Distributed Remote Temperature Monitoring and Acquisition System Based on CAN Bus

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Abstract: In modern industrial and agricultural production, the working temperature change reflects the operating status of equipments and change of many physical characteristics, so the temperature is an important parameter, which needs to be monitored, especially in the severe environment. The workers can make right judgments and operation by a temperature monitor. So it is the most effective and most economical means of equipment safety monitoring. A temperature remote monitoring embedded system platform is designed in the paper. And the embedded microprocessor AT91SAM7X256 is used as CPU of the system. The system realizes real-time remote data collection monitoring and storage through protocol data conversion of the CAN bus and RS232 bus of the distributed temperature acquisition node. At the same time, the system realizes the remote temperature monitoring and control through TCP/IP Industrial Ethernet Web. The system platform can be applied to certain equipments of the power system, intelligent agriculture remote monitoring, intelligent furniture monitoring, intelligent warehouse monitoring and so on. The temperature measurement accuracy is within 0.5 ℃. The system is reliable and stable. And there are not communication failures. So it has very good social prospects.

Key words: Embedded; Distributed; CAN Bus; Data acquisition monitoring; Web temperature monitoring

I. INTRODUCTION

In modern industrial and agricultural production, the working temperature change reflects the running status of equipment and changes of many physical characteristics. So it is an important parameter which needs to be monitored, especially in the harsh and complex environment, such as electricity running system, food processing, crop seedbed, poultry hatching, cultivating bacteria and so on. By monitoring temperature, staff can make the right judgments and operation to ensure the most effective and economical industrial and agricultural production.

ARM embedded system have the advantages of low power consumption and reliable utility performance[1]. So it is modern information technology trend that the ARM embedded system is applied to monitor temperature of industrial and agricultural production. This design uses embedded ARM processor AT91SAM7X256 to build the hardware processing platform. The temperature sensor data collected by nodes is transferred to the system platform through CAN bus, and then transferred to the PC through the RS232 interface to monitor and storage data, but also achieved industrial Ethernet Remote Web monitoring. And real-time multi-point distributed temperature measurement is completed.

Ⅱ. System composition principle

CAN bus is one of the most widely used field bus in the world. It is of high rate, high resistance to electromagnetic interference, and it has the function of point to point, one point to the multi-point data receiving and transferring. It is with 10 ｋ ｍ (5kbps) communication distance, with1Mbps(40ｍ) communication rate. And the netword nodes are up to 110[2]. So the system can meet temperature monitoring with a certain region. And the data transfer rate can also meet the general real-time requirements.

AT89S52 is as the control unit in the temperature monitoring node, and the data communication between nodes is by CAN bus. Distributed remote monitoring acquisition temperature system is shown in fig.1. The user can monitor the temperature nodes by the host monitoring machine and store the temperature data into the database for analysis.

II1. Temperature acquisition node

MCU AT89S52 is as control unit of the temperature monitoring node. It can complete a certain range of DS18B20 temperature sensor data acquisiton. The data between nodes is transmitted through the CAN bus.

Hardware circuit

Temperature data acquisition node is composed of AT89S52 from ATMEL Corporation, PHILIPS's SJA1000 independent CAN bus controller, 82C250 bus transceiver, DS18B20 1-wire temperature chips and so on.

SJA1000 CAN supports CAN2.0 Ａ/Ｂ, and it can complete all the function of CAN bus physical layer and data link layer. 82C250 can supports 110CAN nodes[3]. In the program design, BasicCAN model agreement is used. DS18B20 is a new type of temperature sensor produced by Dallas Corporation, with a single －bus structure. It has the function of temperature measurement and A/D conversion. Its measurement range si -55℃～+125℃ with high precision(0.0625℃)[4]. The node' s hardware is shown in fig.2.

As DS18B20 is a single bus and the output si digital, so mutiple DS18B20 can be mounted to a bus to build temperature measurement network. Using AT89S52 P1 port to connect DS18B20 single bus, using DS18B20 sensor node to search algorithm, single bus sensor nodes temperature collection is completed one by one. And the machine address and temperature node value is transferred to host machine through CAN field bus. Temperature acquistion node has good DS18B20 sensor scalability and flexibility.

Temperature acquisition nodes are set to different priorities in order to avoid conflict. And they are identified by ID. The value is smaller, and the priority is higher. In the system, each node has a fixed, static-priority fixed priority scheduling algorithm. The communication baud rate must be coincident when the CAN timing register is set. And the data of each node mask bus must be transferred along one direction when CAN receives code and mask register.

BasicCAN mode initialization code is as follows:

```
#define        NBTR0  0x41
#define        NBTR1  0x14
//CAN bus data transfer rate is 500Kbps
void BasicCANInitial()
{
CR = 0x01;    //placed in reset state
ACR = 0x23; // write acceptance code register, the node address is 0x23
AMR = 0xdc;  // write receiving code mask register
BTR0 = NBTR0; // write bus timing register 0
BTR1 = NBTR1; // write bus timing register 1, set the bus transfer rate
OCR = 0xAA;  // control register output is set to normal output mode
CDR = 0x08;  // write clock frequency register, close the clock
CR = 0x0e; // write control register, enter the normal operating mode
EX0 = 1; // open the SCM interrupt system, receive data
 EA = 1;
}
```

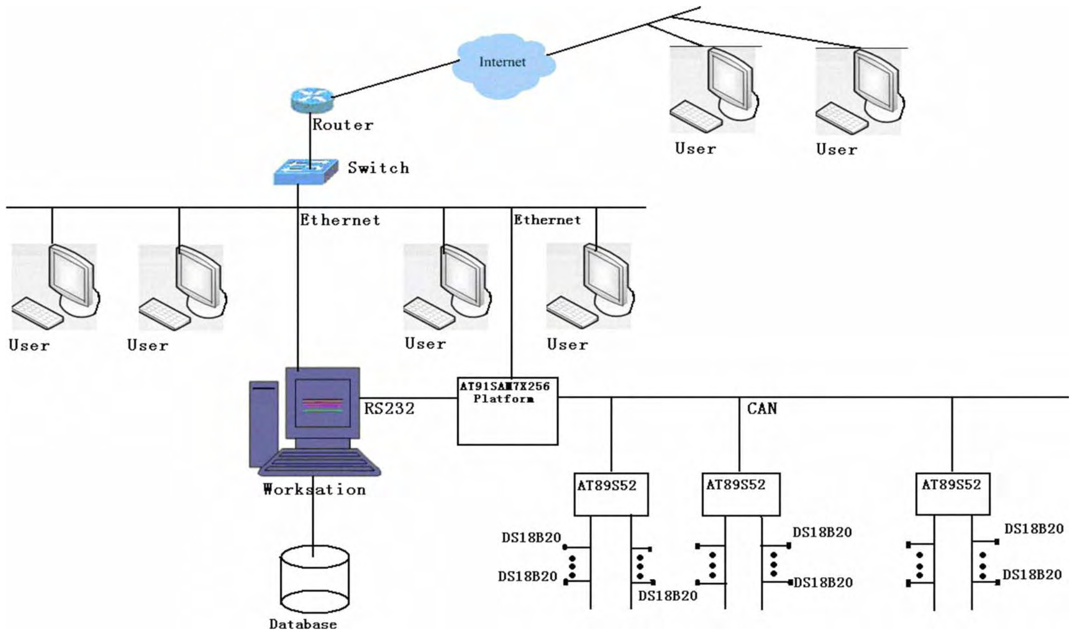

Fig.1 distributed remote monitoring acquisition temperature system

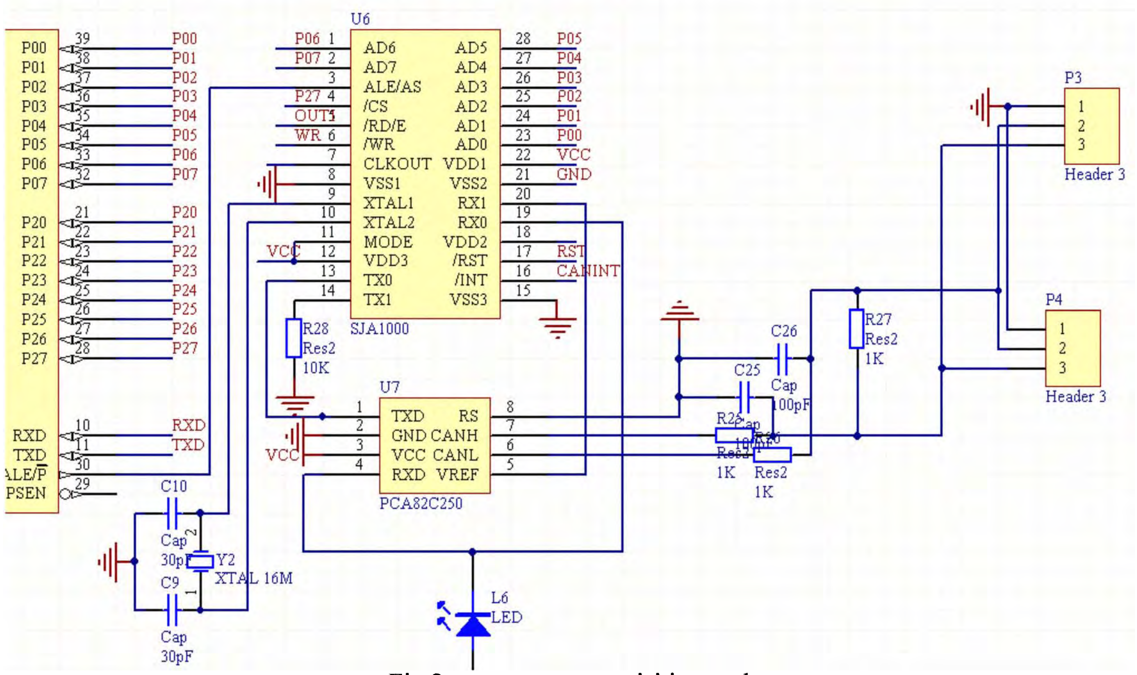

Fig.2 temperature acquisition node

Ⅳ. System control platform

System center control platform is ARM's ARM7TDMI RISC AT91SAM7X256 microcontroller. The micro-controller provides embedded 10/100 Ethernet MAC, CAN, UART and other interface functions. AT91SAM7X256 system platform module includes AT91SAM7X256 microprocessor, Universal Asynchronous Receiver Transmitter, RTL8201BL, TJA1050 and power module. TJA1050 is interface between CANprotocol controller and physical bus. It is shown in Figure 3. And it provides different send and receiver performance for the bus. In serial interface, MAX3232 is as RS232 level converter to be serial port UART. Acoustic signal data reception and transmission are through RXD and TXD. RTL8201BL is a single-port physical layer transceiver, shown in Figure 4. All of the 10/100M Ethernet physical layer functions are implemented.

In the software, the interface chip working method is set, TCP transport protocol is realized by uIP embedded TCP/IP protocol stack for Web. Static IP address, subnet mask and the maximum count of simultaneous connection (UIP_CONNS) are set. Web page uses HTML format. The network client can enter the Web page as long as input the corresponding IP. Data interaction between CAN bus and RS232 is conducted through the break. When data enter CAN bus, interruption is sent. Data in CAN bus are extracted and sumitted to host monitoring machine by RS232, and then data is displayed and stored. At the same time, these data are referred to uIP Web for remote user access. Protocol data conversion between CAN bus and RS232 are realized by AT91SAM7X256 platform to provide remote Web service.

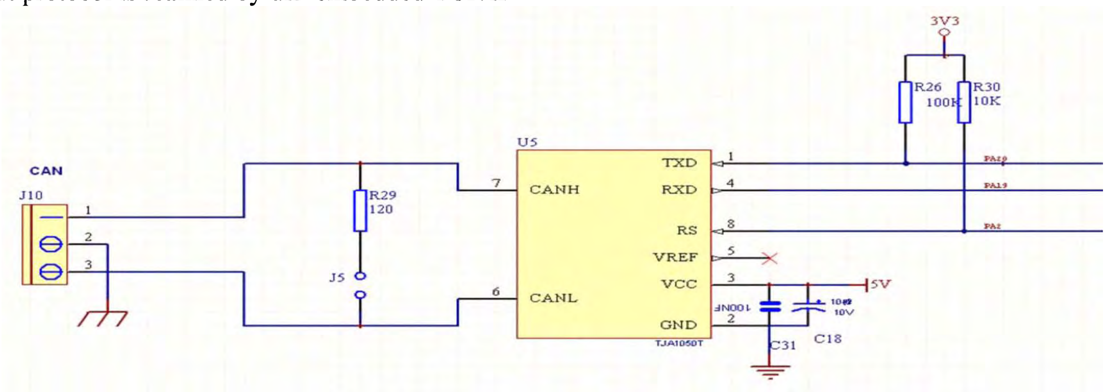

Fig.3 CAN protocol controller

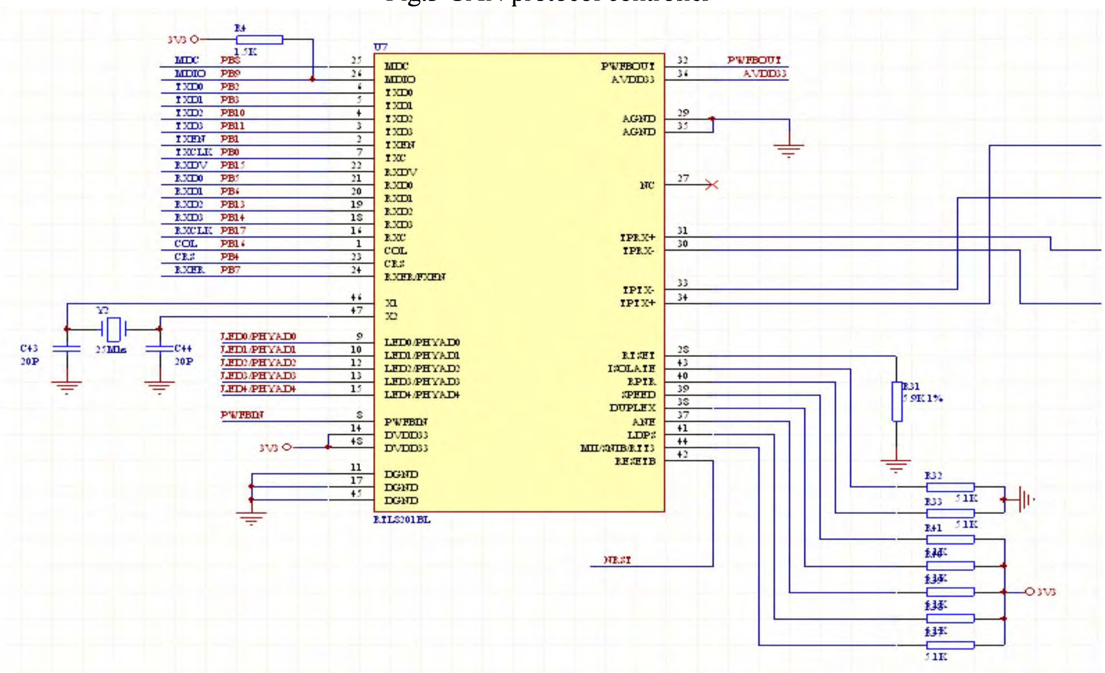
Fig.4 RTL8201BL single-port physical layer transceiver

V. Host monitoring system

Virtual instrument monitoring

Virtual instrument control is realized by LabWindows/CVI. With the serial communication library from LabWindows/CVI, every current sensor can get temperature data, and the data can be display and stored in database. Multi-threaded programming technique is used in the program. So the waveform display and data store can be achieved at the same time. And the data acquisition has real-time continuous. User interface is main threaded program to complete data display. Data store threaded program completes on-site data store as the background thread. With Microsoft ACCESS database, open database connectivity (ODBC) interface uses SQL language to connect data sources and store data. And database inserting, updating, quering, deleting record can be realized. The use of LabWindows/CVI SQL Toolkit:

hdbc = DBConnect ("DSN=client"); //connect database

DBCreateParamInt (hstmt1, "ID", DB_PARAM_INPUT, idvalue); //insert record

Remote Web monitoring

Users can enter AT91SAM7X256 platform site through local area network or Internet for real-time remote temperature monitoring.

Conclusions

According to temperature monitoring needs in the actual production, the design of distributed CAN bus remote temperature monitoring system is completed, and the system design method is described, and node controller and actual circuit of intelligent node are produced. The CAN bus network is composed to verify the program correctness and system stability. System platform can be applied to remote monitoring of some power system equipments, intelligent agriculture remote monitoring, intelligent home monitoring, intelligent warehouse monitoring and so on. The temperature measurement accuracy is within 0.5℃. The system is reliable and without communication failure and it is with certain social application future.

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