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Area Optimized VLSI Implementation for Color Image Edge Detection

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Abstract: Mathematical structure study is recognized as signal processing method and image. Mostly tools such Matlab is suited for image processing. Now the image processing technique is used may field. Image compression by using image edge detection method is used mainly to reduce the memory requirement.Important terminology in image processing is edge detection in computer vision. It is in the front position of image processing for object detection, so it is crucial to have a good understanding of edge detection operators. In the present work, relative analyses of various edge detection techniques in image processing are presented.

Index Terms: Color Edge Detection; FPGA Implementation, Edge Detection.

I. INTRODUCTION

There are numerous edge detection techniques existing for object boundary extraction and segmentation of digital images. Detection of edges [1-2] is a basic difficulty image processing and computer vision. It has been a main regarding issue for the researchers. The principle of segmentation of image is to divide an image into significant regions with respect to exacting application where in digital images; edges are areas with strong intensity contrasts. The intensity from one pixel to the neighbouring pixel can form main deviation in the picture excellence and segmentation of image. For image processing systems and computer vision, first it should be able to detect the all possible edges in the image [8-11]. Each edge detecting operating technique is planned to be sensitive to definite edges. Prewitt, Roberts, LOG, Sobel and Canny are major relating to operators. The most sensitive to edges in the images is determined by the geometry of the operator.

In image segmentation the occurrence of noise makes a trouble. Gaussian noise, Rayleigh noise, Impulse noise and Speckle noise such types of noise in images are very much prone to affect.

Generally the edges of the image are changed of the confined pixel values. So by the calculating local differential operator image edge detection is usually implemented. Color image edge detection and its implementation are based on gray image edge detection. For this first is to convert color image into gray image.

After on local differential operator is used to detect the gray edges. This affects the degree of color image because of edge information lost its color information. Due to this subsequent processing of color image to be unavoidably is affected. Therefore the difficulty in color image edge detection is to be understood.

The edge detection method is very important in the human organs detection. Also it is an important pre-processing for segmentation of image. The border line between two regions with comparatively different gray level properties is known as edge. An edge is a set of connected pixels that appear on the boundary between two regions [3]. Detection of edges in the an image is a terms in image related to the image processing field, particularly in the areas for extraction of features , to consign to algorithms whose aim is to identify the image brightness changes abruptly at the point in image .

In this paper, how the edge detection is done and how it works is proposed. And the paper the sobel edge detection method is explain, which is for the color image edge detection .The paper gives the complete idea about how the area is optimizing by using sobel edge detection technique.

The remaining parts of paper are organized as below. Algorithm based on color edge detection in section II, proposed architecture in segment III, edge detection algorithm in segment IV, RGB model color image edge detection method in segment V, result in segment VI and conclusion in segment VII.

II. ALGORITHM BASED ON COLOR EDGE DETECTION

The Sobel edge detection technique is edge detector operator. It is the extensively used edge detection method. Principle of Sobel edge detection operator is based on the calculating approximation of the gradient of the given image. The approximation of the gradient is computed by convolving two 3x3 spatial masks with the original image. By using the difference between row and column in 3x3 masks among neighbours is calculated. The two masks namely Gx and Gy are as follows:

$$Hx = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix} \quad \text{---------- (1)}$$

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$$Hy = \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix} \quad \text{---------- (2)}$$

The components of gradient across the adjacent lines or columns, is calculated by using above two filter components. As the gradient magnitude which is also defined as the local edge strength and it is given as follows:-

$$GM = \sqrt{Hx^2 + Hy^2} \quad \text{---------- (3)}$$

The equation (3) is costly for every pixel to calculating Square and square root operations. It is more suitable computationally to estimate the square and square root operations by absolute values.
This above equation is used for each color channel separately and hence by fusing the edge maps of each color channel, finally color edge map of color image is computed [1].

Color Edge = (Edge R or Edge G or Edge B) --------- (4)

III. PROPOSED ARCHITECTURE

The implemented system for given architecture and data flow diagram is given in Fig.1.

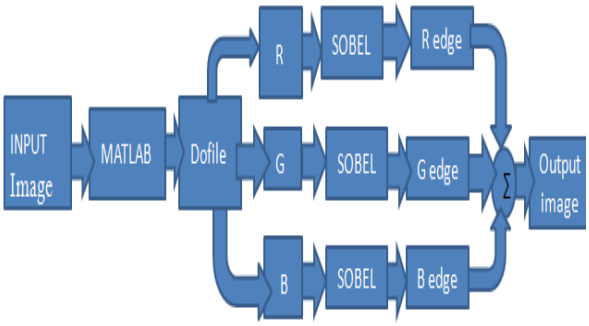

Fig.1. Complete system Block Diagram

Working of above proposed architecture is as follows:-

1) A static color image of size 128x128 is taken as input for given architecture. It is changed into 1D pixel values using the pre-processing block using Matlab.
2) The image pixel values are calculated by the Matlab and form the dofile of it.
3) In the next step the further programming is done in ModelSim and in this we use the dofile which is generated by the Matlab.
4) Then the R edge, G edge, B edge pixel values are calculated and hence we get the output text file with the fusion of R, G and B edge.
5) And finally, the output of ModelSim i.e. the text file that contains the pixel values of R, G, B are paste into the Matlab output window.
6) And by using some Matlab instruction we get final out that is original image and the image with the edges of R, G and B color.

IV.EDGE DETECTION ALGORITHM

The edge detection algorithm work as follows:

Step 1: Image filtering:
Usually noisy image edge detection has some incorrect information of edges. This is happen because the calculation of derivative is extremely sensitive to noisy pixel. Mainly basic filters can reduce noise level and drop a quantity of edge level. Hence for the guarantee to detect more edges moderate noise reduction should be done.
Step 2: Image enhancement:
To determine the changes in the image at each point of neighborhood pixel values is the basic principal of image enhancement technique. Hence by calculating the gradient amplitude edge enhancement is generally able.
Step 3: Edge detection:
There are several pixels in the image that has large gradient amplitude. But all pixels are not taken as edge pixels. Hence to determine the pixel which has to be taken account for the edge pixel gradient amplitude threshold is applied
Step 4: Edge location:
On sub pixel resolution ratio, edge direction and position may be estimated during some employing situation.

On the color representation the color image edge detection depends and color component decomposition process depends on following steps:
Step1: The color image is decomposed into three color component
Step 2: Then calculate and detect the edges of three color component
Step 3: Color image edge is composed by the component edge.

The following example shows the edge detection of method based on HIS and how it will be done:
Step1: To obtain the HIS model the RGB model is converted into it and further it decomposed the color image into module H, module S and module I.
Step 2: After that, the edge of the three components is detected.
Step 3: Create the module edge to color image edge.
Step 4: Finally, the HIS model is transform into RGB model.

V.RGB MODEL COLOR IMAGE EDGE DETECTION METHOD

The following section presents the color model with three components on the color image contrast enhancement method is based. Its requirement is to obtain RGB color table and the RGB color value. The kernel idea is to create non lineal function for pixel operation process.

The first step is to get the value r of red color component, the value g of green color component and the value b blue color component. The deviation or the dissimilarity of the highest value Max (r, g, b) and the least value Min (r, g, b

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） is denoted as D. The median value denoted as M, the highest value Max（r, g, b) and the normalized gray value of GRAY (r,g,b）are calculated. The formula can be given as:

$$GRAY(r, g, b) = a1\times r+a2\times g+a3\times b \text{--------- (5)}$$

Where 0< a1, a2, a3<1 and a1+a2+a3=1
The enhancement coefficient K can be given as:-

$$\left.\begin{array}{l} R1=K\times r; \\ G1=K\times g; \\ B1=K\times b \end{array}\right\} \quad (6)$$

Where K= Gray (r, g, b)/M
If, K=Max (r,g,b) >2n-1, then enhancement coefficient k is not dependable .
K must be supposed a gain, Max (r,g,b)is the highest of r, g, b then the valve of red, green and blue component can be reorganized as:

$$R1=K\times r;\ G1=K\times g;\ B1=K\times b \text{---- (7)}$$

The algorithm for component contrast is given as follows:
Algorithm R1G1B1 = color enhance (RGB)

Input:
Input of this algorithm is RGB image having each component of color is given as n bit and the value of color is in the range of [0, 2n-1].
Output:
Output image is in the form of R1G1B1with contrast enhancement.

Stepwise evaluation of component contrast algorithm is given below:-
Step1:
Initialization:
Let coefficient of contrast is K=1 and let the difference between the Max and Min value of (r,g,b) is given as D.
Step2:
Computation of Color components:
In this step the component value of Red, Green and blue color is evaluated for every pixel value P.
Step3:
If Max (r,g,b)-Min(r,g,b) < D, then M is the median value M=Median (r,g,b) and K is normalized GRAY(r,g,b) of p
Hence, the median value coefficient of proportionality of (r,g,b)K= GRAY(r,g,b)/ M ,
Else
Jump to step 5.
Step 4:
Check if,
K× Max (r,g,b) > 255, the maximum of component is given as:
Max(r,g,b), K GRAY (M) / Max(r,g,b), R1=K×r,

$$G1=K\times g,\ B1=K\times b. \text{---------- (8)}$$

Step 5: Check if p is the last pixel, then move to step 6,else return to step 2.

Step 6:
Image R1G1B1 is the resultant output

The method of the enhanced edge detection of color image is based on color model of RGB which is stated as follows:
Step1: In this step the color image is separated into R component, G component, B component.
Step2: Then the algorithm of color enhance is called.
Step 3: According to the gradient operator the component edge has to detect.
Step4: Finally, there is composition of color edge.

VI. SIMULATION RESULT AND ANALYSIS

The given whole proposed architecture is coded in VHDL. All simulations are carried out using MATLAB R2013b ModelSim SE.3f. Synthesis is done using Xilinx ISE 9.2.1. The initial the input is simulated in Matlab and next is done in ModelSim .The out is got in Matlab. The result obtained is as follows:-

```
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(116) 01001110 0
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(117) 01011101 0
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(118) 01100111 0
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(119) 01100011 0
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(120) 01010010 0
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(121) 01000001 0
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(122) 00111101 0
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(123) 01000001 0
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(124) 01010111 0
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(125) 01101010 0
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(126) 01101111 0
force -freeze sim:/E_SobelColor/s_input_memory_b(127)(127) 01110011 0

Done
```

Fig. 2: Simulation result of input image in Matlab

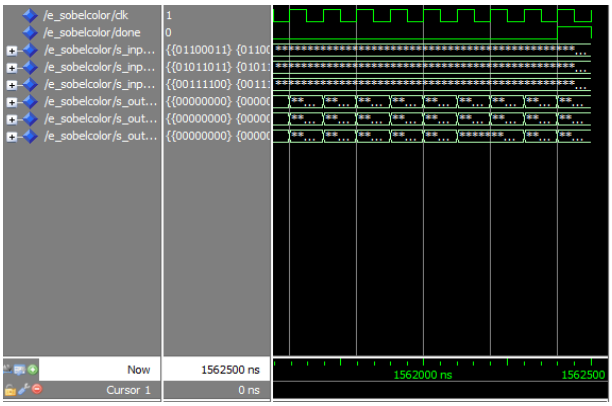

Fig. 3: Output result of ModelSim after simulation of RGB input data with sobel edge detection algorithm

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Fig. 4: Final output processed Image

VII. CONCLUSION

The given proposed VLSI architecture for color edge detection that aims for reduction in the FPGA resource usage. Experimental tests and synthesis result have proved the correctness and effectiveness of the proposed architecture approach. The choice of Sobel edge detection algorithm over the other edge detection algorithm is because it is less sensitive to noise and find out the save thicker edge and save the high priority information in image which helps to identify the object. While about the more efficient and detects number of edges as compared to the other algorithm detection algorithm is the Canny edge but it requires more time to detect the edges and it is too complex method.

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