"A Review on Image Enhancement using Hardware co-simulation for Biomedical Application"

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Abstract - **Digital image enhancement techniques are to improving the visual quality of images. Main objective of image enhancement is to process an image so that result is more suitable than original image for specific application. Image is one of the most fundamental and significant features. The correctness and reliability of its results affect directly the comprehension machine system made for objective world. The implementation of image enhancement algorithms on a field programmable gate array (FPGA) is having advantage of using large memory and embedded multipliers. FPGAs are providing a platform for processing real time algorithms on application-specific hardware with substantially higher performance than programmable digital signal processors (DSPs). This project focus on implementation issues of image enhancement algorithms like brightness control, contrast stretching, negative transformation, thresholding, filtering techniques on FPGA that have become a competitive alternative for high performance digital signal processing applications. This project will use System Generator tool and modular construction methods to build a image algorithm platform in MATLAB. By a brief analysis about display image and resource consumption after achieving on Spartan-3E development board, we can see the image using System Generator for FPGA algorithm design superiority, have the vast application prospects**

Keywords: **FPGA, DSP, Image Processing, Image Enhancement, MATLAB, System generator.**

I. INTRODUCTION

Digital image processing plays a essential role in the analysis and interpretation of remotely sensed data. Data obtained from Medical and Satellite Remote Sensing, is in the digital form, can be utilized with the help of digital image processing. Image enhancement & information extraction are two important components of image processing. Image enhancement techniques help to improve the visibility of any portion or feature of the image. Image enhancement processes have different techniques to improve the visual appearance of an image, because FPGA has superior performance, rich resources, high-speed parallel computing capacity, FPGA digital signal processing systems have become the core of the device, especially in digital communications, video and images. FPGA has been widely used in the field. With use of FPGA design become more flexibility, procedures and modules portability improved, and it also shorten the design cycle, reduce the hardware investment risk.

FPGA has the advantages such as high reprogram ability parallelism flexibility & computational power prove. the FPGA implementation is better option than DSP and ASIC based implementation. FPGAs are usually programmed using Hardware Description Language using (HDL) which uses a low level, hardware-oriented programming model to entirely utilize their potential performance. But the process of programming FPGAs using HDL is time consuming procedure and more complicated for large system design. This situation has been changed by using high level programming tools such as Handel-C, AccelDSP and Xilinx System Generator for DSP, etc.

The XSG blocks operate only in discrete-time and fixed-point format Design entry is the first step for FPGA design flow, this design entry is either using HDL language or Schematic based approach in conventional FPGA design. The design entry of XSG based FPGA implementation is block diagram representation of the entire system By using XSG, complex systems can be implemented easily. This system is implemented on FPGA board using a combination of MATLAB Simulink and Xilinx System Generator prototyping environment. Conventional image edge detection algorithm such as Sobel, Prewitt, Robert and LoG are also implemented in FPGA using XSG. The proposed implementation result will be compared with conventional approach.

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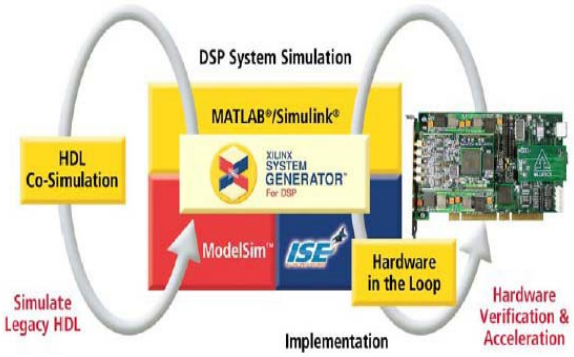

Fig-1 .Design flow of XSG system

II. LITERATURE REVIEW

A lot of work has been done on edge detection algorithm to detect edge of an object .On the basis of edge detection algorithm we can improve quality of image for human interpretation.

Using Xilinx System Generator[2] proposed FPGA architecture for MRI image and tumor characterization and experimental results for various filtering algorithms are given in this paper. This architecture is implemented in XC3S500E-FG320 and only 50% of the resources are utilized for this implementation.

Zhang Shanshan, Wang Xiaohong [3] proposed architecture to identify the edge features of vehicle images. This system is implemented on Spartan-3E board and resource utilization summary is tabulated. This paper used System Generator tool in developing vehicle image processing edge detection algorithms which is developed by Xilinx based on MATLAB. Edge detection algorithm model and design are finished in MATLAB / Simulink, preparation of top-level file in ISE10.0 environment, then achieve the System Generator functions and other modules instantiated

R.Harinarayan,R.Pannerselvam,M.MubarakAli, Dhirendra Kumar Tripathi[4] proposed FPGA-based architecture for edge detection algorithms has been proposed. FPGAs are providing a platform for processing real time algorithms on application-specific hardware with substantially higher performance than programmable digital signal processors (DSPs). The proposed architecture can be used as a building block of a aerial imaging systems for navigation and for the pattern recognition.

Sudeep,K..C.J. Majumdar,[5] A novel architecture for real time implementation of edge detectors on FPGA. Int. J. Comput. Sci., 8: 193-202.In this paper FPGA based implementation of conventional edge detectors such as Sobel, Prewitt, Robert and Laplacian of Gaussian (LoG) are already implemented using XSG.

III. PROPOSED WORK

The entire operation is proposed using Simulink and Xilinx blocks goes through three phases,

- Image pre-processing blocks.
- Image enhancement algorithm using XSG.
- Image post-processing blocks

The design flow of hardware implementation of image enhancement using XSG is given in fig 1.Image source and image viewer are simulink block sets by using these blocks image can give as input and output image can be viewed on image viewer block set. Image preprocessing and image post-processing units are common for all the image processing applications which are designed using Simulink block sets. image enhancement algorithms are different for each and every edged detection algorithms which is implemented using Xilinx System Generator block sets.

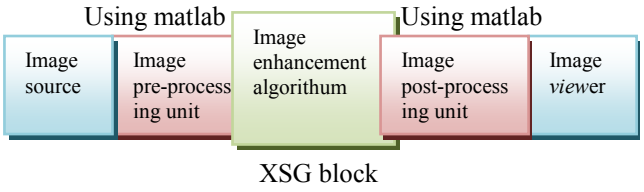

Fig -1. Design flow of hardware implementation of image enhancement.

A. Image pre-processing blocks*:*

Image preprocessing in Matlab helps to provide input to FPGA as specific test vector array which is suitable for FPGA Bit stream compilation using system generator.

- ***Resize***: Resize block set input dimensions for an image and interpolation i.e. bicubic it helps in preserving fine detail in an image.

• ***Convert 2-D to 1-D***: image is converted into sigle array of pixels.

• ***Frame conversion and buffer***: It is used to setting sampling mode and buffering of data.

The model based design used for image pre-processing is shown in Figure 2. Input images which may be color or grayscale are provided as input to the File block.

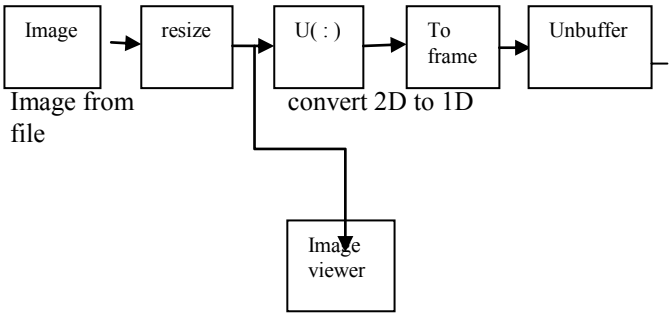

Fig- 2. Image pre-processing blocks

B. Image enhancement algorithum

In this section we discusses the theory of most commonly used image enhancement algorithms like
1) Brightness Control
2) Contrast Stretching
3) Negative Transformation
4) Thresholding techniques

1. Brightness Control

Brightness control is the process of increasing gray level of each pixel by adding a constant value to the image pixels with poor brightness. If the digital image is of poor brightness, the

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objects in the image will not be visible clearly. This is due to image is captured under low light conditions. To rectify this problem, we have to further increase the brightness of the captured digital image and make the image more attractive. The brightness of a dark image can easily be increased by adding a constant to gray value of each pixel. This addition operation will shift the histogram towards brighter side with a constant factor. While applying this method to increase brightness of an image, we must choose the constant wisely so that the complete range of gray values lies within 0 to 255. If the final gray value of any pixel is greater than 255 then the information will be losed.
This algorithm works as follows:
J(r) = I(r) +g, if I(r) +g<=255
J(r) = 255, if I(r) +g<=255
g-is a constant value (g>0). I(r)-is gray level of input pixel (r) and J(r) is the gray level of output pixel (r) after the brightness increasing process.

2. Contrast Stretching

Contrast stretching is the process of improving an image by stretching the range of intensity values it contains to make full use of possible values. This is stretching is restricted to a linear mapping to a linear mapping of input to output values. If low contrast image is resulted due to low light conditions, lack of dynamic range of the camera sensor, contrast stretching operation results in the good quality image. During the contrast stretching operation, we basically increase the dynamic range of the gray values in the image being processed. A piecewise transformation function is used to achieve contrast stretching.
Contrast stretching algorithm works as follows:
J(r) = {I(r)-fmin} (max-min/fmax-fmin) + min
I(r) is the gray level for the input pixel (r) and J(r) is the gray level for the output pixel(r) after the contrast stretching process. fmax and fmin are the maximum and minimum gray level values in the input image. The max and min are the desired maximum and minimum gray levels that determine gray level range of the output image.

3. Negative Transformation

To display an medical images and photographing a screen with monochrome positive film with the idea of using the resulting negatives as normal slides. The negative of the digital image is obtained by using the transformation function:
J(r) = (L-1)-I(r)
Where *L* is the number of gray levels, I(r) is input pixel gray level and J(r) is output transformed gray level. The idea is to reverse the order from black to white so that the intensity of the output image decreases as the intensity of the input increases.

4. Thresholding

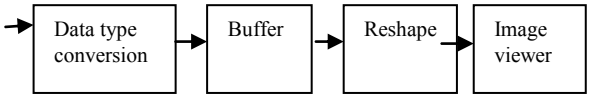
Thresholding an image means transforming all pixels in two values only. This is the special type of quantization comparing the pixel values with a given threshold value. Thresholding makes output image with only two values that is 0 and 255 for 8bit gray level image.
0, if I(r) <=T
J(r) = 0, if I(r) <=T
J(r) = 255, if I(r) > T
Resulting of Thresholding image is a black and white image, this have only two gray level values.

In this project we will implement all these algorithms using Xilinx system generator.

C. Image post processing blocks:

Image post processing helps to recreate image from 1D

- ***Data type conversion***: Data type conversion converts image signal to unsigned integer format.
- ***Buffer*** : Buffer converts scalar samples to frame output at lower sampling rate
- ***Convert 1D to 2D***: Convert 1D image signal to 2D image matrix.
- ***Sink***: Sink is used to display the output image back on the monitor



Data type conversion Convert 1-D to 2-d software o/p

Fig- 3. Image post-processing blocks.

IV.CONCLUSIONS

The Xilinx System Generator tool is a latest application in image processing, which offers a friendly environment design for the processing, because of processing units are designed by blocks. This tool support software simulation, but the important is that can synthesize in FPGAs hardware, with the parallelism, robust and speed, this features are essentials in image processing. In this paper we have presented the basic idea about how image processing can be done in model based approach, The architecture is constructed using a prototype environment which consists of MATLAB-Simulink and Xilinx System Generator tool. The result given in this work proves that the proposed hardware implementation image enhancement gives optimal result for all kind of images such as biomedical image. Thus this proposed architecture is very well suited for real time image enhancement applications.

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It is our almost duty and desire to express acknowledgement to the various torchbearers, who have rendered valuable guidance during the preparation of project. First of all ,I extend my deepest gratitude to our guide .**Prof. P. N. Pusdekar** for providing immense support and guidance.He guide throughout never leaving me unanswerered for any of doubts. It is his constant persuasion, encouragement, inspiration and able guidance that help me in completing project successfully.

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