STUDY OF DYNAMIC OBJECTS IN THERMAL IMAGES ON FPGA

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Abstract: This paper presents the advantages of the FPGA platform for real-time imaging thermal imaging algorithms to prevent emergency situations in energy and heat systems. The project uses a color to detect dynamic objects in thermal images. The results of the analysis were confirmed by computer simulation and good coincidence was obtained with the experimental results.

Keywords: FPGA, thermal images, digital image processing, VHDL, Verilog

1. Introduction

The image processing is a common practice in many areas. Most commonly run with general purpose processors, but bits and pixels are bulky, the processing software faces productivity problems. In this case, the advantages of FPGA come to the fore. Here the processing speed is one of the most important features. Because of the parallel computing architecture, the processing operations perform everything [1].

The thermal camera captures the heat radiated in the infrared range of the electromagnetic spectrum from objects invisible to the human eye. Differences in infrared radiation are represented by colors to interpret temperature differences. In the order of the statement follows that as a typical application the algorithm can be used to detect people.

2. The FPGA digital system

The design of FPGA system used the color by object detection in the thermal image.

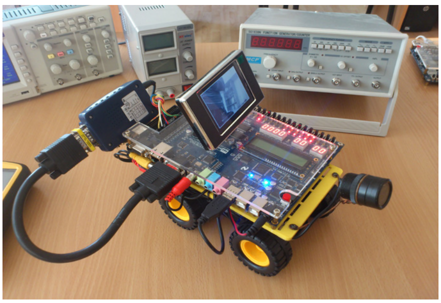

Fig.1 The Altera De2 FPGA system

For research purposes, the FPGA Altera DE2 development board was used as a digital mobile system, as in the Fig.1 [2]. The TV block detects thermal objects and motion, receiving RGB signals at the input , as shown in Fig.2 [3] .

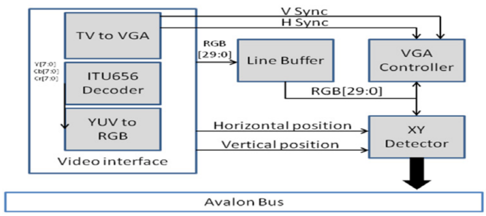

Fig.2. Video Interface and Avalon Bus

The digital image processing is performed to detect red pixels and the resulting image is transmitted to a VGA controller, in our experiment, shown in fig.3.

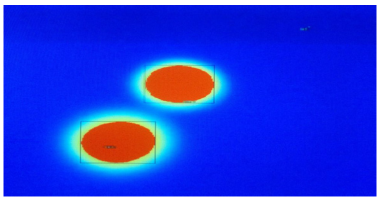

Fig.3 Detection of objects

In the software code, color values can be changed to find the desired colors. It should be emphasized that it is the different colors that represent the different temperature ranges. For example, the blue color shows the coldest areas, red indicates the hottest areas, and the yellow shows the average temperature areas. Activating the SW 0 switch (log.0) from the bordeaux starts the search process.

Fig. 4 The Object Detection Process.

The figure 4 shows the detected objects successfully [4]. The algorithm starts with the detection of pixels of the desired color, respectively follows the receipt of the coordinates of the starting point that are stored and thus identifies the upper limit of the formal contours of the object. The following open pixels in the image give the left, right, and lower borders. Edge points are marked as a square around the object. In each frame, the square is updated. By activating the switch SW1, the motion detection process is started and the parameters are determined. After identifying the objects, you should compare the positions of the envelopes in successive frames [5]. Changes in the center of the square indicate the orientation of the object on the white field, as shown in Fig.5.

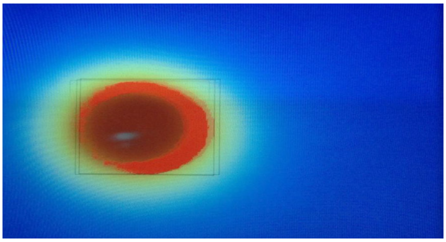

Fig.5 Movement of thermal object.

The motion detection process can be applied to only one object or group of objects. To fine-tune the color-based motion and object detection algorithm, the range of color gamut should be carefully selected, as well as improving the contrast of the color image. The experimentally received Y signal is a copy of the image in the gray scale.

In DE2 board, the TV encoder provides an 8 bit Y signal, so the improvement in the gray scale depends on the number of bits. In this case, at least 2 significant bits must be added to the Y signal for the new contrast. Such an algorithm is used to improve the gray scale contrast for YCbCr. First, the histogram is stretched to eliminate the narrowing of the image from the range of the camera to the gray scale, and then the curvilinear law contrast represented by Figure 6 is applied [6].

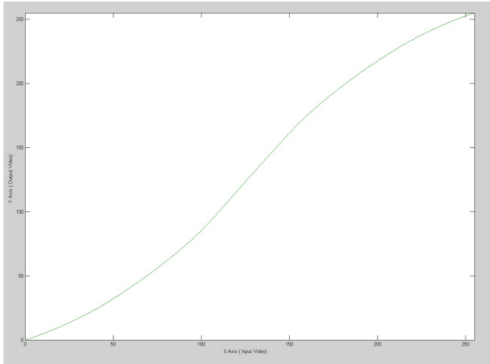

Fig. 6 Curve of high brightness and contrast.

By switching SW 0, it is possible to stretch the image and then, by switching SW 1, apply a high contrast according to the law of the presented curve. By swapping SW 5 a screen split is obtained so that the modified image can be seen on the right and the original image is left. The effect clearly shows that the modified image is much better than the original image. After adjusting the curve law in the brightness channel, the colors also improve. These functions are activated with SW2 and SW3 and the results can be seen in figure 7.

Fig.7 Applying the Brightness Curve

3. Digital Image Processing

Figure 8 shows the blocks of the digital processing structure [5].

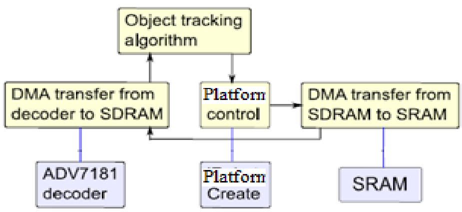

Fig. 8. Structure of the digital system

A. Eliminating Noise

The noised pixels have an abnormal values compared to their neighbors [6]. The salt / pepper type can be represented as bright pixels in dark areas and dark pixels in bright areas. The errors of analog-to-digital conversion and the presence of dead pixels on the sensor may be such a cause. An averaging filter is most commonly used to remove it.

B. The median filter

To determine the average value, the pixel values are arranged in ascending order relative to the value of the pixels selected in the middle. Media filtering uses several blocks to compare. Two blocks have been developed for the experiment. The first detects the salt / pepper noise, and the second block removes it with averaging filters [6], as shown in Fig. 9 .

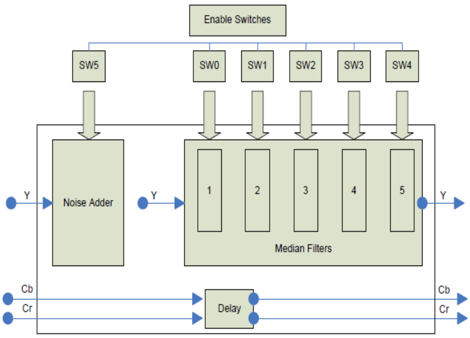

Fig.9 Noise removal system

For median filtering on the image, the pixels of any coordinate line and its neighbors should be available. Buffer registers of 640 pixels are used, which store 3 lines at once and give access to all adjacent pixels for processing. Instead of transmitting b2 pixels to the monitor, the median filter calculates an averaged value between a1, a2, a3, b1, b2, b3, c1, c2, and c3 pixels, and the median value replaces b2. As there is no color treatment here, just the color signals slow down with time delay.

C. Edge Detection

For edge detection pixel values below a set threshold value are converted to 0 and the other to 255. A block diagram of the detection objects [6] is shown in Figure 10.

The detection block receives 10 bit RGB signals and after RGB conversion to the gray scale, the signal is sent in a three-row buffer that is sufficient for the processing. Calculate the Sobel operator for horizontal and vertical edges, and the SW keys reconfigure the system.

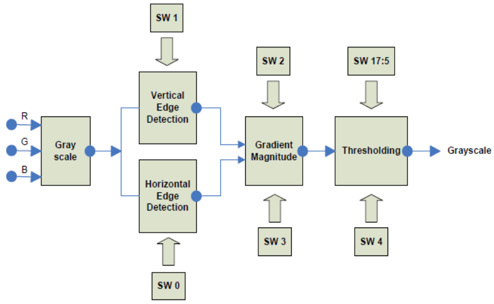

Fig. 10 Block diagram of the boundary detector.

D. Motion detection

The differentiation is a common motion detection technique, with the camera static to the moving objects. Figure 11 shows the block diagram of the motion detection algorithm.

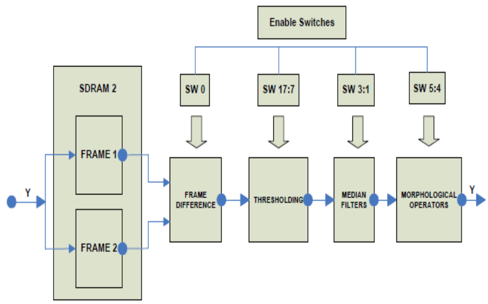

Fig.11 Motion Detector Blocks

The algorithm uses a second SDRAM from the DE2 board. Successive frames in gray are stored and if SW0 is active, the absolute difference between the frames is calculated, and if SW0 is not active, the original gamma is gray and the output frames are transmitted to a VGA monitor [5].The RTL design of the digital image processing system is shown in Fig.12.

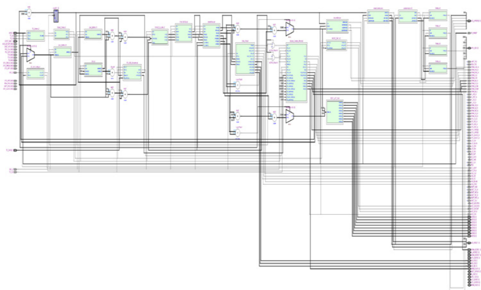

Fig 12. RTL design of the TV system in Quartus II

After adjusting the threshold value with SW 17 to SW 7, the noise is removed and remains a useful part of the moving object. At too high a threshold, the moving object may be lost. Then, if the noise still exists, use the SW1-SW3 medium shift filters. Operators for morphological expansion and erosion are activated with SW4 and SW5. An algorithm for detecting moving objects [7] with background subtraction in our experiment, presented in Fig.13.

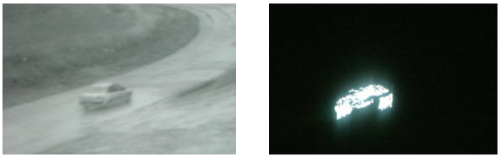

Fig.13 Detection of a moving object

The development project use a source code in C + and languages for hardware description VHDL and VERILOG, environment for the SAP Quartus 9.1 and Altera IP NiOS II [8] .

4. Conclusions

The results show that the designed algorithms work reliably. The image processing methods used today with their mathematical models can be implemented as FPGA hardware. This allows digital image processing to be done not in machine but in real time.

5. Reference

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