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Empirical Design for an advanced Embedded Remote Monitoring System Based on Computer Network Technology

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Abstract

This study presents a design of an advanced embedded remote monitoring system based on the current computer network technology.This monitoring system carries out a data acquisition process by an embedded field monitor uploads the environmental information and alarm massages to a monitoring center computer and completes the data processing and data storage. The field monitor used in the monitoring system is composed of a data acquisition card and a network transmission card. This monitoring system with low cost simple equipments has practical accuracy that is suitable for unmanned machine room, base station, intelligent community and living house.

1. Introduction

At present, monitoring system has been used in many fields (e.g. factory workshop, unmanned machine room, warehouse, supermarket and community).A personal computer (PC) and computer transmission technology has been employed in the monitoring system in this study. Generally, there are two ways to realize the monitoring device cyberization. The first way is to link the Internet by using TCP/IP technology. The other one is connecting to the Internet via a public TCP/IP transmission interface (or gateway) when a transmission occurred [1]. Because of monitoring devise cyberization, this advanced monitoring system is cost-effective. The main feature of this monitoring system is that the field monitoring devise link the Internet directly by some network transmission channels (e.g. Ethernet, Internet/Intranet). Meanwhile, the monitoring system uses a cheap 51 series microcontroller as the MCU of the field monitoring devise and uses an open source embedded real-time operating system μC/OS- II as the software platform [2]. The use of μC/OS-II system is facilitate the future secondary development of the monitoring system.

The monitoring system is composed of three parts: a field monitor, a monitor center and a client. Figure 1 shows the monitoring system of this study.

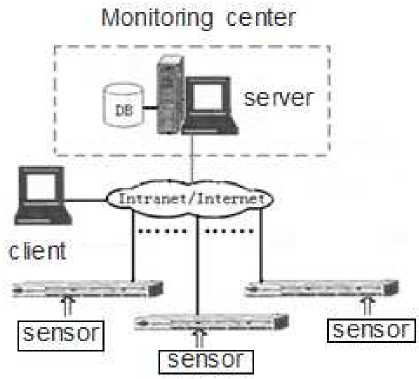

Fig 1. The monitoring system

2. Design of Field Monitor

A field monitor is the most important component in the monitoring system, it is also an important information source of a monitoring system. The field monitor has two main functions: data acquisition and network transmission. In the design of this monitoring system, the field monitor is divided into two parts: a data acquisition card and a network communication card, which is controlled by a microcontroller respectively.

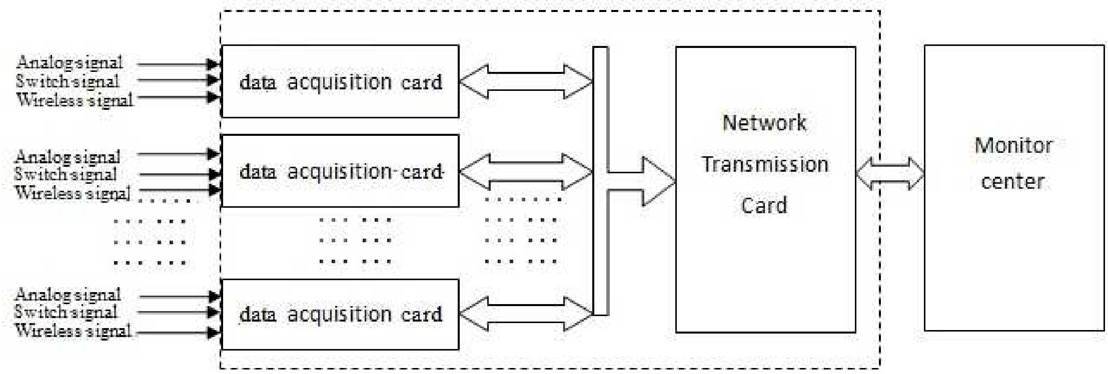

Fig 2 The composition of Field Monitor

2.1 Data Acquisition Card

When the data acquisition card connects a sensor/ transmitter or alarm, it can provide three kinds of input signals: analog signal, switching signal and wireless code signal. The analog signal from temperature sensor/transmitter or humidity sensor/transmitter is usually a voltage value within a continuous range. The switching signal refers to a variable, either “0” or “1” which depends on the signal from smoke, flooding and door sensor/alarm. The wireless code signal refers to existed wireless alarm output codes such as wireless smoke alarm, wireless door sensor, wireless vibration alarm, and etc [3].If a receiving device is added to the data acquisition card, the monitoring system can use a plenty of resources available.This system is suitable for many places such as intelligent community and digital house.

2.2 Network Communication Card

The main fuction of network transmission control card is to establish a connection between the field monitor and the monitor center. The control card will upload the environmental information and alarm messages generated from the data acquisition process to the monitor center server. Besides, when the system starts, all data acquisition cards are initialized, deciding the channels and the threshold of alarm message, etc [3]. The main task of network transmission card is to implement all network transmission functions. Its implementation is to realize TCP/IP technology on the Internet network card. In this study we extend the open source real-time operating system and add the TCP/IP protocol to meet the demands of a monitoring system.

3. μC / OS-II Embedded Real-time Operating System

There are many real-time operating systems available, such as, Vx Works, QNX, uClinux and RTEMS[4].These operating systems have shown fine performances on real-time property and stability. Using the commercial software to develop an embedded monitoring system leads to great expense [4].at the same time, many operating systems do not provide source code. Their inner sanctum operates as “black boxes”. Subsequently, we select the open source embedded real-time operating system μC/OS-II. This system takes less memory, runs fast and lead a low cost. Its real-time performance can completely meet the needs of our monitoring system.

The Transplant Configuration of the µC/OS-II Real-time Embedded Operating System in 51 Single Chip

In µC/OS-II system, the core code of all functions takes only 8.3K bytes. The core code can be even lower to 2.7K bytes since the µC /OS-II system can be cut. Because of the open nature of µC/OS-II, users enable to optimize the code for the hardware to get a better performance [2]. The first task when develop a µC/OS-II embedded remote monitoring system is to transplant the µC /OS-II system into an operating system so the µC/OS-II system can be executed on the embedded microcontroller of the operating system [6]. C language is employed to` write the majority of . µC/OS-II source code.The code referred to three questions about redefinition of the data type, the design of a stack structure, and the save state and restore state when switch a task is written by assembly language. The µC/OS-II system reading and writing the processor registers can only be written by the assembly language. In this study, we select a powerful C language integrated developing environment KeiluVision2 developed by the Germany company Keil to develop the microcontroller [7]. Figure 3 shows the software and hardware architecture of µC/OS-II. The figure demonstrates that the need of completing a transplanting operating system contains rewriting three files, namely OS_CPU.H, OS_CPU_A.ASM and OS_CPU_C.C.

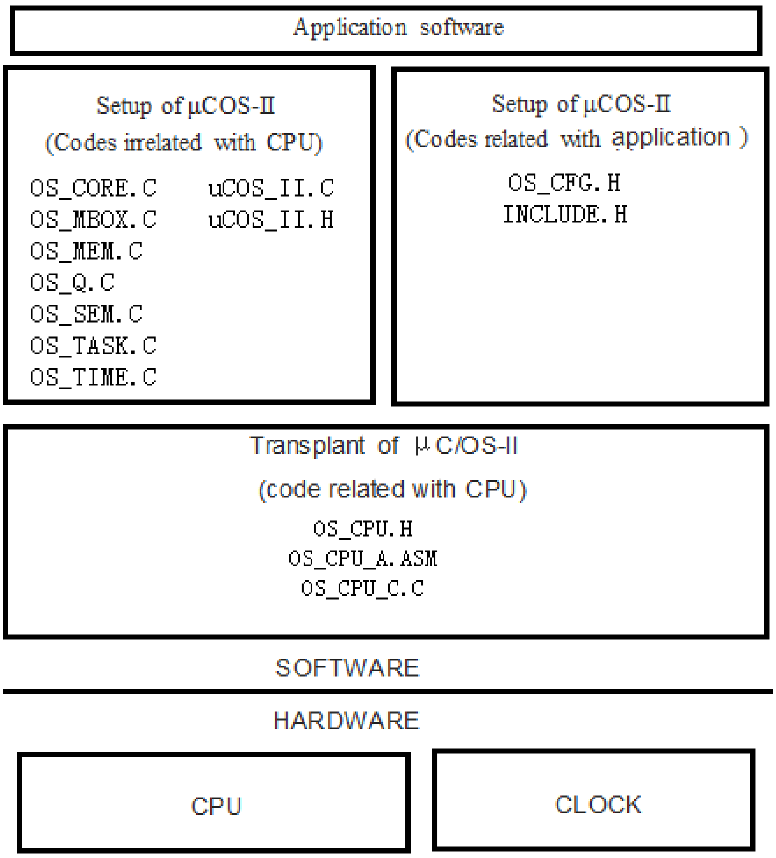

Fig 3. Software and Hardware Architecture of µC/OS-II

4. Monitor Server

The monitor server locates in monitor center, usually a PC. This server connects the field monitor by Internet/Intranet and implements a transmission by using TCP/IP protocol. When the system starts, it establishes a connection between the server and the field monitors and begins to collect data from these monitors. In normal circumstances, a server firstly processes the environmental information collected. Then a change of data is displayed on PC screen according to the setup already established by staff stored in database. When an abnormal circumstance occurs, a server receives some alarm messages sent by the relevant monitors. Meanwhile, the server firstly stores alarm messages in database, then displays these messages on the screen and outputs messages via a computer audio output device. In addition, the server program retrieves relevant information (e.g. accident address, monitor installation address, staff information) to help the staff arranging troubleshooting timely gained from database [3].

5. Field Monitor

The field controller receives the commands sent by PC. This module is controlled by a microcontroller and connects the network transmission card. When alarm messages generated by the field monitor, the PC send commands directly and the field controller receives the commands sent by the host computer and then send the commands to the motor. When no alarm at the scene, the host computer can visit the PC forwardly, send the commands on a basis of the specific needs of controlling the scene.

Conclusion

In this paper, the monitor can directly connect TCP/IP network by the Ethernet interface. The monitor can collect information from various sensors in the field and send messages to the monitor center timely and effectively, warning users there to get the information timely. When an abnormal circumstance occurs, users in the monitor center can send control commands to remedy as soon as possible; meanwhile users can visit the monitor directly and issue to achieve functions.

The advanced embedded monitoring system can be applied in many fields: house network, intelligence community and intelligent home appliances. The monitoring system can also be applied in the factory workshop, unmanned machine room, warehouse, supermarket, unmanned base station, bank, bridge and all-day intelligent monitoring and remote television conference calls. It can meet the needs of users effectively on the remote monitoring area. The monitoring system is portable and easy to maintain, providing an open data accessing mechanism.

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