Analysis of different algorithms Involved In Imaged Edge Detection on FPGA

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Abstract: ***Edge detection is one of the generally used operations in image analysis particularly in the areas of feature sketch out. The main aim of edge detection is to put edges by comparing gray level intensity of the image. Various image edge detection algorithms are used for the edge calculation. Hence if the edges are identified correctly in an image then all its objects can be positioned and basic properties such as area, perimeter and shape of an image can be measured. Hence it helps to optimize the area of the VLSI architecture of the given design. The data of edge detection is large enough, so to achievement the high rate of image processing is not easy task. Field Programmable Gate Array (FPGA) can be used to overcome this task and it is an efficient device to realize real-time parallel processing for huge amounts of image and video data.***

Index Terms: *Edge Detection, FPGA Implementation, VLSI Architecture.*

1. INTRODUCTION

An image the two dimensional function of coordinates x and y the amplitude of A at any pair of coordinates(x, y) is called gray level or the intensity of the image at that position. Edge detection is most important tasks in lower level image processing [1]. Proper detection of edges in the image plays a vital role in the recognition of character like image segmentation, object recognition, scene analysis, focused area selection, etc. By using edge detection we can determine where the gray intensity level is high and where it falls.

The main design issue in image edge detection is their real time implementation. Field Programmable Gate Arrays (FPGAs) is used to provide the real time operation and provide flexibility to change the algorithm at the late stage of system development. These features make the FPGAs a suitable choice for real-time implementation of image processing algorithms. Therefore important consideration is to design the algorithm that will to optimize the area of VLSI implantation. FPGA helps to reduce the area and improve the speed of edge detection processing. The paper is organized as follows. In section II various edge detection algorithm are discussed. Section III represents the proposed plan and flow chart of proposed plan. Section IV concludes the paper.

2. EDGE DETECTION

Edges correspond to the pixels at or around which the image values undergo a sharp variation. An edge describes the limitations between different regions in an image, which helps with segmentation and object identification. They can give you an idea about an image where the shadow falls or any other discrete alteration in the intensity of an image. Conventionally, edge detection techniques apply the geometric interpretation of the gradient to an image, expressed as the rate of change of the gray levels in it. Edge detection is the significant part in the field of computer vision. Edge detection is a primary low-level image processing and good edges are necessary for higher level processing. A pixel in a binary image is an edge point if it has black intensity value, a 4-connected neighbour with white intensity value and black intensity value with an 8-connected neighbour ".

Edge recognition hence measures, detect and locate the changes in image gray. When we monitor the target objects, firstly we observe the clearest part in the form of edge and line. According to the edge and line, we can identify the object structure. Hence, edge extraction is an important technique in graphics processing and feature extraction [2].There are many algorithms developed for image edge detection .Some of them are explain below:

- Robert operator
- Prewitt operator
- Sobel operator
- Laplacian of Gaussian
- Canny edge detection

1. Robert Operator

Robert operator is the old and most basic method for detection .It works on the first order derivative. And it uses first order partial derivative to detect the edges in the image. The vertical and horizontal edges bring out individually and then put together for resulting edge detection. The gradient is not shifted in both directions, because of this it is more sensitive to the noise .It uses 2x2

mask to calculate orthogonal derivative and the mask are given below:

1	0
0	-1

Gx

0	1
-1	0

Gy

2. Prewitt Operator

It is the oldest and best method of edge detection in the image. The prewitt edge detection operation is carried out by convolving the original image with a discrete, tiny and integer valued filter in vertical, horizontal along with both diagonals direction. The prewitt edge detection operator is based on first order derivative. It uses the 3x3 mask. The two masks Gx and Gy are as follows:

-1	-1	-1
0	0	0
1	1	1

Gx

-1	0	1
-1	0	1
-1	0	1

Gy

3. Sobel Operator

The Sobel operator is also order edge detector operator. It is the most widely used edge detection technique. Edge detection using Sobel operator is based on the principle of computing approximation of the gradient of the image. The approximation of the gradient is computed by convolving two 3x3 spatial masks with the original image. It calculates the difference between row and column in 3x3 masks among neighbours. The Gx and Gy mask are as follows:

-1	-2	-1
0	0	0
1	2	1

Gx

-1	0	1
-2	0	2
-1	0	1

Gy

The gradient magnitude is computed in the following way:

$$|G| = \sqrt{Gx^2 + Gy^2}$$

4. Laplacian of Gaussian

The Laplacian of Gaussian operator is use for edge detection. The second derivative of an image is computed with the help of Laplacian method. It works on the principle as if we found any step difference in the intensity of the image, then those differences will be represented by using their second derivative by a zero crossing.

5. Canny edge detection

It is mostly used edge detection technique in the today's image processing field. It is multilevel algorithm to compute the multiple edges in the original image [3]. This method operates on very low error and well localization of the edges. The Canny edged detector used the two thresholds to compute the strong and weak edges. It also takes weak edges when they are connected to the strong edges. The steps involve in Canny edge detection are as follows:

i. In the first step, the image is get smooth and noise is get reduced by applying the first order Gradient filter.
ii. In the second step, the Gradient magnitude is calculated by computing the Gradient of neighborhood pixel.
iii. In the third step, the false edges are get diminish by comparing the pixel with it neighborhood pixel in the gradient direction.
iv. The last step is known as thresholding which take the both low and high threshold value that means the pixel whose values are higher and lower than the threshold value are both mark as edges in the image.

3. Literature Survey

As time passes a lot of improvement and work is done on edge detection algorithm to detect edge of an object .The main aim of edge detection is to improve quality (features) of image for human understanding. The edge detection is the part of image processing which is done at very lower level. It is mainly used is object recognition like it, now a day's image processing is used in various field of medical application, for digital aerial image detection from satellite, security, for vehicle no. plate detection etc.

The paper [1] represent how to implement an image processing algorithm applicable to Edge Detection system on FPGA, by using the Sobel edge detection on Virtex -5 FPGA Platforma focus on achieving overall high performance and to minimize the area and process at high speed. The proposed design uses only one processing element for calculating gradients for all three R, G, and B color components and aims at reducing the FPGA resources usages. The paper [2] represents how to implement an image edge detection algorithm using MATLAB. As MATLAB is generally used tool for the edge detection as it is very easy to simulate image processing.The paper [3] carrying out on an image processing algorithm applicable for edge detection of an image in Xilinx Spartan 3 FPGA by using System Generator. Sobel edge detection algorithm is used as it is very efficient and code is written in VHDL language. The hardware is implemented on both Spartan 3 FPGA kit and with other Xilinx Spartan 3 kit.

In paper [4] represents edge detection of the image using the Canny edge detection algorithm implemented on FPGA kit. As Canny edge detection is most efficient edge

detection algorithm as it has better detection and localization of edges in the image. And it also has more number of edges as compared to Sobel edge detection algorithm.

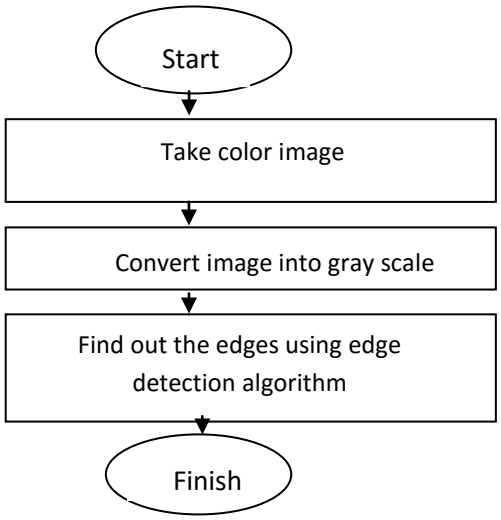
The paper [5] represents optimized area of the implemented hardware. It used Sobel edge detection algorithm, coded in VHDL, simulated in ModelSim, synthesized using Xilinx ISE 10.1 and implemented on Xilinx ML510 (Virtex-5 FX130T) FPGA platform. To realize real-time performance, a parallel architecture is designed, so it uses three processing elements to compute edge maps of R, G, and B color components.

Table 1: Comparison of different techniques used

Sr. No.	Title	Year	Technique used	Advantage
1	Area Optimized FPGA Implementation Of Color Edge Detection	2013	Sobel edge detection algorithm on FPGA platform	Area is optimizes and processing speed is high
2	Study Sobel Edge Detection Effect on the Image Edges Using MATLAB	2014	Sobel edge detection algorithm edge detection using MATLAB	MATLAB is easy tool to use to simulate image process
3	Sobel Edge Detection Implementation using Spartan 3 FPGA and Xilinx System Generator	2015	Sobel edge detection on Spartan 3 and other Xilinx Spartan kit	Area is optimized using Spartan 3
4	Canny Edge Detection Algorithm on FPGA	2015	Canny edge detection	It provides good image detection, clear response and good localization
5	An Enhanced Area Optimized Image Edge Detection Based On Sobel Operator	2014	Sobel edge detection algorithm and Synthesis is done using Xilinx and XSG.	The area is optimized with gradient calculation and the memory module

4. Proposed Plan

The basic thought of edge detection is as to use edge enhancement operator to emphasize the local edges in the resulting image. The propose plan can be understood from the following flow chart:



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The edge detection is carried out according to the following steps:

- Processing of the image to suppress the noise
- Improving quality
- Convert the image into gray scale
- Detection
- Localization

1. Processing Of The Image

The processing of the image includes the smoothing that means to suppress as much as noise without deleting the true edges. This is done by using the various filters.

2. Improving Quality

Improving quality is nothing but the image enhancement by applying it to filter to sharpen the edges of the images.

3. Converting the image into gray scale

Generally gray scaling is grouping of two colours mainly black and white. Where the white color represents the high intensity value and the black color represents the low intensity value. This means that it provides the intensity information in the original image [3].

4. Detection

Computing the edges of the image by using various edge detection algorithms and it helps to determine which edges should be discarded and which should be retained.

5. Localization

This stage helps to determine the exact location of the edge in the image and edge thinning and linking are necessary in this stage.

4. CONCLUSION

Since image edge detection is the technique which is done at the lower level of image processing, hence so we should have the knowledge of various edge detection algorithm used for it. In this paper an attempt is done to analyze the entire image edge detection algorithm implemented on the FPGA based architecture. FPGA helps to implement it in real time application and also it helps to improve the speed of edge detection. Robert Operator is more sensitive to the noise as compared to the others. About Canny edge detection operator, it is more efficient and detects number of edges as compared to the other algorithms but it is more complex method and time required to detect the edges is also more. Sobel operator is less sensitive to the noise. It finds out the thicker edges and also save the high priority information in image.

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