Research on Real-time Image Processing Platform Based on Multi-core DSP

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Abstract. With the wide application of computer technology and the rapid development of image acquisition equipment, high-resolution images bring a great deal of data processing, in addition, various and complex algorithms bring a great deal of computation. In order to achieve fast and intelligent image processing, computer image processing platform is required to have high processing performance and low power consumption. High-speed and high-performance DSP is the key to achieve fast processing. In order to improve the performance of computer image processing platform, this paper introduces the characteristics and requirements of real-time image processing platform, and the application design of multi-core DSP technology in real-time image processing platform.

Keywords: Real-time, Image Processing Platform, Multi-core DSP

1. Introduction
With the wide application of high frame rate and high resolution image acquisition equipment, on the one hand, it enhances human visual experience[1]. On the other hand, it brings heavy processing tasks and higher performance requirements to the back-end image processing system. Digital Signal Processor (DSP) is an important role in real-time image processing tasks[2-3]. DSP is a microprocessor suitable for dense data operation and real-time signal processing. In recent years, the improvement of the working frequency of DSP devices has gradually become slow, and the performance improvement of single-core DSP processors will reach the bottleneck. With the emergence of multi-core DSP, multiple DSP cores as a whole provide services to the outside world, and the overall chip can obtain multiple working frequencies. The power consumption and cost are reduced by more than half compared with the discrete number of single-core DSPs[4-6]. Therefore, the architecture and solution of multi-core DSP is an effective way to solve the bottleneck of processing performance and power consumption.

2. Performance features of real-time image processing platform
As more and more high-speed and denser image data streams need to be processed within a specific time limit, real-time image processing platform is facing the challenge of higher-speed processing requirements. The performance characteristics of real-time image processing platform include high-speed real-time image processing, multi-channel image parallel processing, multi-mode image tracking processing, and multi-source image fusion processing, as shown in figure 1 below.

![Figure 1. Performance characteristics of real-time image processing platform.](image)

2.1. High-speed real-time image processing
Real-time image processing means that the system must complete the specified processing of the image data inputted externally in a limited time. That is, the speed of image processing must be greater than or equal to the update speed of the input image data. Moreover, the delay from image input to post-processing output must be small enough.

2.2. Multiplex image parallel processing
In multi-channel real-time image parallel processing, the main work is to divide the processing tasks and coordinate the processing results between different image processing modules for data exchange, so as to achieve the purpose of multi-channel image data fusion. Therefore, the hardware structure of the real-time image processing platform needs to focus on the transmission coupling of large-capacity and high-density real-time image data streams among the image processing modules.

2.3. Multimode image tracking processing
The idea of multi-mode image tracking processing is a research hotspot in the field of moving object detection and tracking technology. The idea of multi-mode image tracking processing uses image data fusion technology to improve the adaptability of target recognition and tracking from different levels. Image data fusion technology mainly achieves the fusion of target information at three levels: data level, feature level and decision level.

2.4. Multi-source image fusion processing
According to different sensors, multi-source images can be divided into visible image, infrared image and radar image. Because of the different imaging mechanism, the limitation of working time and the influence of environmental factors, a single image can not describe the scene information comprehensively. Fusing visible, infrared and radar images into one image can complement each other.

3. Design of real-time image processing module based on multi-core DSP
In order to improve the processing performance of real-time image processing module, the real-time image processing module is designed based on the development status of multi-core DSP technology and FPGA technology, and their advantages in the field of real-time image processing. According to the architecture development trend of real-time image processing platform, a real-time image processing platform with strong real-time performance, high data throughput, abundant interconnection interface resources, dynamic reconfiguration and certain parallel processing capability is designed.

3.1. Design of real-time image optical fiber transmission
According to the Camera Link image data stream and the optical/electrical conversion mode, the real-time image optical terminal is divided into two parts: the sending end and the receiving end. The transmitter completes the conversion of image from Camera Link format input to optical fiber output, while the receiver completes the conversion of image from optical fiber input to Camera Link format output. In order to make full use of the bandwidth of image fiber transmission, when the image data bandwidth of a single camera is much less than that of a single optical fiber, the structure of transmitting two or even multiple camera images simultaneously using a single optical fiber is designed. Each image data is transmitted on the optical fiber by time-sharing multiplexing.

3.2. Design of real-time image processing module
The complexity of real-time image processing is due to the requirement of multi-mode image tracking. In the environment of real-time requirement, the coexistence of multiple processing tasks is an important way to meet this requirement. The hardware structure of real-time image processing module is designed by using the advantages of multi-core DSP and FPGA. Real-time image processing module based on multi-core DSP is the component of real-time image processing platform. A single multi-core DSP real-time image processing module should be an individual who can complete the processing task independently, or a real-time image processing platform composed of multi-block real-time image processing modules, which can cooperate with each other to complete the processing task. In the real-time image processing module of multi-core DSP, two-stage clock combination is adopted to meet the needs of multi-clock frequency in the real-time image processing module of multi-core DSP. The principle block diagram of the distribution circuit is shown in Figure 2 below.

3.3. Functional structure of the real-time image processing module
The real-time image processing module of multi-core DSP is mainly composed of FPGA and three-core DSP. There are abundant optical fiber transmission interface and PCI Express interface resources on the module, and the storage space of the FPGA and multi-core DSP is large respectively. By combining the low power optimized high-speed serial interface of the FPGA with the optical fiber technology, the real-time image data can be received and transmitted in the real-time image processing module of the multi-core DSP through the instantiation of the RacketIO IP core of the FPGA. In order to meet the requirements of CPCI Express standard architecture, the PCI Express interface of the FPGA and the

![Figure 2. Distribution circuit principle of clock combination.](image-url)
backplane of the CPCI Express are interconnected by using the PCI Express IP core of the FPGA. Through PCI Express channel, real-time image data is tightly coupled and interconnected in CPCI Express architecture.

3.4. Application of the real-time image processing platform

The Real-time image processing platform based on multi-core DSP is not an isolated processor. It is not only related to image processing, servo control, main control processing and other functional modules in the processing cabinet. Instead, the image data stream is used as a link, which is closely connected with each processing module and each processing molecule system through which the image data stream passes, and constitutes a complete electronic system in the photoelectric imaging tracking and measuring system.

4. Conclusion

The continuous development of computer technology and the increasing progress of image acquisition equipment provides more detailed image details, which could support and respond to more complex algorithm requirements. Besides, it brings a lot of data to be processed and makes real-time processing difficult for the application platform of the algorithm. DSP has become one of the main chips of computer image processing platform because of its high-efficiency operation performance and platform development advantages. It is the main solution to balance control and operation requirements with FPGA chips. The birth of multi-core DSP provides an ideal choice for complex image processing tasks. Compared with single-core DSP, the package size of multi-core DSP does not increase too much, but it integrates several powerful cores and rich resource modules, which is convenient for engineering development and has important application value.

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