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Implementation of Real Time Motion Extraction by Using Sobel Edge Detector

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Abstract:
In this paper, the sobel edge detection filter using the fpga based design using both software and hardware components is implemented. The image processing is done using the matlab, and sobel edge detector algorithm using fpga. This uses a pipeline method to implement the edge detection of an image. The sobel edge detection(sed) is used to improve the performance by reducing the memory of the image. The 2D image filter is designed using matlab and synthesized by using cyclone II EP2C20F484C7 FPGA device. the power calculations and area efficient architecture is implemented. The Time Quest timing analysis is done using the quartus tool.

Keywords: *Edge Detection, FPGA, Sobel Operator, Image processing.*

1. Introduction

Now-a-days the image processing is mostly used to correct the captured data of an image through the adjustment of the contrast, resolution and the gradient. The real time image processing technique is used in video-surveillance [1], [3], efficient human computer interaction, traffic monitoring and medical image surgery, [1] this image guided surgery is used in neurosurgery and sinus surgery which is a great achievement because of the risks involved in such disturbances or any interferences. The digital image processing technique is used to process the normal image by quantization and sampling [17].

The detection of edge of an image is the important in the image processing to understand the [8] features of an image. the edge of an image contains the significant information or data and the important features in an image [2]. This filters out the less relevant data [4] and uses the data which is important to the edge of an image. so this reduces the memory size of an image. this technique is used to detect the motion detection and [9], [10] object tracking. The number plate of a vehicle also can be detected using this image processing technique. there are many techniques which are useful for edge detection of an image. the canon edge detection, prewitt operator, Roberts operator, sobel operator and kirsch algorithms for edge detection. the sobel edge is having less complexity of all the above techniques.

An edge is an abrupt change in the intensity of pixels, the changing of the image brightness or contrast, [5] normally the boundaries occur in boundaries of two regions. the unnecessary data in the image is neglected and the storing the structured image.

There are many edge types like ramp, sine, step signals. [6] There are many types such as gradient edge detectors and Gaussian based filters. there are certain steps that should be followed for the edge detection of an image they are smoothing, enhancement, detection, localization[7]. the gradient method techniques are of first order derivatives. the local maxima and minima are used in the image detection.

2. Methodology

Sobel Operator

The sobel edge detection technique is based on the 2D spatial gradient measurement of an image [2]. The gradient measurement is the directional change of the image using the intensity or colour of an image. the image gradients are to extract the information from images. the gradients are used to detect the edge. There are white and gray pixels, where we are converting the white image into gray scale image. the white image has the large gradient values. the gray scale image is having the less or small gradient values.

The sobel edge detector is a slow process when compared to Roberts cross operator, but large convolution kernel smooths the input image to a greater extent, which makes less sensitive to noise.

The thresholding is used to eliminate the noise from images while retaining the important edges. in sobel algorithm to supress the noise, the weight induced on the center of a pixel [4], [2].

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

L_x= Vertical mask (1)

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

L_y = Horizontal mask (2)

For each orientation the algorithm takes 3*3 matrix. The magnitude vector can be defined as

$$L(x,y)=[L_X^2+L_Y^2]^{1/2}$$

$$|L|=\sqrt{L_x}^2+\sqrt{L_y}^2$$

The input of a horizontal mask (2) and the vertical mask (1) of a convolution image is shown above

The size of a gradient can be calculated by gradient vectors as shown in the equation 3. The equation can be approximated by

$$L(x,y)=|L_x|+|L_Y| \quad (3)$$

When we are using sobel operator, for detecting an edge of an image, we have to use the

Horizontal and vertical mask for convolution of an image, and we get same size of an original image

Gradients, then we can get the value of L by adding the two gradient matrices. and to get the edge we are applying the threshold. If the L value is greater than the threshold, then it is selected as edge.

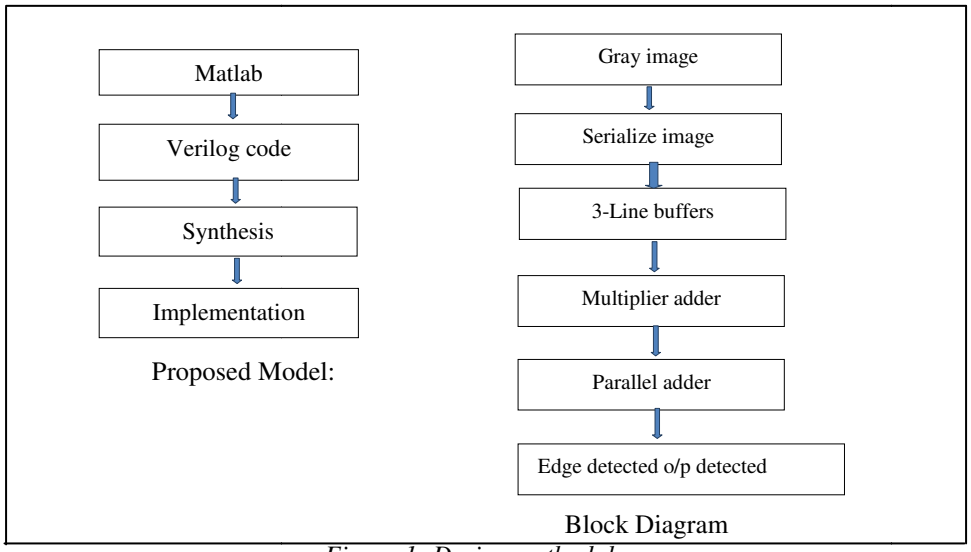

Figure 1: Design methodology

This sobel edge detection is implemented using 2d filter horizontal and vertical convolution. The RGB data is converted into gray scale and this is multiplied with 0 degree and 90-degree kernel of sobel. For the convolution we are using 3-line buffer each of size 256 pixel, each pixel contains 8-bitdata, which is shifted for clock cycle. The 3 line buffers are nothing but the shift registers, the multipliers $X_1$to$X_9$are coefficients of matrix Lx, and parallel adders P_1toP_9 are to store the values of pixel, this is an8-bit register. the 8 bit signed multipliers are used to multiple signed constants such as -1, -2 and -1. The data is shifted by byte by byte and gets multiplied with the constant weight of the gradient. the parallel adder adds the result for total gradient calculation. the same process is continued using square root module.

The matlab is used to detect edge of an image of 256*256-pixelimage [. the original image is having the size of 143 kilobytes, where it is converted to gray scale image the size is reduced to 86 kb. the image is reduced the size when it is converted to gray scale image, the gray image is converted to edge detection image, where the size of an image immensely reduces to 8.24 kb. we can clearly see the reduction of size of an image using sobel edge detector. The input pixels are taken and it is synthesized in the FPGA using sobel edge detector.

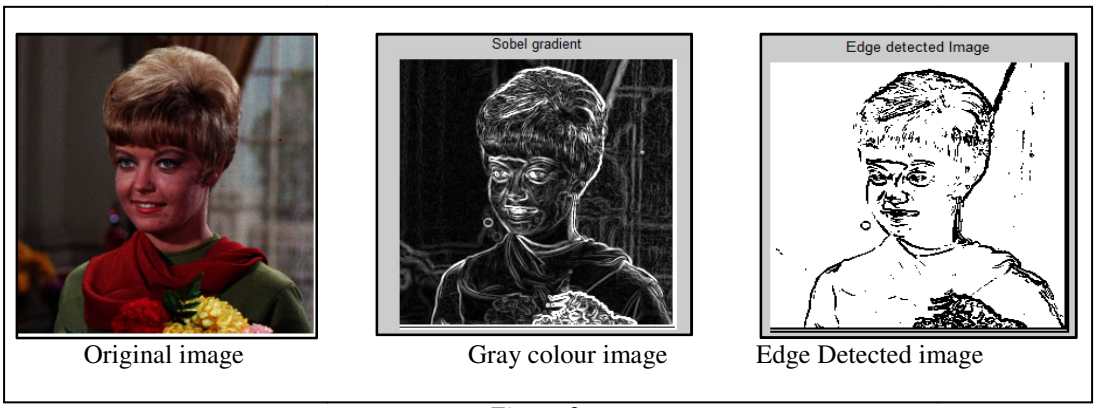

Figure 2

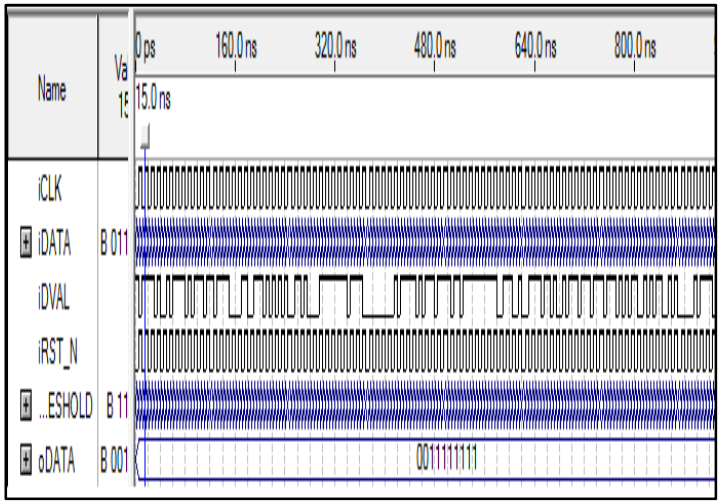

Figure 3: WAVE FORM Output

Pixel	256*256	96*96	640*480	640*480
Board used	DE2-115 Altera	DE2-70 Altera		
Type of FPGA	Altera Cyclone II	Altera Cyclone II	Vertex 5	Spartan 6
Logic Elements	614	16,443	623	469
Used Memory	15,312	646,736	13,03	1200
Clock	57Mhz	54,18 Mhz	40 Mhz	48Mhz

Table 1

The Time quest timing analysis is done using the quartus tool, the values are given below in the table, thwe worst path and the minimum path is given for slack time, the hold time caluclations is also given below.

Slack time	2.064
Hold time	0.620
Clock freq	57 mhz
RR paths (iclk to iclk)	8358343
Sdc period	1.000
Worst slack	-16.510

Table 2

4. Acknowledgment
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5. Conclusion
The process of sobel edge detection is done by using the Quartus II based cyclone II EP2C20F484C7 FPGA device. it is operated using matlab for edge detection. the memory is reduced. the cost is reduced due to the less utilisation of the hardware.

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