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FPGA Based Design Technique for Image Processing

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***Abstract*—VHDL is Hardware Descriptive Language. It is having many elements that can be used to explain the behavior or structure of digital system. It can be used to model a digital system. VHDL language gives support for modeling the system as well as it supports top-down and bottom-up design methodologies. VHDL is a large and verbose language with many complex constructs that have complex semantic meanings and it is possible to quickly understand a subset of VHDL which is both simple and easy to use. Here the system is to be designed in such a way that it will accept the image from PC serially and the image is enhanced using the technique as specified by user and enhanced image can be displayed on monitor. Here the device used for implementation is Xilinx FPGA XS3s400.**

Keywords— Digital image, Negative Transform, Threshold Transform, VGA, FPGA, MATLAB.

I. INTRODUCTION

Nowadays Image Enhancement is very much useful in many applications. This is very powerful technology and can be used in medical as well as in other fields on large scale. The primary principle of this technique is to improve the appearance or quality of image. Within this process, result is more specific than the original image. Any blur image can give more information after use of this technique. Digital camera is best example for enhancement. Enhancement is nothing but improve the appearance of picture. Visualization should be clear after the enhancement process. MATLAB is good tool for implementation of image enhancement technology. There are many techniques which are developed by MATLAB, But in this paper VLSI Technology is used i.e. Very Large Scale Integration Technology. It uses VHDL language for implementation. It has many advantages than MATLAB.

FPGA [Field Programmable Gate Array] is used in verification of conceptual design as well as in electronics system. The internal structure of FPGA is very much useful to understand VLSI design. It has flip flop as a sequential blocks, memory also combinational logic unit.

The aim of this project is to develop a system with the help of FPGA board using VHDL language and target spatial domain technique of image enhancement for Real Time system

II. SYSTEM OVERVIEW

As shown in block diagram of Fig 1, PC is the source of image which will send image to digital hardware (FPGA).The image is sent to digital hardware using Transport utility of digilent board. The gray values of image received from PC are processed using digital hardware designed on FPGA.

Digital hardware consists of digital design for various spatial domain image enhancement techniques such as negative image, thresholding, contrast stretching, etc. which are discussed later. The gray values are modified as per selected image enhancement technique. The processed image is then given to VGA controller. VGA controller will display the enhanced image on monitor .VGA controllers are designed in FPGA architecture itself.

For this design we are using digilent board of FPGA. It does not require external power supply for its operation. It gets power from USB itself which is used for interfacing with PC.

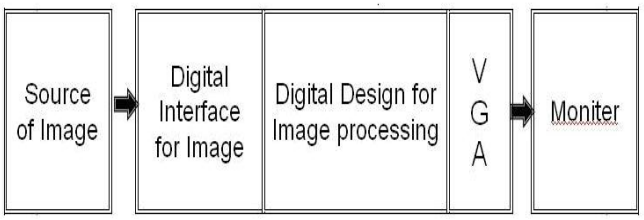


Fig 1. Block Diagram of system

III. OVERVIEW OF DIGITAL IMAGE PROCESSING

Pixel is very important factor from image. In this project processing image is Digital Image. This image is nothing but 2 dimensional representation of pixels with finite digital value.

Digital values are also called as picture element or pixels. Digital image has specific number of rows and columns. Combination of rows and columns give finite number of pixels with digital value. Pixel is smallest individual part of digital image and that are used to hold color at specific point. Example of digital image is as shown in fig 2.

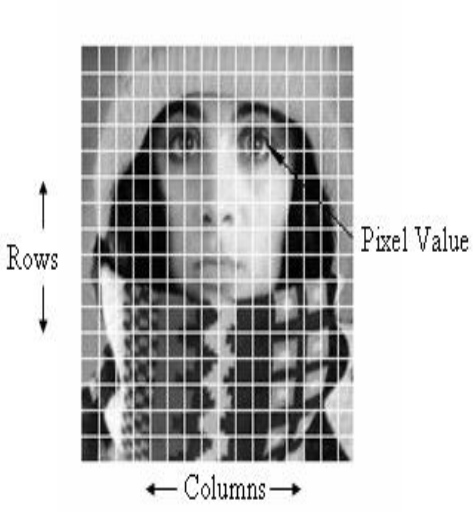


Fig 2. Digital Image

Image is 2 dimensional function i.e. f(x,y), here x and y are coordinates of spatial plane. F is amplitude of coordinates pair (x,y) is known as intensity or gray levels of image at that specific point.

III.1 IMAGE ENHANCEMENT

Image Enhancement is the process to improve the appearance of original image. Output image at the result is with more information than the original. Better Image is the output from blur image that is the basic function of image enhancement. Image Enhancement technology broadly divided into 2 techniques 1) Spatial Domain Technique 2) Frequency Domain Technique. Spatial Domain Technique is very much suitable for image processing. It deals with pixels at a time that means it operates on pixels. Frequency Domain Technique deals with Fourier transform of image and it is little bit complicated because of calculation. Spatial domain technique operates on pixels and as they usually operate on single pixel at a time, it is often refereed as a point processing. It operates on negative transformation, thresholding, gray level slicing etc.

F is original image and G is result image. Pixel value of (x,y) can be mathematical expressed as

$$g(x,y)=T\{f(x,y)\}$$

here T is operator of F.

If s is gray level of G and r is gray level of F, they are given as

$$s=T(r)$$

Here in image there are maximum L-1 number of gray levels are possible.

IV. NEGATIVE TRANSFORMATION

The negative of image is obtained by using transformation function s=T(r), i.e

$$S=L-1-r$$

The idea here is to reverse the order from black to white so that intensity of the output image decreases as intensity of input image increases and vice versa. This transformation will appear as shown in Fig.3(a).

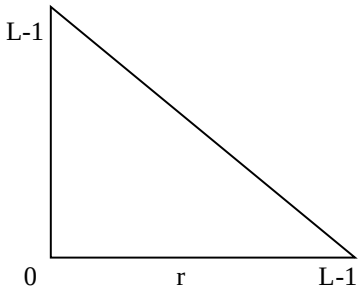


fig 3(a)

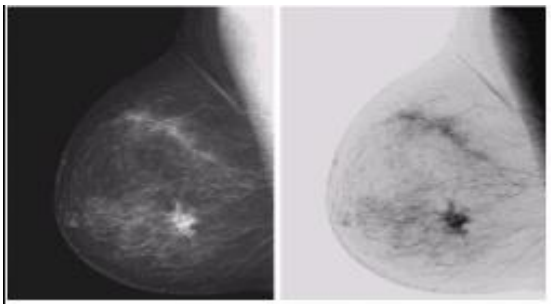


Fig 3(b) fig 3(c)

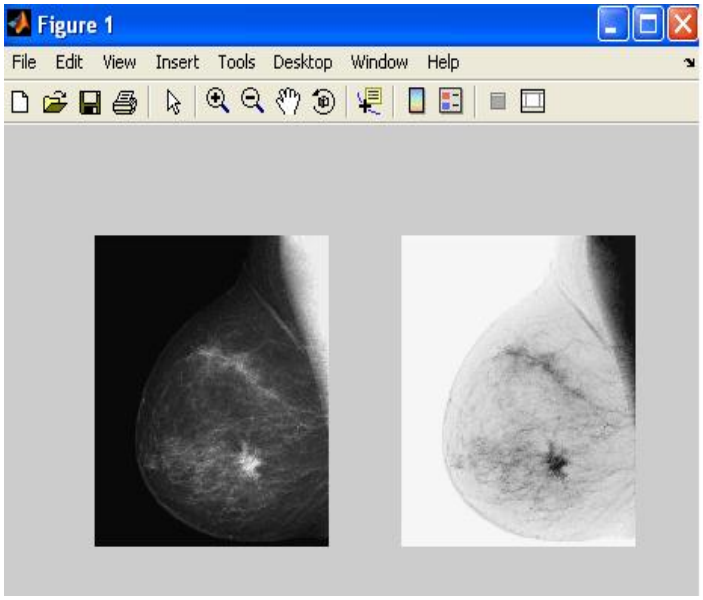
fig 3. Negative Transformation

This technique is very useful in some of the medical applications such as mammogram shown above in Fig.3.(b) in which cancer cells are not clearly visible in original image but when negative of this image is taken then cancer cells can be clearly observed as shown in Fig.3. (c).

VI. RESULT

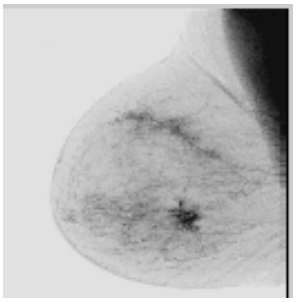
Results of implementation in Mat Lab are as follows. VHDL implementation would be better than the Mat Lab.

(a) Negative Transformation



b) Results of implementation using VHDL.

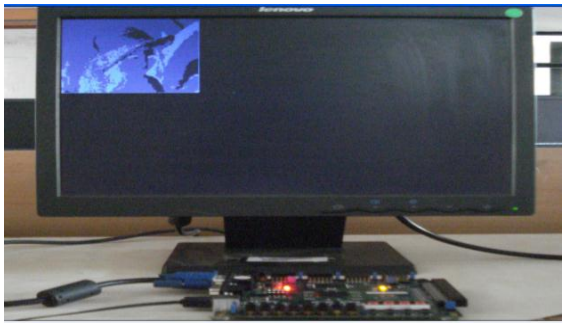
Input Image



Output Image

c) Result On Monitor

Input Image



Output Image

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