Intelligent Driving Detection System Based on unmanned Driving Background

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Abstract. Unmanned driving is the future development direction of the automobile industry, and intelligent driving detection is one of the important research topics. In order to improve driverless technology and traffic safety, this design is based on FPGA technology to design a driving detection system, combined with off-chip SDRAM’s high-speed, large-capacity cache and image processing related algorithms, and it will achieve the function of acquiring target image, cache, detection and display. Finally, the FPGA development board is used to test the driving detection system, which demonstrates that this driving detection system can better improve the safety monitoring problems in unmanned driving. At the same time, the system’s frame rate is close to 55fps, which has practical significance and application value.

1. Introduction

With the rapid development of artificial intelligence and unmanned driving, unmanned driving systems and intelligent traffic control systems have been widely used in transportation, medical and other fields[1]. In daily traffic, the intelligent driving detection system is an important part of the driverless field[2,3]. Intelligent vehicle detection that uses image processing, pattern recognition and visual technology, increased in the monitoring and control system for for intelligent detection analysis module[4]. With the aid of computer powerful data processing ability of filtering useless video screen, automatic identification of moving object, judging monitoring images of the abnormal situation, so as to advance warning effectively, make handling of the affair[5]. At the same time, the driverless car must be monitored and be able to be switched to manual driving mode at any time, which can effectively control the speed and direction of the vehicle in emergency situations and avoid traffic accidents[6,7].

In this context, this article develops an intelligent driving detection system for unmanned driving based on FPGA chips[8]. It uses the characteristics of FPGA parallel computing efficiency and low hardware cost to perceive the surrounding vehicles, so as to avoid and deal with obstacles quickly and accurately, reduce the probability of accidents greatly, and ensure the safety of people’s lives and property. In the current era, it has great development significance and research value[9,10].

2. Implementation of Intelligent Driving Detection System

The FPGA-based intelligent driving detection system adopts a top-down design idea, and the system is roughly divided into four modules, which includes CMOS video image acquisition module, SDRAM memory module, FPGA image processing module and VGA display module[11,12]. Firstly, the OV5640 CMOS camera is controlled by the FPGA core to capture the video data stream in real time, and the grayscale image is obtained after image preprocessing, which is subjected to median filtering...
and Sobel edge detection, and then cached in the SDRAM memory. Secondly, the SDRAM is read through the control of the SDRAM, the two adjacent frames of images in the memory are sent to the target detection module to perform inter-frame difference processing on the adjacent two frames of images, and one frame of image data is corroded and expanded in a parallel manner. Finally, VGA display of the video images and moving target detection are realized. The overall system frame diagram is shown in Figure 1.

Figure 1. Block diagram of the driving detection system

3. Simulation Analysis and Realization of Intelligent Driving Detection System

3.1. Image acquisition module simulation

For the image acquisition module, the Testbench simulation program is written to simulate and verify it on the modelsim software. In order to better observe the simulation results and analysis, effective pixels were set as 12 rows and 8 columns in the simulation of image acquisition. Figure 2 shows a partial enlarged view of the CMOS image acquisition module.

Figure 2. A partial enlarged view of the simulation of the CMOS image acquisition module

It can be seen from the simulation waveform Figure 2, when cam_href is low, the data of cam_data remains unchanged, and coms_frame_data does not output valid data. when cam_href is high, the coms_frame_valid signal starts to change periodically. Cam_data starts to input valid values. after two clocks cycle, coms_frame_data starts to output valid data. The 8-bit data of two cmos_data in each row were converted into 16-bit data in cmos_frame_data, and the data mosaic in RGB565 format was completed. The image acquisition module was successfully implemented.

3.2. Sobel edge detection module simulation

For the Sobel edge detection module, the Testbench simulation program is written to simulate and verify it on the Modelsim software. In order to better observe the simulation results and analysis, effective pixels were set as 12 rows and 8 columns in the simulation of Sobel edge detection. Figure 3 shows a partial enlarged view of Sobel edge detection.
Figure 3. A partial enlarged view of Sobel edge detection simulation

It can be seen from the simulation waveform Figure 3, the data in the first row, second row and third row were set to 173, 237, 45; 175, 239, 47; 177, 241, 49. this design sets the threshold Sobel_Threshold of 250, which obtains the values of Gx_tmp1, Gx_tmp2, Gy_tmp1, Gy_tmp2 after one clock cycle, and then obtains the values of Gx_data and Gy_data after one clock cycle. When the third rising edge of the clock arrives, the value of Dim (that is, Gxy) is 512. Compared with the preset threshold of 250, the result post_img_bit is 1, which is consistent with the actual value. This results show that Sobel edge detection algorithm is correct.

4. Hardware test of driving inspection system

4.1. System simulation test

The simulation verification of this design will play the driving video through the computer to achieve the simulation effect. The monitored video results and processed driving video images are shown in Figures 4 and 5.

Figure 4. Driving video image before processing

Figure 5. The processed video image of driving

It can be seen from Figure 5 that the results processed by the driving detection system can better verify the realization of the driving detection function, and have better practicability for driverless driving detection.

4.2. System hardware test

After comprehensive compilation, the project is downloaded to the development board, and the camera is used to monitor the traffic on the road in real time during the day and night. The monitored and processed traffic images are shown in Figures 6, 7, 8 and 9.
Figure 6. Snapshot images of driving during the day

Figure 7. The driving image processed by the daytime driving detection system

Figure 8. Snapshot images of driving at night

(a) (b)

Figure 9. The driving image processed by the night driving detection system

It can be seen from Figures 7 and 9, that this driving detection system can realize the driverless driving detection function during the day and night. However, due to the low pixels of the camera and the influence of the weather, the detection image is blurred, but the detection function of unmanned driving can be realized overall. As it can be seen from the test, a mirror image will appear after the image is processed by the system since there is water on the ground in rainy days (Figure 9(b)). In the daytime, the low camera pixel of the camera reduces the definition of the original image, resulting in the double image of the detected image (Figure 7). At night, due to the influence of the camera pixels and the lights, part of the information of the detected vehicle is lost, and the driving test result is not very clear (Figure 9(a)).

5. Conclusions
This paper mainly designed a kind of driving detection system with FPGA as the core, which improved the calculation speed by using the characteristics of FPGA parallel structure. Combined with edge detection and frame difference image processing, realizing the driving detection on VGA. The system has good practicability, it can improve the safety index of unmanned driving in life, improve the problems which exists in intelligent transportation.

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