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Image Enhancement based on Verilog Hardware Description Language

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Abstract:

In this study we demonstrated and improved the real time configurable results of Image enhancement using Verilog Hardware description Language (VHDL). New filters are added to the image in order improve the quality of the image, which helps in analysing the image more precisely. Image processing plays a vital role in the fields of health care and services based on multimedia and etc. Image Enhancement using Hardware language is a whole new approach which uses the re-configurable circuits for digital image processing. This paper analyzes the advantages of utilizing Field Programmable Gate Array (FPGA) over Digital Signal Processor (DSP's) as a tool for image processing applications, such as brightness manipulation, threshold operation, filtering image, and inverting images. The implementation of the image enhancement techniques on FPGA using VHDL is quite different from implementing image processing in MATLAB or using DSP`s due to the parallel nature of HDL.

Keywords - Image Enhancement, Digital Image Processing, Verilog, Hardware Description Language, DSP, MATLAB

I. INTRODUCTION

In modern society, Digital Image Processing (DIP) has been used in numerous fields, particularly in the medical filed, in order to diagnose the diseases. Image enhancement is the strategy for increasing the quality of the image. Image enhancement alludes sharpening of image features like edges, limits, or contrast to make a realistic presentation of the image for more helpful for analysis of image.

The advancement of the hardware for medical imaging is firmly connected to the analysing the medical images [4]. In health care industry, images are taken directly from the convalescent, so these images contain some distortion effects which may happen during obtaining results [4]. The image enhancing methods and noise removal methods are valuable, particularly in image processing level. In health care field the images are obtained through the following techniques: radiography, CT scan, ultra sound etc. These techniques can be utilized to study the present state of the convalescent organs like lungs, brain etc. and can monitor the patient for diagnosis and treatment [5].

FPGAs are one of the best equipment for the image processing because of its parallel architecture and exceptional memory [6]. The FPGAs are proficient in help the exhibition of all the quick imaging calculations: image reconstruction, enhancement and image analysis and pattern recognition, and so on. Implementation of these applications on re-configurable equipment offers a lot more prominent rate than a software execution [7]. Hardware implementation has gotten an attention for image processing, particularly for real time image processing because of the advances in VLSI innovations [8].

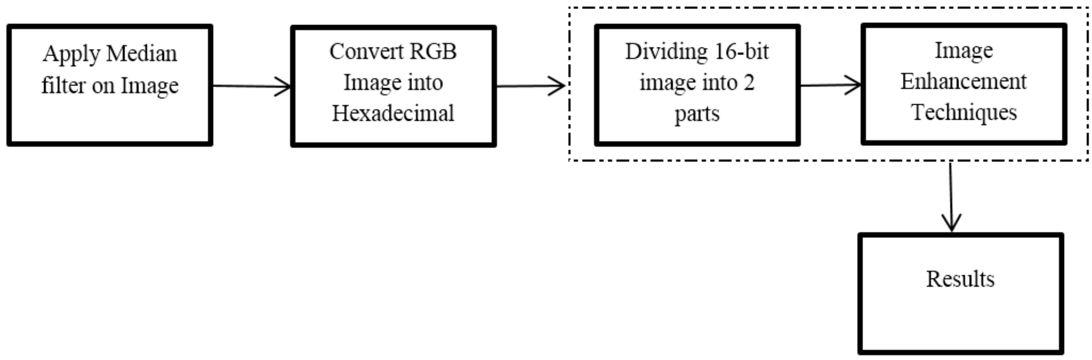

Fig 1: Workflow of the project

Image enhancement methods can be characterized into two classes:

A. Spatial domain technique:

The spatial space method alludes to the upgrade of image dependent on activities performed straightforwardly on pixels of the image. Kinds of spatial space procedures:

a. Range operations:

1. Point operations.
2. Neighborhood operations.

b. Domain operations.

B. Frequency domain technique:

It enhances the image with the help of mathematical transforms such as Fourier transforms. The idea of blurring an image by reducing its high frequency components, or sharpening an image by increasing the magnitude of its high frequency components is intuitively easy to understand.

Point operations are only least complex image channels, where the newborn numerical quantity of a pixel is decided by the actual value of the solitary pixel. As referenced, point operations perform the operations directly on pixel esteems without changing the size and shape or structure of the image. The pixel esteem is given by

$$a = I(x, y)$$

which relies solely upon the past worth a = I (x, y) at a similar position. This pixel esteem is autonomous from some other pixel esteem, including any of its adjoining pixels. To plan the first pixel esteems to the new qualities a capacity f (a) is utilized,

$$a' \leftarrow f(a) * I'(x, y) \leftarrow f(I(x, y))$$

for each point on image with a spatial coordinates (x, y). The most regularly utilized point activities for image improvement are threshold operation, contrast operation, inverting operation, brightness manipulation etc.

The paper is organized as follows- in section II we describe Related works, section III we discuss the Methodology, in IV we will discuss Results, in section V we conclude the paper.

II. RELATED WORK

Using MATLAB for the all the enhancement techniques is a tedious task, the better alternative is to build a separate re-configurable hardware for enhancing the images. By the use of re-configurable software and hardware the calculation time is greatly reduced.

In [8] they given the significance of advanced image processing dependent on hardware executions to accomplish better results, this paper examines essential image upgrade procedures with their usage and results using VHDL. The utilization of VHDL is to give signal processing results is a very new strategy supplanting the old-style reproductions and offering an immediate association with equipment VLSI usage. This paper is giving a creative technique to re-enactment followed by prompt execution probability. The current HDL approach is applied to image handling and likewise a diagram of basic guideline and ideas, alongside regular calculations typically utilized for image upgrade are portrayed. The paper centers around image improvement in the spatial space, with specific reference to point preparing techniques like: contrast control, brilliance control, altering images, edge activity.

In [9] FPGAs are giving a stage to preparing continuous calculations on application-explicit equipment with generously better than programmable computerized signal processors (DSPs). This venture center around execution issues of image upgrade calculations like lucidity control, contrast extending, negative change, thresholding, separating procedures on FPGA that have gotten a serious option for superior computerized signal handling applications. This undertaking will utilize System Generator apparatus and particular development techniques to assemble an image.

Calculation stage in MATLAB. By a concise examination about resulted image and asset utilization subsequent to accomplishing on Spartan-3E improvement board, we can see the image utilizing System Generator for FPGA calculation plan prevalence, have the huge application possibilities.

In [10] Whenever the one type of picture is changed over to another structure, the debasement happens in the nature of the first picture. Subsequently to improve the visuality of the picture, the picture upgrades procedures are utilized for the enhancements. These Techniques are the differentiation extending, lucidity control, reverse activity, limit activity and so on the picture improvement should be possible with the assistance of the both programming usage and equipment execution. In any case, as the equipment usage has preferable execution over the product execution consequently, we utilize the configurable framework that is continuously to upgrade the picture quality. Picture handling with the assistance of equipment portrayal dialects is the strategy with new methodology in the zone of advanced framework configuration utilizing VLSI.

In [11] Image amplification methods are to improving the visual nature of Image. fundamental goal of picture improvement is to deal with a picture all together that final product is more prominent reasonable than unique picture for explicit application. This paper shows consistent hardware picture upgrade strategies using field programmable door exhibit (FPGA). picture improvement calculations are lucidity expansion, brilliance deduction, rearranging and thresholding use in this paper. FPGA is exceptionally option of quick execution of advanced sign handling application. These calculations are executed in Verilog HDL utilizing Xilinx ISE, MATLAB.

In, references [12], [13], [14] a health care image processing system was proposed using VHDL and FPGA based the hardware architecture for a real-time configurable system for digital image processing.

III. PROPOSED METHOD

We propose this study to improve the image enhancement and simulate the hard ware architectures in order to achieve the real-time configurable results for DIP using VHDL and FPGA. We proposed the new set of image processing techniques: brightness operation, inverting operation, threshold operations and achieved real time configurable results.

The task is executed on FPGA with the help of Verilog, which is Hardware Description Language. The application allows the image in hexadecimal format and gives the digital image as output. We convert the digital image into bitmap format and give as an input to the system and the hex characters are quickly changed over to parallel organization by VHDL.

We need to separate the image from the background in order to enhance the image and analyse more precisely, there are some advanced techniques like

A. Brightness Manipulation

B. Threshold operation

C. Contrast stretching

A. Brightness operation:

Let's say an image is taken in dark light, by increasing the brightness of the image we can get the required information from the image and if the image is taken with the brighter background, we can reduce the brightness in order to get the required information.

A dark area in a image may get more splendid after the point activity and the normal utilized point activity are expanding what's more, diminishing of brilliance. On the off chance that an administrator takes every pixel worth and adds a consistent number to it, at that point this point activity builds the splendor of the image and comparable deduction activity lessens the sharpness. I(x,y) denotes input grey level, Q(x,y) denotes output grayscale.

$$Q(x,y) = \begin{cases} I(x,y) + t, \text{if } I(x,y) + t < 255 \\ 255, \text{if } I(x,y) + t > 255 \end{cases}$$

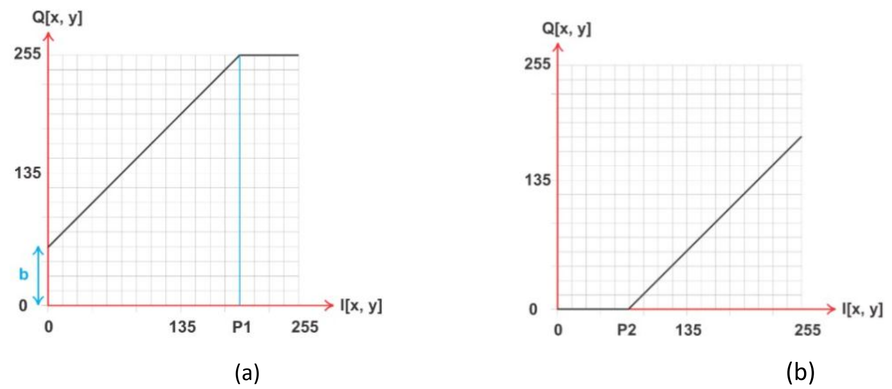

Fig 2: (a) Graph while increasing the brightness (b) brightness while decreasing the brightness

B. Threshold Operation

Thresholding activities are especially fascinating for division during the time spent disconnecting an image of interest from its experience. Applying threshold operation on an image implies changing all pixel values into two values either maximum or minimum. Set the pixel over a limit an incentive to 255 and underneath it to 0.

$$F(x,y) = \begin{cases} G_o(x,y), \text{for } G(x,y) < a_{th} \\ G_1(x,y), \text{for } G(x,y) \geq a_{th} \end{cases}$$

C. Invert operation:

Altering a force image is a basic point activity that inverts the requesting of pixel esteems (by duplicating with−1) and enhances map the outcome to the allowable reach again RGB pixel esteems should be leveled and it is finished by taking the normal of the three shading segments.

$$R_{eq} = G_{eq} = \frac{(R + G + B)}{3}$$

IV. EXPERIMENTAL RESULTS

We have used the image of dimensions 128*128*3 and Vivado 2012.4 version of Xilinx for developing the software.

Fig 3- Original image vs Threshold image

The Fig.4 shows the invert operation of the image. Each pixel within the input image having a logical 1 features a logical 0 within the output image and therefore the other way around. Hence, applying logic to not a binary image changes its polarity.

We use the logical NOT gate in bit-wise fashion, in order to store the grayscale image in bytes, Therefore, the resulting values of pixels will be the input value subtracted from highest pixel value (255). Below shows the grayscale image. By inverting the image, the value of the dark pixels will increase and the value of the brighter pixel will decrease, as result we can get the information that we cannot get from the original image.

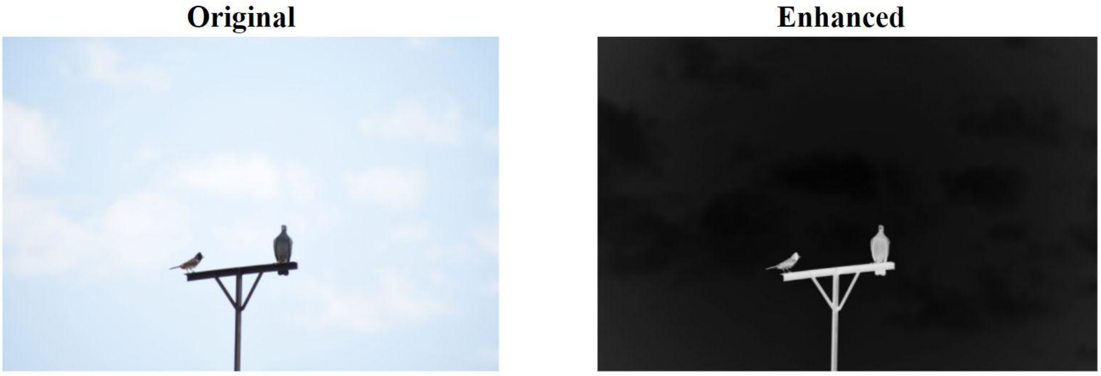

Fig.4 – Original image vs Inverted image

The Fig.5 shows the brightness change of the image. An image must have the right brightness for straightforward viewing. Brightness shows the overall lightness or darkness of the picture. The brightness of an image is defined by the higher gray-scale values. That is, the higher the gray-scale value the higher the brightness of a picture. Thus, the brightness of an image is the higher values of the gray-scale levels

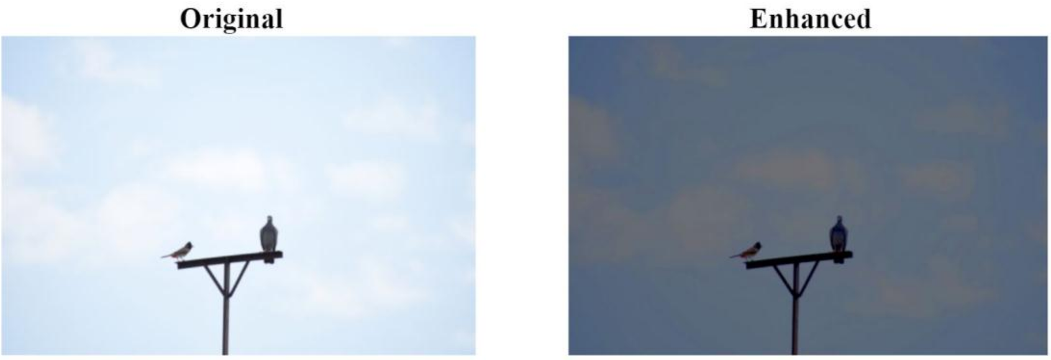

Fig 5– Original image vs Brightness Subtracted image

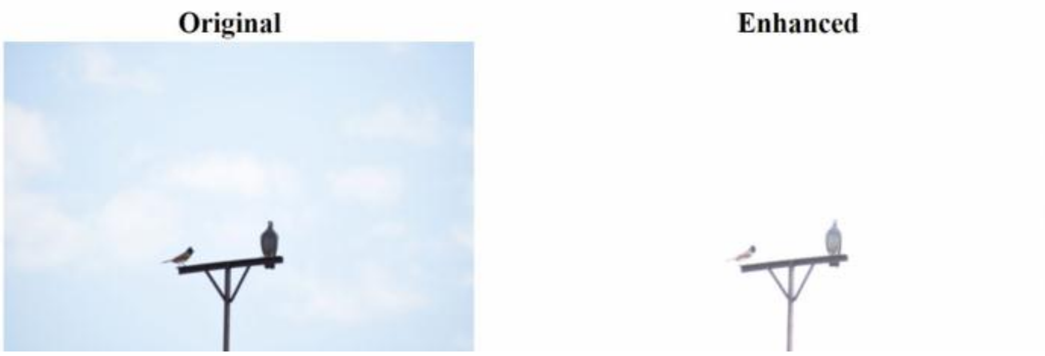

Fig 6– Original image vs Brightness Addition image

V. CONCLUSION

In this study demonstrate the betterment of the VHDL based framework for image enhancement recently portrayed. New arrangement of channels was created at the FPGA level for image enhancement to get the images with the finest quality and to help the health specialists in analysing the medical images. The superiority of this methodology is that the usage at the FPGA level of our framework can prompt a prevalent speed of image processing and don't need a devoted DSP to deal with the images. In order to demonstrate the improvement and recreation of image processing in VHDL were utilized by Xilinx. The more noteworthy capability of this framework lies truth be told that it isn't important to utilize an extra processor committed to image processing.

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