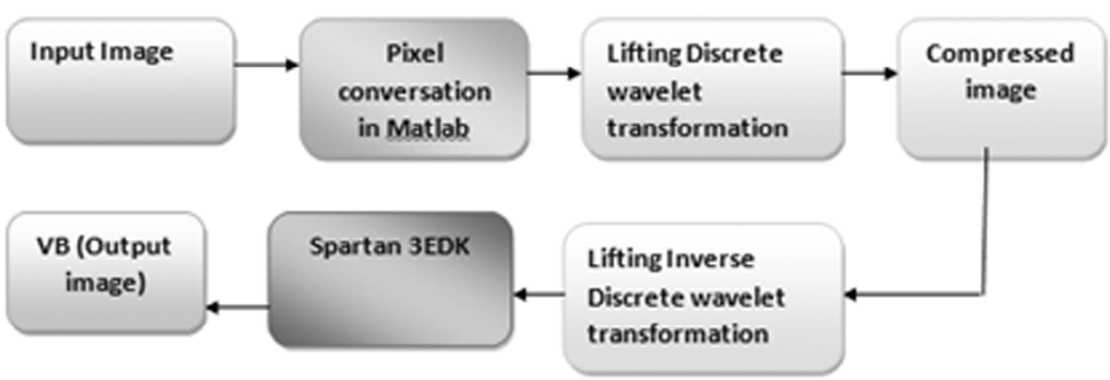

Figure 1: Block diagram of existing system

For the Haar wavelet, we have the following steps:

- Predict(x) = x
- Update(y) = y / 2

The Haar case is very easy to derive and implement. Further, the operation can be performed on an input signal or image in- place (see Figure 2), making it both time and space efficient. However, Haar has poor results due to the simplicity of the prediction step. Since every wavelet transform has a transform that can be formulated in terms of lifting steps, several other more effective transforms can be derived and used, such as Daubechies and symmetric biorthogonal. The derivation of bi orthogonal wavelets in particular is discussed in great detail in the next section.

Compression requires two major steps: de correlation and coding. The process of lifting provides spatial de correlation of image data, but no actual compression is performed by this step. Hence, a coding step must follow lifting to reduce the amount of data. An entropy coder, such as Huffman or arithmetic, can be used for this purpose.

3. PROPOSED SYSTEM

This paper focus on fusing the medical image such as CT, MRI of brain image of the same person. The lifting wavelet transform is applied to compute a multi resolution representation. Then the obtained wavelet co-efficient are fused. The target image is obtained by performing inverse of LWT.

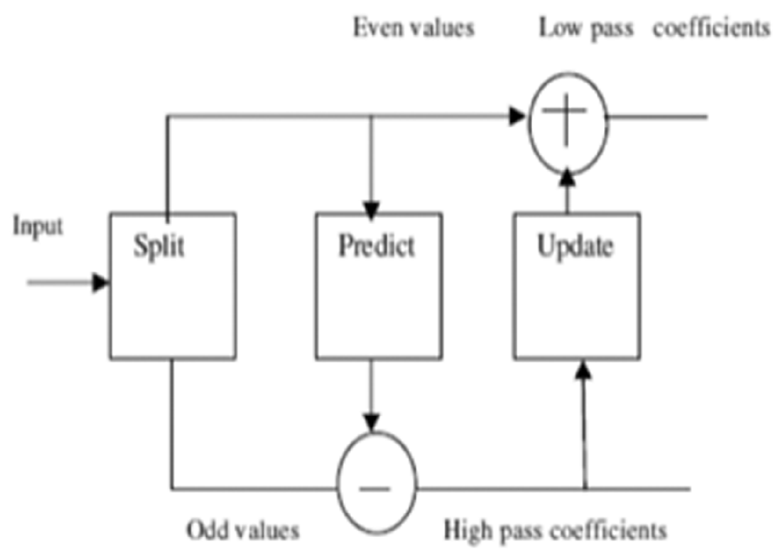

Figure 2: Lifting structure

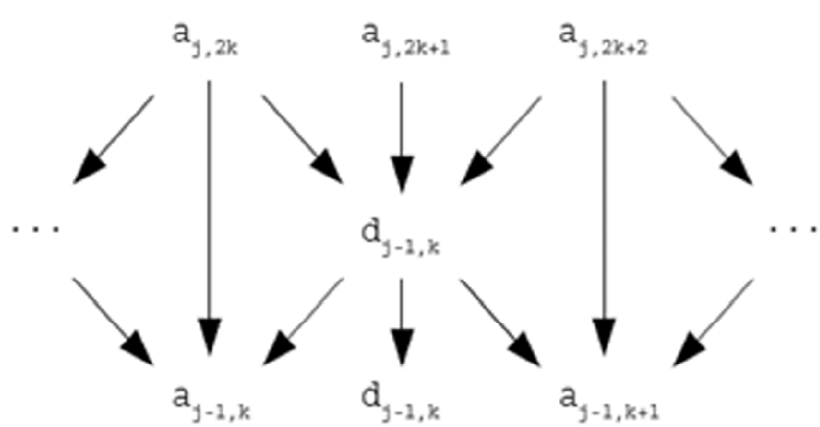

Figure 3: Technical expression

Algorithm:

Step 1: Read the first image (CT) in variable M1 and find its size (rows×column s1)

Step 2: Read the second image (MRI) in variable M2 and find it size (row×column s2)

Step 3: Convert the input image s1 and s2 to gray scale image

Step 4: Compare rows and column of both input images and make sure that the image to be fused in same size.

Step 5: Decompose the obtained input image using LWT

4. RESULTS AND DISCUSSIONS

This work investigate that the CT and MRI image of the same person and the same spatial part are fused by lifting wavelet transform.

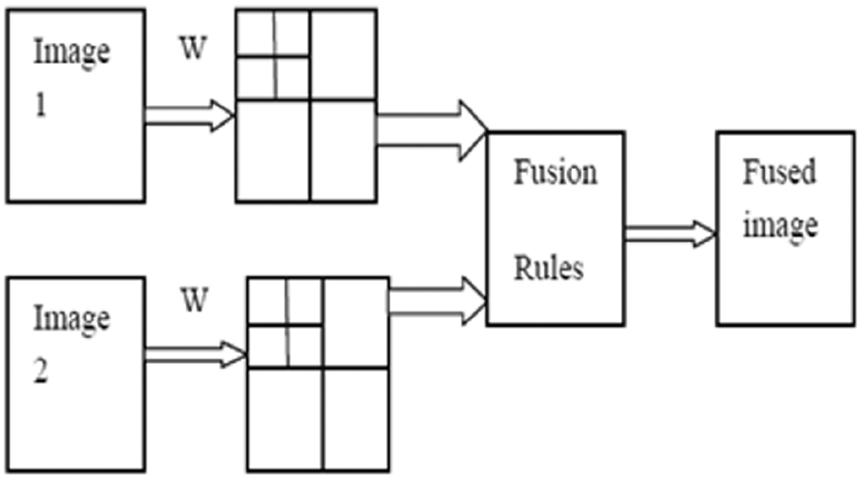

Figure 4: Image fusion scheme

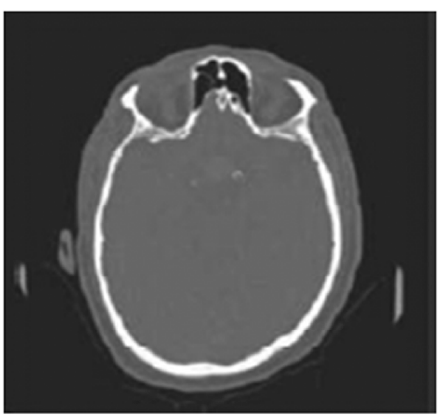

Figure 5: CT image

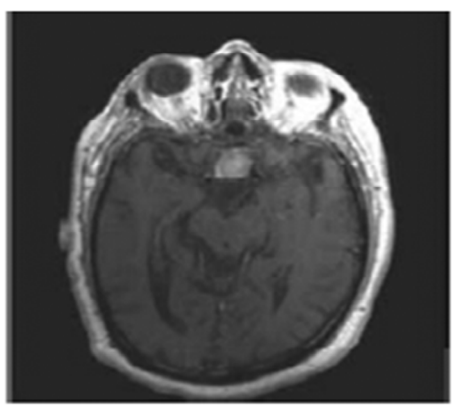

Figure 6: MRI image

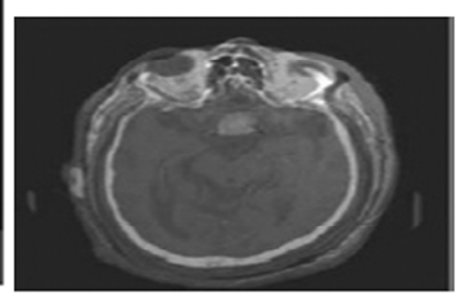

Figure 7: Fused image

Table 1
Result analysis

Fusion Method	*Mean value*
DWT (sub band coding) for pair 1	22.7902
LWT (lifting scheme) for pair 1	35.9446
DWT (sub band coding) for pair 2	47.2581
LWT (Lifting scheme) for pair 2	51.1420

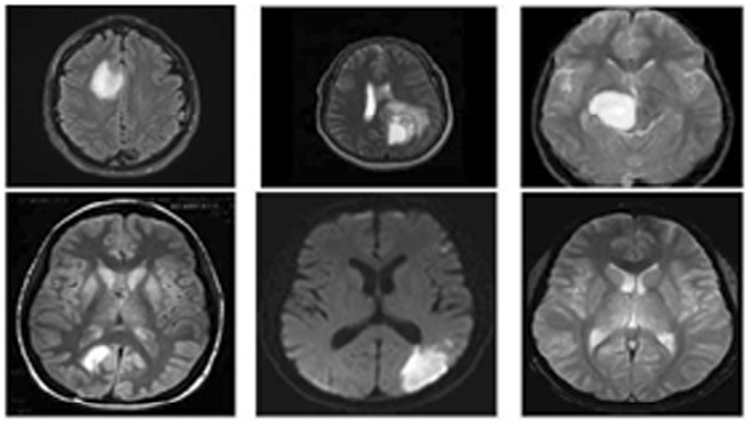

Figure 8: Brain MR images containing tumor

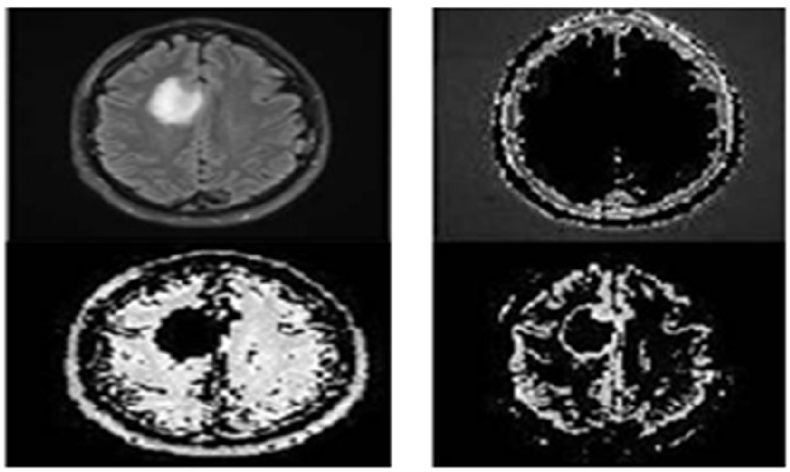

Figure 9: Clustering of brain image

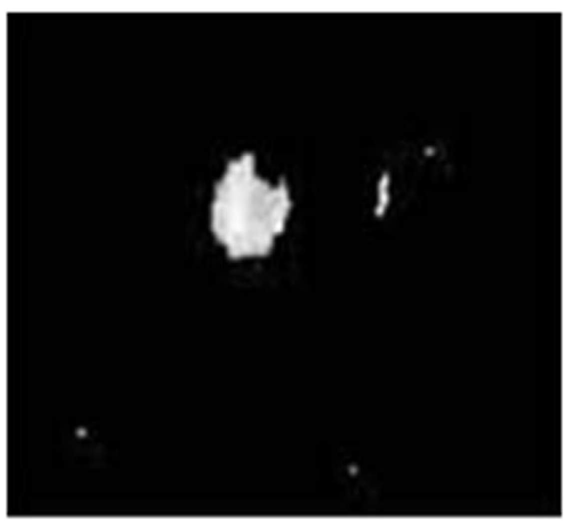

Figure 10: Tumor detected image

Some of the brain MR images containing tumor taken for testing our proposed algorithm are shown.

5. CONCLUSION

This paper concentrated and worked towards with the characteristics of the Second Generation Lifting based Wavelet Transform in an initial stage and put forward an image fusion algorithm based on efficient proposed lifting based Wavelet Transformed images. Our scope is fusing the medical image and finding the affected parts from that image using image segmentation process. Brain images are collected like CT and MRI images of brain, for finding the brain tumor affected parts in both Computed Tomography (CT) provides the best information on denser tissue with less distortion. Magnetic Resonance Image (MRI) provides better information on soft tissue with more distortion. Fused image was segmented using efficient K-Means Clustering algorithm, then found out the threshold values for finding the perfect edges of tumor affected part. The illusion method was followed for enhancing the edges of the tumor. Finally the affected parts was found successfully. This segmentation process could be effective in the bio-medical applications. In this project, a hardware implementation of a real-time fusion and image segmentation system was proposed. The system is based on an Xilinx Spartan 3 EDK FPGA and implements a configurable linear pixel level algorithm which is able to result in colour fused images using System C language.

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