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# FPGA Implementation of Runway Extraction using Image Fusion Method

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**Abstract:** ***Image Fusion is one of the major research fields in image processing. It is a process of combining the relevant information from a set of images, into a single image, without the introduction of distortion wherein the resultant fused image will be more informative and complete than any of the input images. Image fusion techniques can improve the quality and increase the application of these data .This paper presents the design and implementation of a low-cost vision-based system for an aircraft during approach and landing under low visibility, based on image processing algorithm. Reconfigurable device like FPGAs have emerged as promising solutions for reducing execution times by deploying parallelism techniques in image processing algorithms. Xilinx Platform Studio-10.1 software platform is used to design an algorithm using c language. MATLAB is used to perform RGB to gray conversion and to obtain pixel data matrix from image.***

**Keywords:** runway extraction, DWT, lifting scheme, image fusion, FPGA.

## 1. Introduction

Digital image processing is widely used for image processing operations like feature extraction, segmentation, pattern recognition.

Image fusion means the combining of two images into a single image that has the maximum information content without producing details that are non-existent in the given images. With rapid advancements in technology, it is now possible to obtain information from multi source images to produce a high quality fused image with spatial and spectral information. Image Fusion is a mechanism to improve the quality of information from a set of images. Important applications of the fusion of images include medical imaging. microscopic imaging, remote sensing, computer vision and robotics .Use of the Simple primitive technique will not recover good fused image in terms of performance parameter like peak signal to noise ratio (PSNR) and Men square error (MSE). Recently, Discrete Wavelet Transform (DWT) and Principal Component Analysis (PCA), Morphological processing and Combination of DWT with PCA and Morphological techniques have been popular fusion of image.

The two-dimensional discrete wavelet transform (2-D DWT) is widely used in many image compression techniques and adopted to be an ingredient in many image compression standards, such as JPEG2000 etc. This is because the DWT can decompose the signals into different sub-bands with both time and frequency information and facilitate to achieve a high compression ratio. The computation transform has been widely implemented in very-large-scale integration (VLSI) to meet real time requirement. At present, many VLSI architectures have been proposed based on the lifting scheme.

During the recent years, Field programmable gate arrays (FPGAs) have become the dominant form of programmable logic device. In comparison to previous programmable devices like programmable array logic (PAL) and complex programmable logic devices (CPLDs), FPGAs can implement far larger logic functions. FPGAs are reconfigurable. The term "reconfigurable" refers to the ability of changing functionality of the device and gate array is basic internal architecture that makes re-programming possible. This increases flexibility of the device. Therefore, the application of FPGAs in image processing has large impact on image or video processing. Also, image or video processing often requires large memory to handle video data stream, image processing, which increase the complexity of hardware and software. Thus, FPGA is a better solution. Hence, this paper presents implementation of runway extraction using image fusion algorithm on FPGA.

## 2. Proposed Work

**DWT**

DWT analyzes the data at different frequencies with different time resolutions. Fig. 1 shows the DWT decomposition of the image. The DWT decomposition involves low-pass 'l' and high-pass 'h' filtering of the images in both horizontal and vertical directions. After each filtering, the output is down-sampled by two. Further decomposition is done by applying the above process to the LL sub-band.

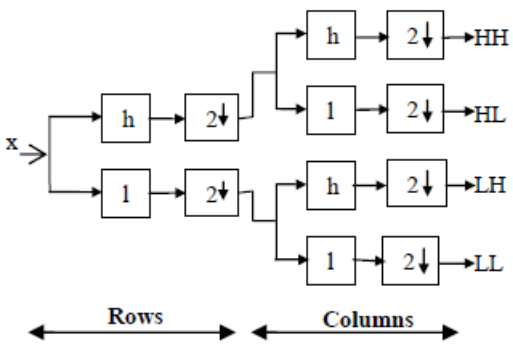


**Figure 1:** 2 DWT Decomposition

**LIFTING DWT**

The lifting scheme has been developed as a flexible tool suitable for constructing the second generation wavelet. It is composed of three basic operation stages: splitting, predicting and updating. Fig.2 shows the lifting scheme of the wavelet filter computing one dimension signal:

1) Split step: where the signal is split into even and odd points, because the maximum correlation between adjacent pixels can be utilized for the next predict step.
2) Predict step: The even samples are multiplied by the predict factor and then the results are added to the odd samples to generate the detailed coefficients.
3) Update step: The detailed coefficients computed by the predict step are multiplied by the update factors and then the results are added to the even samples to get the coarse coefficients.

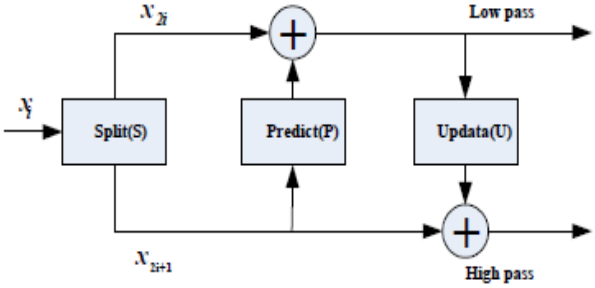


**Figure 2:** Lifting DWT Block Diagram

**Image Fusion Algorithm**

It is a well documented fact that regions of images that are in focus tend to be of higher pixel intensity. Thus this algorithm is a simple way of obtaining an output image with all regions in focus. The value of the pixel P (i, j) of each image is taken and added. This sum is then divided by 2 to obtain the average. The average value is assigned to the corresponding pixel of the output image. This is repeated for all pixel values.

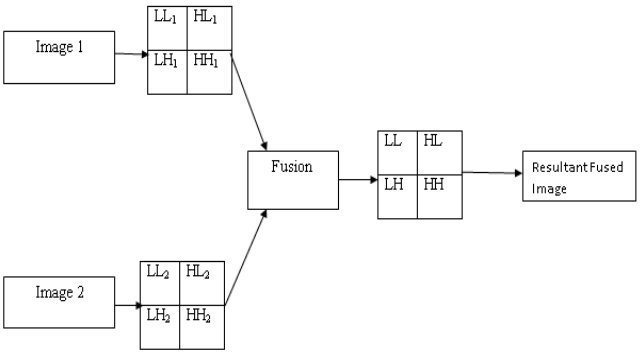


**Figure 3:** Image Fusion

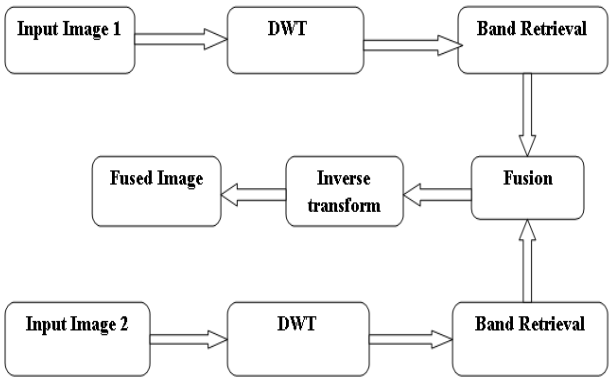


**Figure 4:** Block Diagram of Proposed Work

In this work, we can use following steps:

- 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.
- According to definite standard to fuse images, local area variance is choose to measure definition for low frequency component.
- Inverse Transformation is taken to get Original Image

## 3. Results

This paper proposes implementation of runway extraction using image fusion algorithm with the help of c language. Two images are taken as an input. If this input image is colored, then firstly, this RGB image is converted to grayscale image with the help of MATLAB. This image is very large, thus it is resized. The header file of image is generated which contains pixel value of image.

Further implementation is done in Xilinx Platform Studio 10.1. With the help of XPS 10.1, text file generated by MATLAB is read. DWT is performed on images. After implementing on FPGA SPARTAN3 we get the result as shown in fig . Output is shown in VB.

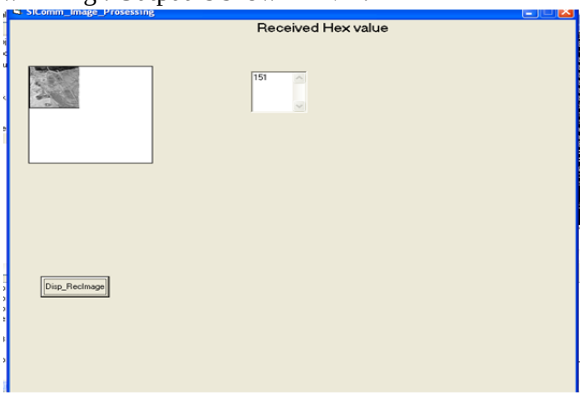


**Figure 5:** Input Image 1

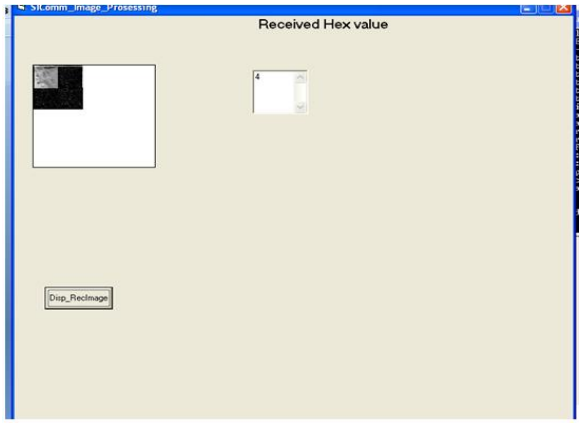


**Figure 6:** Input image 2

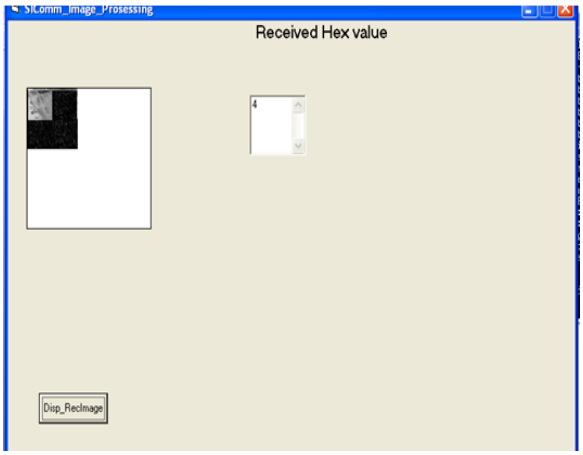


**Figure 7:** DWT of First Image

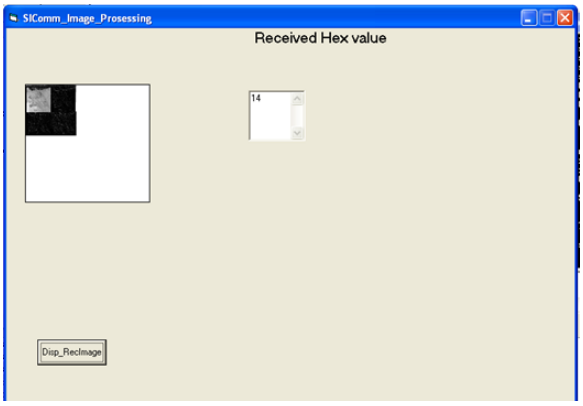


**Figure 8:** DWT of Second Image

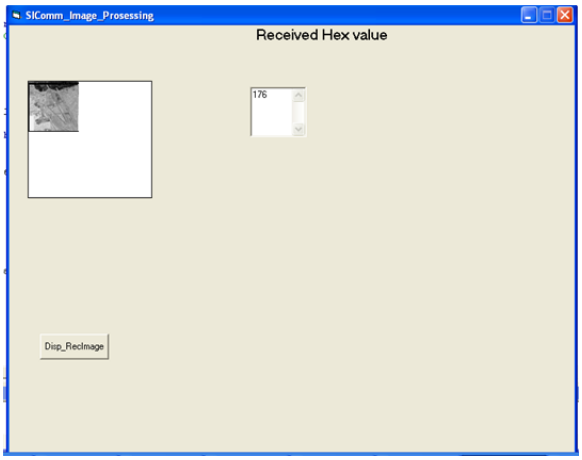


**Figure 9:** Fused Image

**MSE:**
MSE is calculated as
**MSE = ( ( i/p-o/p) ^2) n*m**
Where, n*m is the number of total pixels. f (i,j) and f(i,j)' are the pixel values in the original and reconstructed image
**PSNR:**
Peak signal to noise ratio is calculated as
**PSNR: 10log (255^2/MSE)**

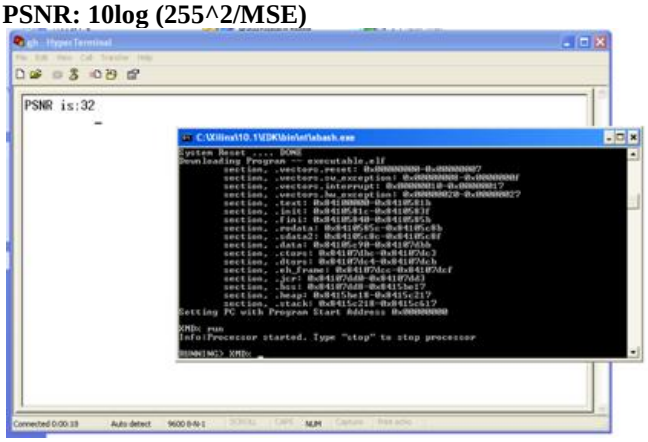


**Figure 10:** PSNR

## 4. Conclusion

This paper presented FPGA based runway extraction using image fusion method. Image fusion method combines original information from various images. This gives resultant image as original image. DWT enhance the quality of image. Algorithm provides resultant image without loosing information from input images. Implementation is done on FPGA spartan3 board. Image fusion has many applications such as in remote sensing, medical applications, military, security etc.

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