Research on CCD High-speed Data Acquisition and Computer Simulation Processing System Controlled by Single Chip Microcomputer

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Abstract. CCD (charge-coupled device) is a unique performance of the semiconductor photoelectric device, CCD technology applied to displacement, thickness and other geometric measurement, can achieve high precision, online dynamic detection and non-contact measurement requirements. This system USES the method of combining FPGA and single chip microcomputer to measure the thickness of the object using CCD as the sensor. In this design, the CCD driver pulse circuit, control logic and calculation circuit are all integrated in FPGA chip, thus improving the reliability of the system and creating conditions for the system integration. External display and control circuits such as liquid crystal display, keyboard and EEPROM memory are designed by SCM. The whole system embodies the characteristics of high integration, simple structure and superior performance. This paper introduces the principle, design and implementation of the system in detail.

Keywords: Charge-coupled Devices, Laser Triangulation, Field Programmable, Single Chip Microcomputer

1. Introduction

CCD device of the output signal is more special, TCD1501D to Toshiba production under the linear CCD device as an example, its output signal in terms of its amplitude is analog signal and its amplitude can reflect the each pixel unit by light induced charge after how many, they should be analogue, at the same time in the process of signal output and sensor in the process of nonlinear and signal transfer charge loss, suggests that the CCD output signal device has the characteristics of the analog signal. However, in terms of time, these signals are controlled by an accurate and stable clock and are shifted out under the action of clock pulses, similar to the digital shift register. According to the detection results, it is the presence or absence of photo generated charge in each pixel that is

important, not the amount of charge. The combination of two aspects shows that CCD signal has analog and digital characteristics, so it is often referred to as digital video signal.

2. Raise questions

CCD has a small size, high precision, low power consumption, long service life and the advantages of electronic self-scanning, due to the conversion efficiency and SNR CCD chip photoelectric properties such as only at the right timing, driven by to achieve the best value of the device design, photoelectric signal output is stable and reliable, therefore, the design of drive circuit is become one of the key issues in its application[1-3]. Because the driving sequence of CCD devices of different manufacturers and models is different, the driving circuit of CCD is difficult to be standardized and productized. Therefore, the CCD driving circuit must be designed in the measuring system with CCD as the photosensitive element.Interface between SCM and FPGA is shown as figure 1.

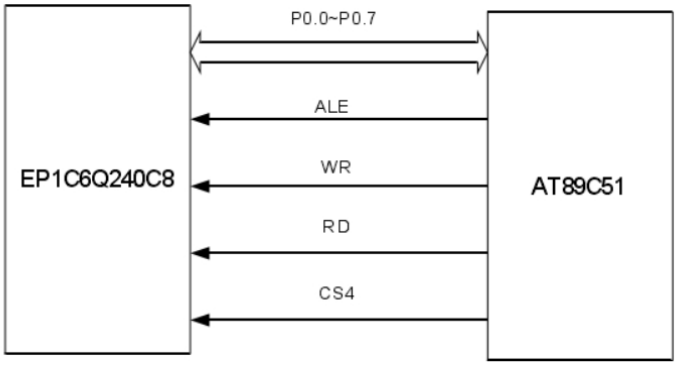

Figure 1. Interface between SCM and FPGA

The measurement system based on FPGA has high speed, high reliability and simplified circuit. FPGA integrates a lot of logic gates, each logic unit can be independent of each other, not restricted by other units, so that signals in the transmission, execution can be multi-channel, multi-process parallel execution, thus greatly improving the speed of data processing. In general, high-speed data acquisition requires A buffer after high-speed A/D sampling to provide A buffer for the transmission of single-chip microcomputer[4-6]. However, data processing after FPGA is realized by hardware, which can achieve the capability of high-speed processing, so there is no need for A special buffer to cache data.

At the same time, in 20 years, the CCD application technology research has made remarkable progress, and its applications in aerospace, astronomy, remote sensing, size and spectrum measurement, laser interferometry, fax and scanning technology, medical equipment, broadcast video, industrial vision system, military electronic countermeasure, national defense, public security, security, fire monitoring, traffic control, and many other fields.

3. Dual channel CCD data acquisition and single chip processing system

3.1. Thickness measurement principle of dual channel CCD sensor

The upper and lower laser emitting systems respectively project the laser beam onto the upper and

lower surfaces of the measured object, and the receiving system images the scattered light of the irradiated spot onto the photoelectric conversion device CCD. After the discrete analog signals output by each CCD are collected and processed by the measuring circuit, the relative displacement of the measured object on one side is obtained. The thickness of the object is obtained by subtracting the sum of the two relative displacements from the constant L obtained after the calibration of the system.

3.2. Overall design of the system

The design of this system is to calibrate each optical path of double-sided optical path respectively, because the effect of the surface of the measured object on the light on each optical path is different, resulting in different intensity of light, so that the peak of the analog voltage of CCD output may fall within the required threshold range. Therefore, it should be possible to adjust the CCD integral time of each optical path separately to make the voltage peak within the required threshold range. In this way, the data acquisition system is required to conduct two-channel sampling and A/D conversion.Connection diagram of high-speed processing display and MCU.Meanwhile, Connection diagram of high-speed processing display and MCU is shown as figure 2.

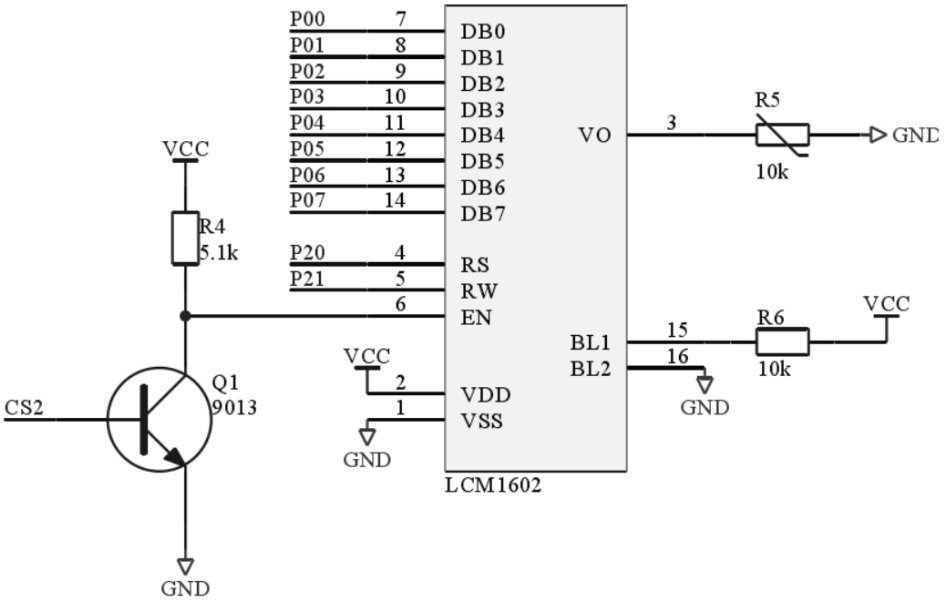

Figure 2. Connection diagram of high-speed processing display and MCU

3.2.1. *Timing sequence driver module of CCD device.* The function of the timing sequence driver module of CCD device is to provide accurate and stable timing pulse for CCD device in the system so that CCD device can work normally.

3.2.2. *Pretreatment module of CCD output signal.* Due to the large amplitude of reset pulse interference mixed in the original video signal output by CCD, in order to obtain high-quality image video signal, the original video signal must be properly processed and amplified before being sent to A/D converter. This is the CCD output signal preprocessing module to complete the work.

3.2.3. *A/D conversion module.* The function of A/D conversion module is to convert the pre-processed CCD video signal and then input it into the FPGA data processing module.

3.2.4. *FPGA data acquisition and processing module.* The function of FPGA data acquisition and processing module is to collect the data after A/D conversion, and integrate the control circuit, operation circuit and communication interface with MCU in FPGA[7]. The computational circuit USES the barycenter method to calculate the micro-displacement of the object measured by two CCDS. The control circuit ensures that the two CCD signals are collected completely and the relative displacement is obtained before calculating the thickness of the measured object. The interface of SCM communication realizes the communication function between SCM and FPGA.

3.2.5. *SCM control module.* The functions of the SCM control module are:

- Receive the data transmitted from FPGA and send it to the LCD screen for display under the control of the button.
- Control the beginning or end of the operation of A/D converted data by pressing the button.
- Communicate with the upper computer, write programs to the SCM through the upper computer and debug the system.

The combination of the above five functional modules and the optical road part constitutes the whole system of CCD data acquisition and processing. The working process of this system is as follows: CCD generates analog voltage signal driven by FPGA, preprocesses the analog voltage output by CCD, and then converts it into digital signal by A/D conversion device, enters FPGA for acquisition and processing, and the processed data is transmitted to SCM, and finally displayed by LCD.

4. Conclusion

Based on the study of traditional CCD measurement system, a data acquisition and processing system based on single-chip microcomputer +FPGA dual-chip structure is proposed in this paper. The combination of single chip microcomputer and FPGA integrates signal acquisition, data storage, data display and man-machine interaction, with simple structure, small size and diversified functions. Its hardware architecture provides a new way of thinking for high-speed data acquisition and processing. Combining with specific design occasions, it can also transform a variety of forms of data acquisition system to meet the needs of different applications. Therefore, it is of great practical significance to develop a CCD measurement system based on the combination of FPGA and SCM.

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