ISSN 2278-3091

International Journal of Advanced Trends in Computer Science and Engineering, Vol.2 , No.1, Pages : 114-117 (2013)
Special Issue of ICACSE 2013 - Held on 7-8 January, 2013 in Lords Institute of Engineering and Technology, Hyderabad

Development of Communication Protocol conversion Equipment based on Embedded MCU and RTX51

E.Pradeep[1], P.Sai Chaitanya[2], V.Vikram[3]

[1]Asst.professor,kamala Institute of Technology and Science, India, pradeep.e.kumar@gmail.com
[2]Asst.professor,kamala Institute of Technology and Science, India, chaithu456@gmail.com
[3]Asst.professor,kamala Institute of Technology and Science, India, vikram.vippula@yahoo.co.in

Abstract **-** Using the embedded multi-MCU and high-speed dual-port RAM data sharing technology, communication protocol conversion equipment based on embedded multi-MCU and real-time multitasking operating system RTX51 has been researched and developed, which adopts RS232 or RS485 communication interfaces for lower machines such as data acquisition I/O modules, smart intelligent instruments and so on. Then, the data are transferred by Ethernet communication interface to the remote monitoring systems such as DAS or DCS. The functions of industrial communications network relaying and protocol conversion will be realized, therefore, the serial devices of device layer can be easily connected to the networked control layer. The system has high reliability and real-time performance, and can facilitate the realization of data exchange, data sharing and information processing among embedded MCU.

Keywords *- Embedded platform, Communication protocol conversion, Modbus protocol, RTX51, Data acquisition and monitoring.*

INTRODUCTION

With the widely application of networked, intelligent, digital distributed control system in electric power, petroleum, metallurgy, iron and steel, transportation and so on, the field signals need to be sent up to monitoring systems such as DCS through data communication network after being continuous collected and processed by data acquisition system[1]. The field signals need to pass through different data communication networks before sent to the upper monitoring system because the equipments of field layer are different in data processing and transmission from those of control layer or monitor layer, so the communication protocol conversion equipment is essential. In recent years, embedded technology has been rapidly developed and the embedded systems can adapt to strict demands of the supervisory control and data acquisition system in features, reliability, cost, size and power consumption etc. The construction of the communication protocol conversion equipment for data acquisition and monitoring system based on the high-performance embedded processor has important application significance.

A communication protocol conversion equipment based on embedded multi-MCU and real-time multitasking operating system RTX51 has been researched and developed, which adopts RS232 or RS485 communication interfaces for lower machine such as data acquisition I/O Modules, smart intelligent instrument and so on. Then, the data are transferred by Ethernet communication interface to the remote monitoring systems such as DAS or DCS. The embedded multi-MCU and high-speed dual-port RAM data sharing technology are applied in this communication protocol conversion equipment, thus the reliability and real-time performance of the system are improved and also the realization of data exchange, data sharing and information processing among embedded MCU becomes convenient.

STRUCTURE DESIGN OF THE SYSTEM HARDWARE

The protocol conversion function of the industrial communication network is realized in the protocol conversion equipment based on embedded multi-MCU in order that the serial devices of equipment layer can be easily connected to the networked control layer. RS232 or RS485 communication interfaces are adopted for lower machines using Mod bus/RTU protocol such as data acquisition I/O modules, smart intelligent instruments etc in the communication protocol conversion equipments[2]. Then, the data are transferred by Ethernet communication interface using Mod bus/TCP or TCP/IP protocol to the remote monitoring systems such as DAS or DCS. The embedded multi-MCU and high-speed dual-port RAM data sharing technology are applied in this communication protocol conversion equipment. Therefore, the circuit design is simplified, the reliability and real-time performance of the system are improved and also the realization of data exchange, data sharing and information processing among embedded MCU becomes convenient. The system diagram of the protocol conversion equipment is shown in Fig. 1

ISSN 2278-3091

International Journal of Advanced Trends in Computer Science and Engineering, Vol.2 , No.1, Pages : 114-117 (2013)
Special Issue of ICACSE 2013 - Held on 7-8 January, 2013 in Lords Institute of Engineering and Technology, Hyderabad

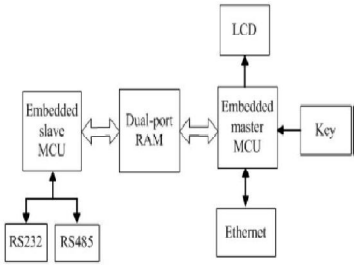

Fig. 1: The system diagram of the communication protocol conversion equipment

Fig. 1: The system diagram of the communication protocol conversion equipment One of the key technologies of this system is embedded multi-MCU technology. The RS232 or RS485 communication interfaces are adopted for lower machines such as data acquisition I/O modules, smart intelligent instruments etc in the embedded slave MCU so that the industrial field measured data are achieved and put into the dual-port RAM. While the settings of the system parameters, LCD display, keyboard processing, and the data transmitting to the remote monitoring systems such as DAS or DCS by Ethernet communication interface that using Mod bus/TCP or TCP/IP are managed in the embedded master MCU.

The other key technology of this system is high-speed dual-port RAM data sharing technology. The IDT7134 is used as the dual-port RAM chip. This chip is a high-speed asynchronous dual-port static RAM, which has two completely independent ports and there are control bus, address bus and data bus for each other, and integrate the logical competition circuits. The operations on the dual-port RAM are equal to those on its external RAM by the embedded MCU. The problem of the using of the dual-port RAM is how to avoid that data from the same RAM unit are occupied simultaneously by the master MCU and the slave MCU. In this paper, according to the data transferring features, the memories are distributed and the arbitration function is implemented in the software aspect. The IDT7134 RAM is divided into two parts, one is used to store data from the embedded master MCU to embedded slave MCU, which is allowed to be read and write by embedded master MCU and read only by embedded slave MCU; the other one is used to store data from the embedded slave MCU to embedded master MCU, which is allowed to be read and write by embedded slave MCU and read only by embedded master MCU. Then the problem of the data sharing conflict is solved in this way. In addition, the 74HC373 and 74HC573 are used as the address latch unit of this communication protocol conversion equipment, and they are separately used to latch the address unit of left and right port of the dual-port RAM.

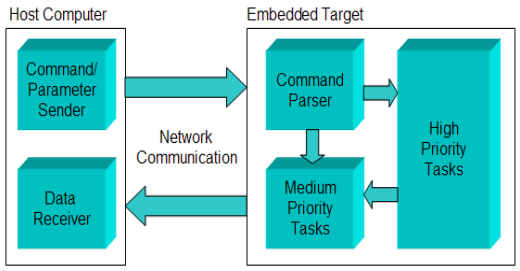

Fig. 2: The application structure of the embedded communication protocol conversion controller

Fig. 2 is the application structure of the embedded communication protocol conversion controller. As shown in the figure, the communication protocol conversion controller as the Mod bus/RTU master, which use Mod bus/RTU protocol to communicate with all kinds of Mod bus/RTU slave equipments Then, the real-time data are transmitted to the workstation such as operator and engineer station of the monitoring center through Mod bus/TCP protocol.

DESIGN AND IMPLEMENTATION OF THE SYSTEM SOFTWARE

The real-time pre-emptive multitasking operating system RTX51 which is source code opened, portable, tailoring, curable is used as the software platform of the communication protocol conversion equipment based on the embedded platform. The real-time multitasking kernel is the most critical part of the real-time operating system, whose basic functions include task management, resource management, system management, timer management, memory management, time management, information management, queue management and so on. These functions are called by users in the form of the kernel API functions. The usage of RTX51real-time operating system kernel simplifies the design of the application system, simplified the entire structure of the system, hierarchy the complex application programs.

In the real-time multitasking systemRTX51, the kernel takes the responsibility of managing every task that is, allocating time for CPU, and communications of various tasks. Task switching is the basic service provided by the kernel. RTX51 distributes independent stack space for every task, which can realize quickly task switching. RTX51 always sets the highest priority task in running state. For this, the scheduling algorithm is always executed while calling system API functions, interruption ended and timer interruption ended. The computation is simplified by the calculated data. The relay can be foreseen by the designed ready list structure. The flow chart of the system main program is shown Figure 3. The function of

ISSN 2278-3091

International Journal of Advanced Trends in Computer Science and Engineering, Vol.2 , No.1, Pages : 114-117 (2013)
Special Issue of ICACSE 2013 - Held on 7-8 January, 2013 in Lords Institute of Engineering and Technology, Hyderabad

OS Init () should be called before any functions of RTX51 provided. Two tasks are established by the function of OS Init (), which are respectively idle task and statistical task. The idle task runs when other tasks are not ready, while the statistical task mainly calculates the utilization ratio of CPU. The function of In it Hardware () mainly completes the settings of the system clock, the function of In it Para() initialize the system global variables, and the function of Comm. In it initialize the parameters of the UART serial port. The communication task of the system is dealing with the response frame from the slave devices. The function of sending the request frame is accomplished by the idle task established in the kernel of RTX51. There are three Interruption service subroutines such as the timing interrupt, the external zero interrupt and the communication receiving interrupt. The timing interrupt realizes the function of delay and overtime control etc. The external zero interrupt sends the communication completed semaphore.

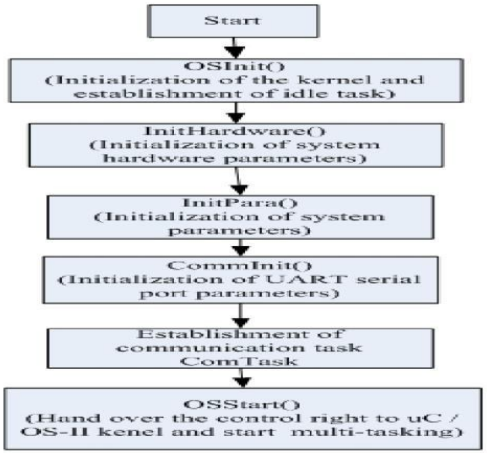

Fig. 3 : The flow chart of system main program

The functions of communication task: (1) Reset the pointer of the reception buffer, set the permission sign of sending, call the function of OS Sem Pend () for waiting for the response frame, set the overtime and switch the task of RTX51 kernel. (2) After the kernel switched to the idle task, send request frame in the function of OS Task Idle Hook () of idle task, and reset the sign of sending permitted. (3) a: Receive the semaphore of communication accomplish-ment, that is, receive the response frame. Process data if the data checking is correct. Else, handle it as error. b : Overtime processing if overtime and not receive response frame. The function of communication service interrupt (not managed by RTX51(kernel):
(1) Receive data and send it to the buffer.

(2) Plus one to the receiving buffer pointer.

(3) The data length of the receiving buffer reaches the predetermined value.

(4) Trigger the external zero interrupt.
External service zero interrupt (managed by RTX51 kernel):
(1) OS Sem Post () send the semaphore of communication accomplishment to the task of communication processing.

(2) Call the function of OS Int Exit(), switch task in the kernel, and back to the highest priority task, that is the communication processing task.

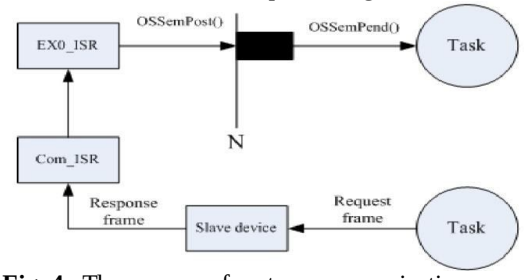

Fig. 4 : The process of system communication dispatching

The process of system communication dispatching is shown in Figure 4, the communication dispatching moves the function of sending request frame to the idle task, and changes the subroutine of communication service interrupt into the subroutine of non-maskable interrupt, and then it cannot be managed by RTX51 kernel. However, services provided by the kernel cannot be used in the subroutine of communication interrupt service, that is to say, the function of OS Sem Post () cannot be called to send the completed communication semaphore. In order to solve this problem, a service subroutine of external zero interrupt is added, which will be triggered after receiving complete response frame in the communication interrupt service subroutine (managed by RTX51 kernel), the function of OS Sem Post() is called in the external zero interrupt service subroutine to send the receiving response frame semaphore. In this way, not only the response speed of communication is accelerated, but also the real-time performance and the reliability are improved.

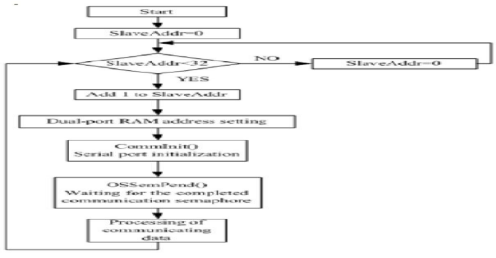

Fig. 5 : The flowchart of communication task program

ISSN 2278-3091

International Journal of Advanced Trends in Computer Science and Engineering, Vol.2 , No.1, Pages : 114-117 (2013)
Special Issue of ICACSE 2013 - Held on 7-8 January, 2013 in Lords Institute of Engineering and Technology, Hyderabad

The flowchart of communication task program is shown in Figure 5. Re-initializing the serial UART after each communication should be taken more attention to, that the accumulated errors of communication baud rate can be eliminated. Communicating with 32 slave equipments can be realized and the address of slave equipments will be sent successively. The function of communication task is mainly data requesting and waiting for receiving interrupt service subroutine. The flowchart of data request program is shown in Figure 6.

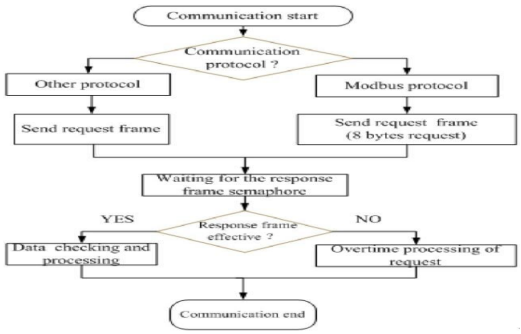

Fig. 6 : The flowchart of data request program

Fig. 7 is the embedded communication protocol Conversion equipment material object.

Fig. 7: The material object of embedded communication protocol conversion equipment

CONCLUSION

In recent years, with the rapidly development of the industrial process control fields and the widely using of the networked, intelligent, and digital distributed control system, the process of the field signals transferred to the host monitoring system must be realized by the communication protocol conversion equipments which can complete the interconnection of different data communication networks. The embedded multi-MCU and high-speed dual-port RAM data sharing technology are used in this paper, and a communication protocol conversion equipment based on embedded multi-MCU and real-time multitasking operating system RTX51 has been researched and developed, which adopts RS232 or RS485 communication interfaces for lower machine such as data acquisition I/O modules, smart intelligent instruments and so on. Then, the data are transferred by Ethernet communication interface to the remote monitoring systems such as DAS or DCS. The function of relaying and protocol conversion in the industrial communication network is realized, thus the serial devices of device layer can be easily connected to the networked control layer.

REFERENCES

[1] J. Li, B. Zhang, D.Y. Qiu. “Multi-computer communication based on Modbus RTU in power quality monitoring system”. Electric Power Automation Equipment, 2007,27,(1):93-96.

[2] B. Xi, Y.J. Fang. “Application of embedding technology in networking of serial-port devices”. Electric Power Automation Equipment, 2007,27,(8): 99-101.

[3] H. Zhang, Y.Y. Huang, D.G. Peng. “EGI based on the Modbus protocol for EWS”. 2007,13(2):15-18.

[4] Y. Yue, C.G. Zhang, A.J. Yuan. “Design and implementation of embedded man-machine interface based on Modbus”. Industrial Control Computer, 2006, 19 (1):8-10.

[5] D. Li, C.Q., Zhong X.F. Yuan, etc. “Study on Embedded Equipment Web Monitoring and Control Based on Industrial Ethernet” Proceedings of the 6th World Congress on Control and Automation, June 21-23, 2006, Dalian, China, pp:4600-4603.

[6] D.G Peng, H. Zhang, L. Yang, etc. “Design and Realization of Modbus Protocol Based on Embedded Linux System”]. Symposia. July 29-31, 2008, Chengdu, Sichuan, China, pp:275-280.