Design and Implementation of 1553B Bus Controller in VxWorks

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Abstract: With the development of computer information technology, the application of digital control system in bus controller is more and more extensive. At the same time, the outfield update logic is easy to make mistakes, and the operation is very frequent. Therefore, on the basis of introducing the theory of 1553B data bus, and based on VxWorks real-time operation, this paper constructs a bus communication system and its implementation method from two aspects of hardware and software systems respectively. Finally, the validity and accuracy of the system design are verified by experiments, which can supplement and improve the existing theory.

1. Research Background

1.1 Literature review

With the gradual deepening of space exploration, satellites have become an important tool in communication, exploration of earth resources, and national defense security. At present, the key of satellite navigation system is to use navigation satellite to achieve positioning, which is of great significance to promote economic development and social progress (Li and Zhang, 2010). With the help of the integrated electronic equipment simulation test system and the operation system based on VxWorks platform, it is of great value to test and improve the communication system (Shen et, 2016). In this case, many scholars have launched a detailed discussion. Some scholars based on VxWorks platform 1553B bus test system, through the design of analog communication protocol and virtual equipment, put forward specific application methods. The results show that the optimization system can be tested according to the existing VxWorks system and the dynamic update of bus messages. Compared with similar detection, it has the advantages of low cost and fewer experiments, and can be applied in a wide range of scenarios (Wang et al, 2011). Some scholars designed 1553B bus fault system based on VxWorks system to study the experimental requirements of avionics. At the same time, according to the designed system and the communication characteristics of 1553B bus, the author analyzed the detection method suitable for this line fault, and gave the specific design scheme. The research scheme shows that this research can effectively improve the existing communication design system and improve the fault detection error rate (Yuan, 2019). Some scholars have pointed out that reducing the cost of software development is an important way of software reuse. Therefore, the 1553B bus mode generated by driver class reusable software can break through the predicament of reusable software framework design, shorten the development cycle of driver software, and further meet the development needs of existing software systems (Liu et al, 2015). Some scholars have found that 1553B multi-channel transmission data module has been widely used in airborne equipment. Therefore, based on the theory of bus interface module technology, the author designs the test of 1553B bus interface module and the specific experiment. Finally, the research results show that this study is helpful to supplement the existing research theory and to optimize the existing overall design line system (Wang, et al, 2012).

1.2 Purposes of research

The design of 1553B bus communication system controller is of great significance for technology evaluation, system testing and other fields. Most of the existing 1553B bus controllers are based on Windows PC, which can not meet the real-time requirements of target systems in civil

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and military applications. Relatively speaking, VxWorks system has the advantages of good real-time, high reliability and high degree of simulation. It can effectively promote the optimization of real-time operating system and improve the optimization of 1553B communication system. In this case, based on VxWorks system, the 1553B bus controller system is designed and implemented in order to provide some reference for improving the existing drive system.

2. Design and Implementation of 1553b Bus Controller Based on Vxworks System

The internal time division command of the aircraft, also known as the response multi-channel data bus, is called “MIL-STD-1553B” in English. It is a centralized time division serial bus, the domestic standard is GJB289A-97. From the operation characteristics, 1553B has good clock synchronization and data transmission capabilities, and can centralize control and distributed processing operation (Li, et al, 2016). From the point of view of type, 1553B bus connects three kinds of devices, namely bus controller (BC), bus monitor (MT), and remote terminal (RT). The basic information transmitted by 1553B is word, including data word, status word and command word.

Before optimizing the 1553B bus controller, a certain system is needed. At present, Windows system can not optimize the system in real time. It can only rely on VxWorks system (Zhang and Shi, 2013) which has core functions such as micro-kernel, advanced network support and C/C++ standard language. The system is a widely used real-time operating system. It has the advantages of fast processing of communication information and efficient handling of abnormal events. It can ensure accurate and fast context switching when switching tasks. In terms of system operation, VxWorks system is a separate cross-development mode. In other words, the design of 1553B bus controller from the aspect of VxWorks system can improve communication efficiency. The design ideas and schemes are as follows.

2.1 Hardware system design

In the process of designing hardware environment, it mainly includes the following aspects. First, the communication node. These nodes can provide the basic conditions for the operation of the whole system (Zhan et al, 2014). Among them, the nodes are general-purpose PCs, which are further refined into one host machine, four target machines are one BC, one MT and two RT. The hardware configuration of the machine is Core i5-4460, the motherboard with local bus interface, 8G memory and 500G hard disk capacity. At the same time, add 200 M Ethernet network card.

In the design of 1553B bus communication network, four target computers need to be connected to these networks to process data at any time, so that the overall working state can enter an orderly and stable state. In the design of bus communication network, the following hardware should be set up: using capacitive twisted pairs not exceeding 100 pF/m, and no less than 13 twisted pairs per meter; using coupling transformer with turn ratio of 1:41; adopting multi-channel transmission bus interface, which is the core hardware equipment to realize 1553B bus communication. In this case, AEBIP-S interface board, which has PCI local bus interface, can be integrated through BC, RT, MT design. At this time, the data storage capacity is 9K*16bit.

In order to realize the connection between the host and the target computer, it is necessary to build the Ethernet of the development environment to realize the interactive development, so as to realize the program debugging between the host and the target computer. In terms of hardware configuration, 24 Tengda Ethernet switches and twisted pair cables are used as transmission media.

2.2 Design of software system

While completing the hardware environment, it is necessary to design the target computer software system, which mainly includes the following aspects. First, VxWorks real-time operating system. On the basis of managing hardware resource allocation of target machine, VxWorks system of hardware environment needs to be designed to provide running environment for communication system (Zou et al, 2018). Second, install MBI transmission software. The software can effectively hang you on the 1553B protocol chip to transmit all the message formats of MIL-STD-1553B.

Third, install MBI driver software. Thirdly, system application software. At this time, we need to optimize the MBI device driver layer software, and then optimize the specific content of the database. In order to simulate the data communication mechanism of 1553B bus in different states, it is necessary to analyze the data flow process inside the platform, that is, to design the software architecture. Among them, MBI transmission software is provided by the manufacturer; in addition to network card driver, other driver software is provided by WinDriver company; VxWorks driver software is provided by Realtek manufacturer.

2.3 System implementation

BSP files are configured for the target machine in the host, and VxWorks kernel is customized by using Tornado development tools to boot the target machine. At the same time, VxWorks images are loaded into the target machine by remote manipulation to develop software applications.

First, MBI driver software design. From the point of view of structured hierarchical design, the driver software is divided into protocol interface layer, hardware function layer and interface layer. Hardware interface layer mainly completes resource initialization configuration, which provides host access to hardware resources. It includes device initialization and hardware resource access interface library. The hardware function layer mainly implements the interrupt processing of VxWorks system by calling the hardware interface layer to install the interface parameters for the operating system. In this process, the hardware function layer mainly includes opening, closing, device writing operation, device I/O control operation and so on. The protocol interface layer mainly calls the function layer interface according to 1553B protocol, and implements the management and communication functions of MBI system by encapsulating the use logic of PCI bus and protocol chip. It includes MBI control interface operation, stop, test process, RTC reading, setting, and other state reading clock control interface.

Secondly, system application software design. When designing system software, it needs to be done from seven aspects. First, load the system startup module. After the system is powered on, the configuration of MBI motherboard application and the system can control the good operation of other modules when the driver software is loaded, as well as release the existing resources after the system is shut down. Secondly, the equipment management module is designed. This module mainly includes data structure initialization and allocation function, while loading consulting and testing, function mode design and other content, further in the system when there are errors to achieve the reset function. Subsequently, the application of message management module. This module verifies the validity of various information resources, parses the meaning of received information resources and various echo functions under different modes. Next, the BC simulation module is loaded. Under BC mode, the simulation function of MBI in bus controller can effectively control the information of data, then load the information, and realize the function of receiving and sending information. Subsequently, under the function of information and networking of RT, accepting the status of RT can effectively integrate the whole system. Next, we need to analyze the commands from the bus controller under the remote terminal of MBI, which include information state feedback and error information during transmission. Finally, the bus monitor module is loaded. This module is a function simulation in bus monitor mode. It can monitor bus data according to the monitor list, and record and display specific information. At the same time, this module can display the error report during the system operation and provide backup resources for the bus controller.

3. Implementing Effect

By running the design system and defining 1553B protocol message, we need to send 20 data words to the remote terminal under the command of bus controller node, and use digital oscilloscope to intercept waveform. On this basis, the design of 1553B bus controller system based on VxWorks is completed. Through specific tests, it is found that the design system can quickly respond to the relevant requests of the system and users. At the same time, with the help of very advanced information technology, task communication makes information queue, semaphore and other mechanisms to achieve fast operation and output, which is conducive to improving the

real-time information. In addition, through the system test, the response time of the 1553B bus controller has exceeded the traditional mode under the VxWorks operating system. The average time is reduced to 50 microseconds, and has a fast response capability. The long-term validation of several stages shows that the 1553B bus controller system runs stably. With the help of the accuracy of time scales uploaded by the system, the analog time is reduced by 1/3, and the switching time has been reduced to 1/2 of the original time. In this case, the redundancy switching time of the controller has also been reduced to 1/2 of the previous time.

4. Conclusion

To sum up, an effective bus communication line is of great significance in the current communication system. Effective connection between data bus and communication equipment can promote the effectiveness and efficiency of data transmission. Under the current Windows system, the 1553B bus communication system can not realize the effective implementation of data, and the high efficiency of VxWorks operation system and the rapidity of information processing can promote the good operation of the bus controller. Therefore, based on the VxWorks operating system, this paper designs the 1553B bus controller, and optimizes the software and hardware. The design found that the system designed is better, can effectively promote the improvement of the communication system, can also provide some supplements for the relevant theory.

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