International Journal of Future Generation Communication and Networking
Vol. 13, No. 2s, (2020), pp. 468–473

Image Fusion Technique Implementation Using FPGA

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Abstract

In recent times, the application of Image fusion have grown immensely in the areas of medical science, forensic and defense departments. An image fusion technique is used to create a fused image that gives all the useful information from the source image. Image fusion process is nothing but the integration of information from a number of registered input images without the distortion. Image fusion produces a single image by fusing information from a group of input source images together using either pixel, feature or decision level techniques. The fused image contains better information content for the scene than any one of the individual input images alone. The accuracy and overall detailed information of the image is increased. This system deals with the design of image fusion technique in MATLAB using Discrete Wavelet Transform (DWT) technique. The system is then interfaced on FPGA with the help of Xilinx.

Keywords-*Image Fusion, Image Processing algorithms, DWT, FPGA, MATLAB, Xilinx.*

I. INTRODUCTION

Image fusion is very important subject related to different areas such as object detection, image processing, robotics, and medical imaging. Image fusion is a technique that deals with creating an image where all the objects are in focus. Image fusion is a technique which fuses the data from two or more input/source images from the same scene to generate one single image containing more detailed information of the scene that any of the source images. Image fusion deals with acquisition, processing and fusing the information provided by different sensors or by the same sensor. It is the processing of images about a given region obtained from different sensors by a specific algorithm. The fused data gives more detailed information than the separate dataset. The fused image is generated to improve the image content and to make it better for the user to detect, recognize and identify targets. Image fusion can takes place on pixel-level, feature-level, and decision level.

1) Pixel-level image fusion is the combination of raw data from different multiple source/input images into a single image.
2) Feature -level fusion technique needed the extraction of different features from the source/input data before the features are combined together.
3) Decision-level fusion fused the results from multiple algorithms to give a final fused output.

Pixel level image fusion method has various methods such as weighted average, Principal Component Analysis (PCA), Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) and Stationary Wavelet Transform (SWT). The DWT method is important in an image fusion technique for its excellent feature & time frequency analysis. Wavelet transform fusion is defined as considering the wavelet transforms of two registered input images together with the fusion rule. The fused image is reconstructed by taking IDWT.Input images should be registered for fusion.

ISSN: 2233-7857 IJFGCN

II. LITERATURE SURVEY

[1] "Implementation of Image Fusion based on Wavelet Domain using FPGA". ManasaPemmaraju Sai Chand Mashetty, SrinivasAruva,MohanshankarSaduvelly, Bharat-BabuEdara. Image fusion is a data fusion technology which combines multi-images of the same scene from various image sensors data. In this paper Wavelet based Image fusion technique is used and implemented on a FPGA-based hardware system using a Xilinx Studio EDK 10.1. The FPGA technologies gives basic digital blocks with adaptable interconnections to attain high speed digital hardware realization. Finally, the proposed algorithm in this project was applied to experiments of multi-focus image fusion and complementary image fusion.It has been observed from the results that System-C performance for wavelet based image fusion in synthesis level is better than Verilog implementation. A hardware implementation of a real-time fusion system is done based on an Xilinx Spartan 3 EDK FPGA and implements a linear pixel level technique which is capable of resulting in fused images using System C language.

[3] "Image Information Fusion Based on FPGA". GANDHI PRIYA P. With the development of different types of biosensors and remote sensors on board satellites, more data have been accessible for researches. Different terms such as data illustration, data integrating had been used. The fusion means the squeezing of information obtain in several domains. In this paper, the simplest method for image fusion was presented. It requires less computation time, and this system gives us result with low cost. It can be used for medical imaging, satellite imaging applications. The hardware realization which is based on FPGA technology provides a fast solution for image fusion. Future work in this field is planned for extension of other type of image modalities and also video fusion.

[4] "A Review on Recent Improved Image Fusion Techniques". K.C. Rajini, S. Roopa. In this article, the comparative study of different Image fusion approaches and the related work was done till now is presented. Wavelets have gained a lot of importance due to its energy compaction and multiresolution properties. This paper shows the overview of image fusion technique and the results from a different number of wavelet-based image fusion schemes are compared. The image fusion using various techniques to extract the significant information from the source images and to enhance the visual quality of an image is discussed. It was observed that high spatial resolution was obtained in traditional image fusion techniques which result in image blurring problem. To get the better of these issues 'wavelet-based image fusion technique was proposed. Wavelets provide a high-quality spectral content with least spectral distortion. In this article different wavelet transform are applied on pixel level-based image fusion and the results are compared using different objective based performance measures.

III. METHODOLOGY

This project involved the implementation of the image fusion using FPGA. Inthe process of image fusion technique, first the input image 1 is pre-processed by MATLAB and converted into .h file. Then the input image 2 is pre-processed by MATLAB and converted into .h file. This two .h files are given to SPARTAN 3E FPGA kit. In FPGA kit Discrete Wavelet Transform technique is used. Discrete Wavelet Transform technique is used for the image fusion purpose. Processing of image is done in FPGA. FPGA gives the output image which is nothing fused image.

A. Description of the Device

The block diagram below shows how the two images are fused together using Discrete Wavelet Transform (DWT) technique. The block diagram of the fusion system consist of images, DWT technique, Spartan-3E FPGA kit and fused image block.

B. Input Image

For the image fusion, two images preferably of the same size are taken. Image fusion requires that images to be registered first before they are fused. Image registration is performed for each of the image using steps like feature detection, feature matching, transform model estimation etc.

ISSN: 2233-7857 IJFGCN

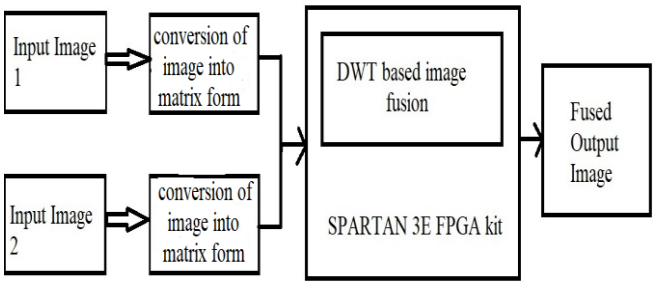

Figure.1.Block diagram of Implementation of Image Fusion Technique using FPGA

C. Discrete Wavelet Transform (DWT)

The Wavelet Transform is a multi-decomposition of an image in biorthogonal basis and results in a non-redundant image representation. This basis is called as wavelets i.e. they are the functions generated from one single function called as a mother wavelet. DWT-IDWT based image fusion technique which consist of two input images, wavelet coefficient and fusion decision map, and the fusion block. The two input images image1 and image2 are taken as inputs. The wavelet transforms decompose the image into LL, LH, HL, HH frequency bands.

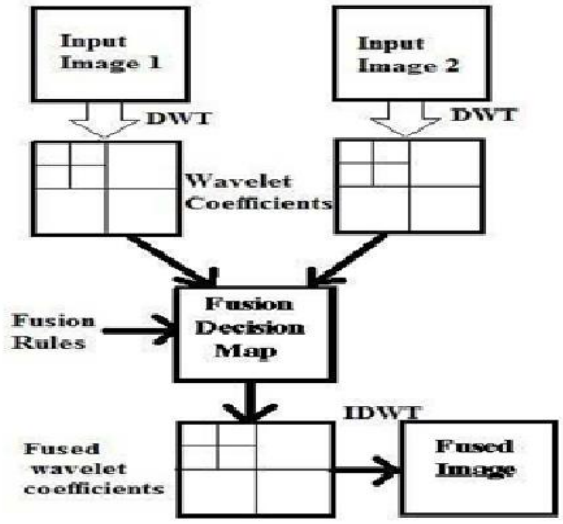

Figure.2.Image Fusion using DWT process

The wavelet coefficients of the input images are fused by taking the average of input images. The resultant fused image is obtained by applying the inverse wavelet transform IDWT at the receiver.

D. Spartan-3E FPGA kit

Image processing algorithms are conventionally implemented in DSP, ARM processors and some special purpose processors. However, all these implementation styles are limited by throughput which becomes very critical parameter for several image processing applications. The FPGA technologies offer basic digital blocks with flexible interconnections to achieve high speed digital hardware realization. The FPGA consist of system of logic blocks, such as look up tables, gates, or flip-flops and some amount of memory. In this project the Spartan-3E FPGA kit is used. Spartan-3E FPGAs are programmed by loading configuration data using JTAG cable into reprogrammable, static CMOS configuration latches (CCLs) that collectively control all functional elements and routing resources. The FPGA's configuration data is stored externally in a PROM or some other non-volatile medium, either on or off the board. After applying power, the configuration data is written to the FPGA.

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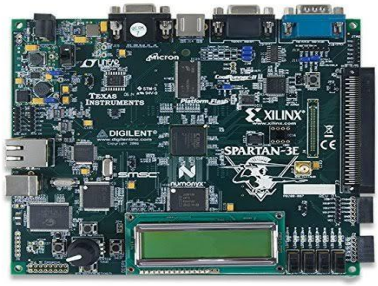

Figure.3.Spartan 3E FPGA Kit

Spartan-3E specific features:

- Parallel NOR Flash configuration
- Multi Boot FPGA configuration from Parallel NOR Flash PROM
- SPI serial Flash configuration x Embedded development
- Micro Blaze™ 32-bit embedded RISC processor
- Pico Blaze™ 8-bit embedded controller
- 4 Mbit Platform Flash configuration PROM
- Complete GUI based FPGA design and verification environment

IV. SOFTWARE REQUIREMENTS

A. MATLAB-Simulink Simulation

Image processing algorithms are implemented in DSP, ARM processors. However, all theseimplementations are limited for various image processing applications. The FPGA technologies gives basic digital blocks with the flexible interconnections for high speed digital hardware realization. The FPGA made up of the system of logic blocks, such as look up tables, gates, or flip-flops. In this project the Spartan-3E FPGA kit is used. Spartan-3E FPGAs are programmed by loading configuration data using JTAG cable into reprogrammable, static CMOS configuration latches (CCLs) that accurately control all functional elements and routing resources. In FPGA the PROM or some other non-volatile memory are used for storing the data by either on/off the board. After providing the power, the configuration data is provided to the FPGA.

At different points during the design flow, we can verify the functionality using a simulation tool. We can usedISim, with the ISE Design Suite or ModelSim simulators. MATLAB is developed by MathWorks and different functions of MATLAB such as matrix manipulations, plotting of functions and data and interfacing with programs written in different languages. The video and image processing toolbox and the Xilinx block set toolbox is used from the Simulink library to design the model. Two separate software models are prepared for the design of image fusion technique using Discrete Wavelet Transform.

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V. V. RESULT

1] Sample Input 1:

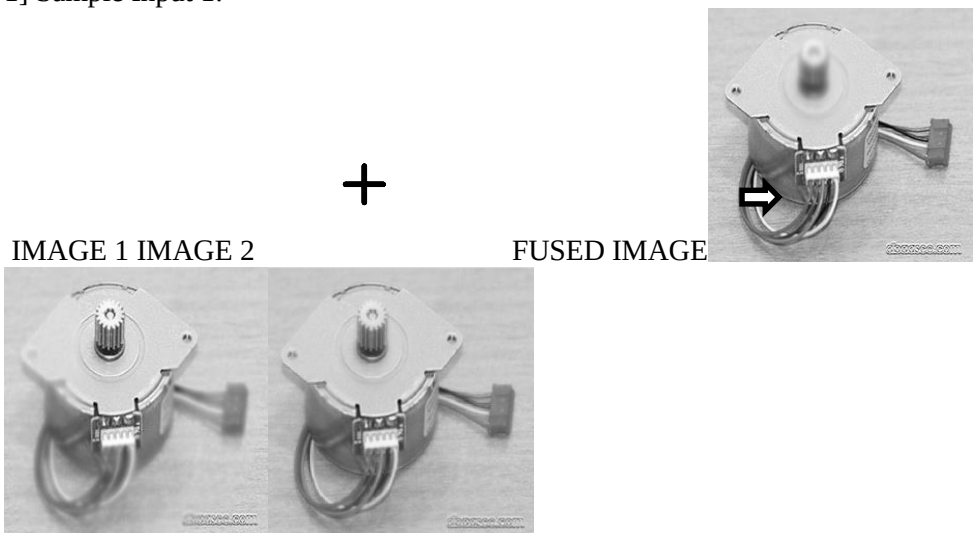

Figure 4. Result of Sample Input 1

2] Sample Input 2:

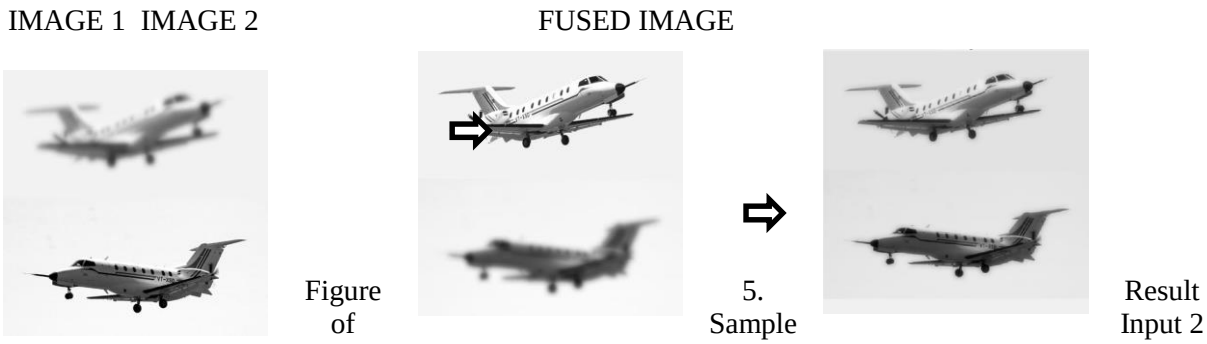

Figure 5. Sample Result of Input 2

VI. CONCLUSION

The resultant image is more reliable, clear and more accurate. Image fusion is giving a new image that retains the most desirable information and characteristics of each input image. The fused image contains better information content for the scene than any one of the individual input images alone. The fused image is generated to improve the image content and to make it better for the user to detect, recognize and identify targets.

ISSN: 2233-7857 IJFGCN

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ISSN: 2233-7857 IJFGCN