Research on Implementation of Wearable Computer Software and Network Communication Based on Dynamic Reconfigurable Technology

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Abstract: With the advent of the information age, wearable computer equipment has gradually become the main symbol of the development of current industrial technology, and dynamic reconfigurable technology has played an important role in it. Based on this, this article studies for wearable computer software and its network communication based on dynamic reconfigurable technology. Firstly, it gives an overview of dynamic reconfigurable technology, introduces its concept, principle, classification and software and hardware task division method, and then explains the related content of wearable computer technology, including its development history, application and platform advantages, finally designs a smart watch, analyzes the overall design ideas, the application of dynamic reconfigurable technology and the realization of communication functions. The application of dynamic reconfigurable technology not only makes wearable computer software more convenient, but also greatly improved its communication quality.

1. Introduction

With the continuous advancement of integrated circuit technology research projects around the world, modern people can enjoy more and more high-end scientific and technological achievements, and people's lives have undergone tremendous changes. The design and the realization of dynamically reconfigurable, wearable computer software platforms and process provides new ideas for the future development of the field. With the simulation experiment process of the basic design content, we can see the economic value and social influence that can be generated when it is put into physical industrial projects [1]. Wearable computers under the influence of reconfigurable technology are more adaptable to the environment than in the past, and are worthy of promotion and application in a wider range of practical industrial preparation projects, which will greatly change the daily lives of modern people.

2. Overview of dynamic reconfigurable technologies

2.1 Dynamic Reconfigurable Concepts and Principles

The concept of the dynamic reconfiguration system was proposed earlier than the FPGA dynamic reconfigurable technology. A dynamic reconfiguration system refers to a digital logic system that changes in time series. The occurrence of time series logic is not a combination of different regions and different logic resources in the chip. It can be quickly implemented by dynamically reconfiguring the local and global chip logic of FPGA with dedicated cache logic resources. That is to say, the FPGA logic function is dynamically configured in real time during the real-time operation of the system. It can reconfigure only the logic units that need to be modified internally, and the logic units that have not been modified will not be affected and work normally. Generally, the traditional processor executes the main program, and specific tasks are assigned to FPGA-based co-processing. In fact, during most of the processing time, only a relatively small part is used to calculate internal tasks, and the hardware can significantly speed up the execution time. During the reconstruction process, tasks can be performed as needed to the coprocessor for processing.

The so-called FPGA dynamic reconfigurable technology refers to the programming based on static memory (SRAM) and a special FPGA. Driven by certain control logic, it can not only realize the system reconfiguration circuit function, but also achieve high-speed dynamic transformation of system logic function [2]. Most FPGAs are based on SRAM look-up table structures. They are generally only suitable for static reconfiguration, downloading all configuration data to SRAM at one time and setting the logic functions of the FPGA. According to the FPGA, configuration methods, etc., the total reconfiguration time ranges from a few milliseconds to a few seconds. In the past, FPGAs that are commonly used for refactoring research include Xilinx's XC6200 series and Atmel's AT6000. They are also based on the SRAM structure, but each unit of the SRAM can be accessed individually configuration, division and reconstruction. Their functions do not affect each other, so they have the characteristics of partial reconstruction. The advantages of doing so are obvious, but they will also pay the price of increasing the size of the hardware circuit and power consumption. In order to finally achieve the complete physical configuration of the electronic system FPGA devices with dynamic partial reconstruction functions should be used, such as the Virtex-II series of Xilinx now.

2.2 Classification of Reconfigurable Systems

Generally speaking, the fixed computing components of reconfigurable computers are CPUs, and the variable structure is FPGA. According to the coupling relationship between CPU and FPGA, reconfigurable computing systems are divided into the following categories:

2.2.1 External independent computing unit

The CPU and FPGA are connected through a dedicated or general-purpose I / O bus. The FPGA independently completes some calculations, the logic is relatively complex, and the reconstruction method is generally coarse-grained. The biggest advantage of this structure is flexibility, the host and reconfigurable devices can be combined at will, and even shared through the network. Moreover, the performance of both the CPU and the reconfigurable device can be very high. The disadvantage is that the I / O interface easily becomes a bottleneck that limits the performance of the system. Due to the good scalability, currently mainstream commercial reconfigurable computers and high-performance reconfigurable computers in research generally use this structure, such as BEE4 from BEEcube, and RASC RC100 from SGI.

2.2.2 Coprocessor

The reconfigurable device is tightly coupled to the CPU and works as a coprocessor of the CPU. Compared with the previous method, the reconfigurable unit communicates with the CPU much faster, but the communication will be more frequent. The structural units are generally fine-grained. Typical systems are XD1000 from Xtreme, PipeRench from Carnegie Mellon University, etc.

2.2.3 Embedded processor

The embedded processor is to build a completed system, namely SoPC (system on programmable chip), in a single-chip reconfigurable device. This method has been highly respected by FPGA manufacturers, such as the embedded Power PC in Virtex 4, and Virtex 7 Embedded ARM. And FPGA vendors provide easy-to-use development tools, such as Xilinx's EDK. Due to the large output and cheap availability of FPGAs, there have been many researches on such systems in the embedded field in recent years. The main disadvantage is that the frequency is not high, and the ability to connect peripherals is limited, so it is not suitable for large-scale systems.

Each of the above three systems has advantages and disadvantages. Generally, the system hardware with low communication costs is used more frequently, which requires more intervention by the processor, and the performance of the devices with tighter coupling systems tends to be lower. With the deepening of research, the speed of reconfigurable systems is getting faster and faster, and versatility and flexibility are becoming more and more important. Therefore, loosely coupled systems and tightly coupled systems with CPUs embedded in reconfigurable devices are currently the mainstream structure of high-performance reconfigurable computers and embedded reconfigurable systems [3].

2.3 Software and Hardware Task Division Method

Reconfigurable systems include general-purpose processors and reconfigurable devices. Usually, general-purpose processors are used to perform software tasks, and reconfigurable devices are used to handle hardware tasks. The role of software and hardware task division is to obtain a system that meets the time, the realization of requirements such as cost and power consumption, the quality of the partition result largely determines the quality of the system design. The partition of software and hardware is a complete NP problem, so the goal of the researcher is to quickly find an approximate optimal solution. The methods are mainly heuristic algorithms, such as mountain climbing, genetic algorithms, simulated annealing, and tabu search algorithms.

Arato et al. respectively gave a division method based on plastic linear programming and genetic algorithms. Linear programming-based algorithms can obtain the optimal solution, but they are only suitable for small-scale applications, and the calculation time will increase exponentially with the problem size. Although genetic algorithms can only find approximate optimal solutions, they are a more practical approach.

3. Wearable computing technology

3.1 Development and Status of Wearable Computing Technology

As a new computing model, the concept, metaphor, architecture, form, and function of wearable computing are constantly evolving, and there is currently no more standardized, clear and complete definition. One of the internationally recognized inventors of wearable computers, professor Steve M of Canada believes that wearable computers are a type of computer system: "The personal space belonging to the user is controlled by the wearer and has the continuity of operation and interaction, that is, always on and always accessible ".

The idea and prototype of wearable computers have appeared as early as the 1960s. The most representative is the computer for roulette developed by Thorp and Shannon, students of the Massachusetts Institute of Technology [4]. In the 1980s, Steve M developed a prototype of a typical wearable computer with a head-mounted display based on the Apple-II 6502 computer.

In the 1980s and 1990s, with the rapid development of computer software, hardware, and Internet technology, researchers from scientific research institutions such as the University of Toronto, the Massachusetts Institute of Technology, Carnegie Mellon University, Columbia University, and Xerox European Laboratory developed a group of Representative wearable computer prototypes such as Wearable Wireless Webcam, KARMA, Forget-Me-Not, VuMan I, etc.

In 1997, the Massachusetts Institute of Technology, Carnegie Mellon University, and the Georgia Institute of Technology jointly organized the first International Conference on Wearable Computers. This international conference has been held once a year since it was first held and has been held for 14 sessions. The Ministry of Advanced Research Projects and the Boeing Company have also held several seminars on wearable computers. Since then, wearable computing has started to receive widespread attention from academia and industry, and has gradually been used in many fields such as industry, medical, military, education, and entertainment.

Both the United States and the European Union have invested heavily in basic research on wearable computing. For example, the European Commission launched the world's largest single civil wearable computing research project in 2004, wearIT @ work, which lasted for 5 years. The Science Foundation has also continuously funded a number of wearable computing research projects in human-centered computing and other special projects. In addition, strong support from the military is also an important force to promote the rapid development of wearable computing technology. The Advanced Research Projects Agency, the U.S. Army Communications and

Electronics Command, and the National Aeronautics and Space Administration are important funders of wearable computing research [5]. In addition, engineering at multiple universities in the United States, Russia, France, the United Kingdom, Japan, and South Korea Research institutes such as colleges, universities of science and technology all have specialized laboratories or research groups focused on the research of wearable computing technology. Chinese scholars also carried out research on wearable computing in the late 1990s, almost in line with international wearable computing research Synchronize.

3.2 Application of Wearable Computing Technology

With the development of disciplines, scientific methods and technical research issues such as core concepts of wearable computing, system infrastructure, perception and interaction, and pervasive computing, human-centered computing, socially-perceived computing, and cyber-physical systems, etc. The cutting-edge academic direction has formed a cross-convergence trend, which may lead to the emergence of some innovative application models in the next generation of wearable computing research.

3.2.1 Blue collar computing

The special "carry" and "interaction" methods of wearable computing terminals have spawned the "blue collar computing" mode. This is a new field job information support mode that emphasizes the user's tasks in the workspace, especially when the work is performed at critical moments. When living in the living space, you can get the natural, effective and multi-person collaboration support of the information space. Typical applications include maintenance and installation support systems for special occasions, diagnosis and treatment assistance systems, behavior monitoring and health protection systems, and digital individual system. Blue-collar computing is also one of the most unique and successful application models of wearable computing at present.

3.2.2 Human-computer interaction and collaboration

Wearable computing highlights the enhancement of human perception and intelligence. The wearable sensing system achieves a near-body-rich sensor distribution, while the continuous, enhanced, and interventional modes allow users' sensory channels to simultaneously focus on the virtual and real 2 information spaces or to achieve a smooth switch between the two, the two basic links of traditional human-computer interaction, that is, the exchange of control information and display information, have undergone significant changes in wearable computing. For example, wearable sensing systems or network performance supports efficient personal context perception and recognition, such as eye tracking, location, posture and physiological perception, gestures, and emotion recognition, etc., which will enable the control information exchange link to be carried out in a more natural and coordinated manner. In addition, in the display of information exchange process, it can adopt the characteristics of multi-modal and heterogeneous display devices such as flexible tactile / touch display, and can also support the basic wearable computing model Augmentation and Mediation through continuous tracking, fusion, and adjustment of the display information flow. Wearable computing can combine research results in the fields of perceptual computing and collaborative computing to study new metaphorical representations of wearable interactions.

3.3 Advantages of Wearable Computer Platform

The modern people's demand for high-tech electronic devices is constantly increasing, and wearable computers are smaller, expandable, and have lower power consumption, which is very popular. In order to ensure that wearable computers have a good development space, it is necessary to achieve the following optimizations:

3.3.1 Reduce energy consumption

The wearable computer is characterized by being able to be carried and moved with it, and it has a certain degree of portability, so its battery cannot be too bulky, thereby avoiding affecting the portable needs of the carrying person. However, in order to require sufficient power, it can provide power for long-term work, it is necessary to reduce energy consumption. Based on dynamic reconfigurable theory, the circuit design can be simplified through circuit reuse, which can reduce the overall volume [6]. In software the setting is realized by professional code.

3.3.2 Facilitate interaction

Users who wear wearable computers need to realize the real-time operation of the computer so that information can be exchanged. Therefore, it is necessary to add a sensor system to the wearable computer to feedback the obtained information to the computer users, and users can easily issue instructions to the computer [7]. At present, most of them use the touch screen and physical keys to issue instructions, and provide feedback through vibration and ringtones.

3.3.3 Networking function

At present, society has become the digital information age, so networking technology is also the main technical module in wearable computers, and because the wearable computer software platform can be used in different environments, then WiFi, radio and other methods must be used to achieve network connectivity. But in order to ensure that the software's functions will not change due to different network connection methods, the design of a unified network interface must be achieved, and it must also fully consider that it has a good transmission speed in the process of connecting with other devices [8]. Communication can be realized through TCP / IP protocol mode, because this mode is a way of programming with SOCKET technology, which can be used by general software developers, and it is also convenient for development.

3.3.4 Real-time

Because the wearable computer software platform needs to respond quickly to the instructions issued during use, it is necessary to reduce the complex characteristics of the system during the design process, so that the system's response speed can be effectively improved, which can effectively meet people's needs for requirements for the use of wearable computer software platforms.

4. Wearable computer software and implementation of network communication

4.1 Overall Concept

From the above analysis, it can be seen that the wearable computer software platform is quite different from the traditional computer software platform, so we should design it completely from a new perspective.

The wearable computer software platform designed for this development is optimized based on dynamic reconfigurable technology. From the software platform development and network communication, the dynamic reconfigurable technology can be used to support and improve the software platform. The design quality of the dynamic wearable computer software design meets the needs of users. In addition, the wearable computer software platform designed this time can also optimize and improve the performance of software applications and improve the usability of the software in the user community. Using dynamic reconfigurable technology to optimize the development path of wearable computer software platform and network communication quality, design a smart sports watch with microcontroller AT-mega644PA as the control core, using PCF8563 clock chip, three-dimensional acceleration sensor, temperature sensor, the barometric pressure sensor collects movement data, and uses the OLED display to realize the display time function, display temperature, barometric pressure, altitude function, and step counting function, combined with the bluetooth module, to realize the communication function with the Android phone. Using the Android APP with the smart watch, the smart watch can transfer data to the Android phone. According twice processing, movement number of steps, calorie consumption, exercise distance, exercise time, recording and analysis of regular exercise, can provide health issues for the user based on the data, ensure that the software platform designed to meet the actual needs of users.

In the design of dynamic reconfigurable wearable computer software, the development of software functions can be mainly combined with the external hardware platform of the computer, so that the system application functions of specific dynamic wearable software can be realized. Analyze our theme to determine our design, the functions of the system are as follows: display time, including year, month, date, day of the week, and real-time time; display temperature, pressure, altitude; record walking or running steps and display; transfer sensor data to Android phone; Android phone software receives data, store in database to save historical data; record data while sleeping and analyze sleep status; SMS reminder, call reminder function.

4.2 Application of Dynamic Reconfigurable Technology

In dynamic reconfiguration, based on the software platform design needs, it mainly includes the following two stages: For the first stage, that is, the integration of the entrance design and module design part of the dynamic reconfigurable module, it is mainly the dynamic reconfiguration of the general functional scope. For the second stage, it is to implement the design part of the specific dynamic reconfigurable module, which mainly includes the initial budget, the implementation of the module, and the final compilation.

For the dynamic reconfigurable technology, the reconfiguration configuration of the hardware logical resources in the system can be implemented dynamically through the reconfiguration technology, and the chip functions can be dynamically reconfigured according to the function and timing changes, so that smaller computer software and hardware resources to maximize the system timing control function.

For software communication, the GPS data is collected by the GPS sensor, and the latitude and longitude information collected by the GPS is analyzed to collect the movement distance, and then the step number is reversed according to the step size set by the user. OLED is the active emission of the device components, just like an integrated circuit diode, can make small pixels, so the resolution can be very large, plus the material polymer organic material, can make a very thin and light design, which is the main advantage, suitable for use for wearable electronic devices with high volume requirements [9]. The wireless transmission method is adopted, and the bluetooth transmission and WIFI communication are suitable for the communication between the microcontroller and the Android smartphone in the wireless transmission method. The wifi communication module is suitable for large data transmission, and the transmission speed is also fast. The biggest weakness is that the power consumption is high, and its stability is not high enough. The bluetooth technology is also relatively mature. It has better stability in short-distance transmission, and its power consumption is relatively small [10]. As our smart wearable device, we must look for modules with low power consumption as much as possible, and our device mainly transmits user's motion information. The amount of information is not very large, and the distance to be transmitted is not very large. We don't need wifi wireless local area network. Our requirement is to be able to transmit stably, so the bluetooth module is our ideal choice.

4.3 Hardware Design

For the development of the dynamically reconfigurable wearable computer software platform designed this time, FPGA is used as the basic system in the software, and a hardware platform consisting of the TCP / IP network and the host is applied. For the host, you can use TCP / IP network transmits the configuration file to the physical layer interface in the software target system. After that, the configuration file can be temporarily stored in the DDR SDRAM through the PLB bus, combined with PLB and OPB.

The bus transfers the configuration file to the CF card for storage. Then, for the system hardware design, the system server transmits the reconfiguration command to the Powerpc processor in the system, and the System ACE chip can be used to configure the configuration file in the FPGA chip. This completes the dynamic reconfiguration process of the system and completes the function of system reconfiguration.

5. Conclusion

The design of dynamically reconfigurable wearable computer software can not only improve the adaptability of the wearable computer software platform to the environment, but also improve the quality of software network communication, increase 18.0%, and play an active design to realize the benefits. It can be integrated into computer software miniaturization and highly reliable implementation of the function of dynamically reconfigurable wearable computer software, and can also improve the utilization of platform resources of the software, reduce the development cost of the software, and enable the software development to exert application benefits in practice. In the continuous development of modern integrated circuit technology, various electronic devices, including smart phones, are gradually moving towards miniaturization. After the changes in computer requirements standards, mobile electronic devices have become popular with people. To achieve continuous improvement of the software platform, we should base on dynamically reconfigurable technology to comprehensively analyze the design of the dynamic reconfigurable wearable computer software platform.

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