

Comparison of edge detectors on FPGA SoC system

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Abstract. This paper explain that comparison of edge detectors used widely in video processing. The mentioned edge detectors are Sobel, Prewitt and Roberts. SoC (System on Chip) is selected for performance analysis of above edge detectors. SoC systems are suitable for video processing and its application which has both CPU and FPGA cores. In this study, firstly, real time video is received by the usb webcam into CPU part of the SoC system. This is simple than other FPGA system which has only FPGA core. Because, CPU part of the SoC system doesn't require any special hardware to get video frame into system. CPU is running linaro operating system which is developed using linux for SoC systems. Secondly, received video frame is processed by FPGA core part of the system which has built in design for related edge detector. Finally, processed video frame is displayed on monitor. Edge detectors are compared about fps and quality of the edges.

Keywords: video processing, edge detectors, fpga, soc.

1 INTRODUCTION

This document shows the performance analysis of edge detectors in video processing using new SoC FPGA system. The FPGA SoC system has CPU and FPGA core which is designed for edge detection processing. Edge detectors are compared in edge quality and fps performance.

1.1 Target system

A new approach FPGA system is called SoC FPGA. SoC stands for system on chip. SoC FPGA system are useful for video processing because their structure which is designed for fast prototyping. Zedboard is used for this study

2 EDGE DETECTION

Edge detection is used in image processing to get feature extraction. In this study, Sobel, Prewitt and Roberts are used to compare each other.

2.1 Sobel edge detector

Sobel edge detection algorithm is popular to get feature extraction. Sobel algorithm is filter which is applied to source image. Sobel filter has two component which are horizontal and vertical filters to get horizontal and vertical edges. Sobel horizontal filter is

$$G_x = \begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} * I, \quad (1)$$

where I is the source image and G_x is result image. The vertical filter is,

$$G_y = \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix} * I, \quad (2)$$

where I is the source image and G_y is result image.

Finally, gradient is calculated and to compare threshold value every pixel in result image to detect edges.

2.2 Prewitt edge detector

Prewitt edge detection process is similar to Sobel but, applied filter values are different. Prewitt horizontal filter is

$$G_x = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix} * I, \quad (3)$$

where I is the source image frame and G_x is result image frame. The vertical filter is,

$$G_y = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix} * I, \quad (4)$$

where I is the source image frame and G_y is result image frame. After get the final image frame which is convolved, determine the edges using threshold.

2.3 Roberts edge detector

Roberts detector use filters as Sobel and Prewitt but its filters are diagonal. Diagonal filters are the better choice than Sobel and Prewitt filters in order to get diagonal edges. Roberts filters are

$$G_x = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} * I, \quad G_y = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix} * I, \quad (5)$$

where I is the source image frame and G_x and G_y are result images which are determined using different filter which has a diagonal direction. Roberts detectors also use threshold to get edge in applied filter image.

3 FPGA SOC SYSTEM

The new approach FPGA SoC systems are used in industrial application because their fast prototyping features. The new FPGA SoC system has two cores. One of them is a CPU and the other one is an FPGA core. A CPU part of the system has operating system which is based linux linaro system.

Linaro system is developed for SoC system to prepare prototype easily. The CPU part which has linaro system has advantages. System doesn't require any special hardware for many applications. For example, a classical FPGA system want peripheral device to get real time video frame into system. On the other hand, a SoC system use simple webcam to get frame easily.

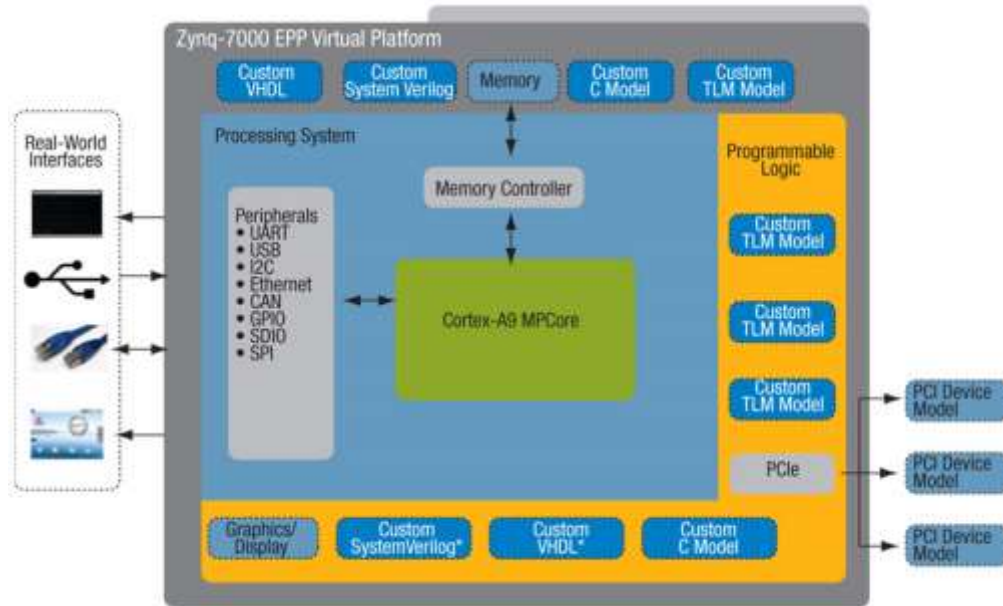


Fig. 1. Zynq-7000 FPGA SoC system

Fig. 1 shows an FPGA SoC system which has processing system, programmable logic and attachable peripherals which can be a monitor, an usb devices and so on.

4 EXPERIMENTAL RESULTS

4.1 Setup

In this study, development base is selected as Zedboard from Digilent which has Xilinx FPGA core Zynq-7000 and dual core ARM processor. ARM processor which has linaro operating system is used to get real time video frame by means of usb webcam.

4.2 Results

Fig. 2 and Fig. 3 demonstrate results of the experiment.

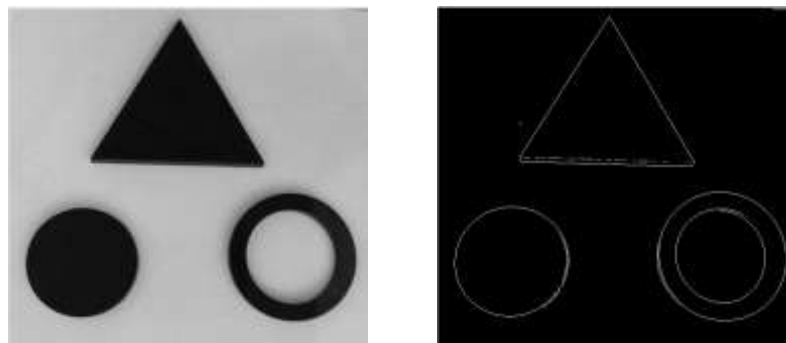


Fig. 2. Original image and sobel filter

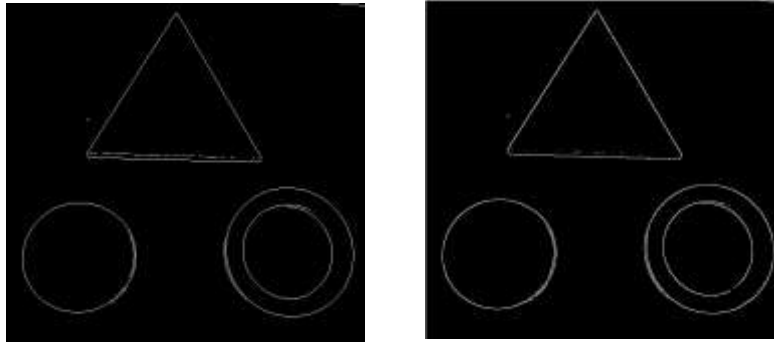


Fig. 3. Prewitt and Roberts filters

When Fig. 2. and Fig. 3. are examined, Sobel and Prewitt edge detectors are better than Roberts edge detectors to extract horizontal and vertical edges. On the other hand, Roberts edge detectors fine to find diagonal edges.

Performance analysis of the edge detectors on the FPGA SoC system are compared in fps. Fps rates of the edge detectors are showed in Table 1.

Table 1. Comparison of the edge detectors

	Sobel	Prewitt	Roberts
FPS	18,86	19,54	24,03
Resolution	320x240	320x240	320x240

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