Distributed Building Temperature Control System Based on CAN Bus

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Abstract:- This paper proposed a kind of distributed building temperature control system based on CAN Bus, and has produced the system of hardware structure design, the software design, can examine the building temperature and control the exceptional on the real-time, be indicated through experiment that system is reliable and save energy.

Key-Words:- temperature control,CAN Bus,energy saving

1 Introduction

Gradually climbs along with the temperature, electric power industry welcomed has used electricity once a year most seasons: The electric power welcomes a peak summer. Since 2003, the power supplied has become more and more serious in china. And more and more people appeal for building energy conservation. Air conditioning's energy conservation is one of the most important components of building energy conservation[1].

Many public buildings air conditioning is one of highest energy consumption sources in China. Take Beijing as the example, in 2005, although the Beijing large-scale public building only accounts for the whole city civil construction total area 5.4%, but whole year the total power consumption actually achieved 3.3 billion kilowatts[2], approach all inhabitants to live use electricity one half, according to the preliminary understanding, Beijing's public building generally can achieved to energy saving for 30% to 50%through technology transformation, One of most important method is through the real-time examination building interior temperature to control building in air conditioning.

2 The principle of system structure and hardware design

Regarding the different building, its internal room distributes and constructs is different, in order to realize the system construct conveniently, the system uses the distributional structure, Based on the SJA1000 CAN communications platform in order to realize various pitch points reliable communication; In this foundation, the console set each pitch point temperature value setting for every room, and realize the entire building temperature real-time examination, by the LCD demonstration examination result, the unusual situation is reported by the warning through speech Property by the signal and controlled through the gate of air conditioning's system , realization energy conservation goal. The system design goal is measure and control temperature in a building each room, because measured the temperate point and control point is dispersion, therefore the system uses the distributional structure, The console is connected each part of control pitch point distributing in the building through the CAN Bus. System structure diagram like figure 1 shows.

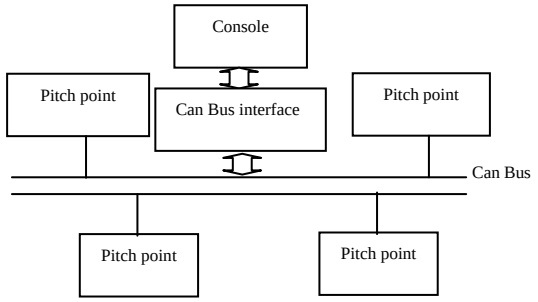

Fig.1 Diagram of system structure

2.1 The console hardware design

The AT89C52 MCU is the primarily controller in console, It connects with the warning module, the memory module, the clock/calendar electric circuit and the keyboard module. its structure drawing see Figure 2.

The control pitch point also is controlled by the MCU, connected temperature examination module and the CAN Bus interface module. The system has used the AT89S52, it is a section low power chip that is produced by ATMEL Corporation, has 4 KB in-system programmable (ISP) FLASH memory integrated. The scene programming debugging and

the system function changing is much conveniently flexible, using AT89S52 to take the system the master controller. When system normal work. The console send a definite control temperature value to a designate pitch point Distributed in the building through the CAN Bus. The pitch point receive the console's orders and read the temperature detector DS18B20 temperature value distributed in each room through 1-Wire bus, transmits each room temperature data and the number of room to the console through the CAN Bus. According to the definite temperature value which receives from console control the air gate of air-conditioning system in each room. After receive the data a pitch point send to, the console reads the time from real-time clock/calendar chip PCF8563 through the I2C Bus, with the data which just received store to the memory AT24C128, then process each room temperature value. When the value achieve the data which is established from keyboard in advance, the console output warring to the alarm circuit on reports the alarm. Meanwhile the room number, the time and the temperature value delivers the LED display circuit to display. Every room alarm temperature value is established through the keyboard input module, the console process value and stores in the memory corresponding the input.

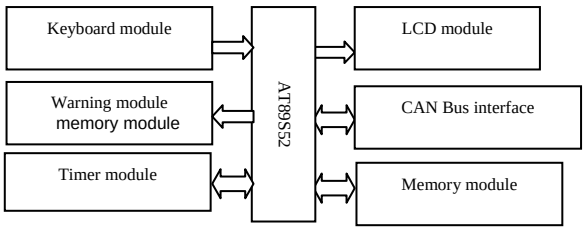

Fig 2. The console structure

2.2 The CAN Bus interface design

The CAN Bus corresponds high as 1 Mb/ s, the most long-distance range may reach 10 km; The CAN Bus corresponds using the short frame structure, spends the data transmission time shortly, so the probability which disturbed is low, and the CAN Bus has good error detecting measures, therefore its reliability is high. In the CAN Bus network each pitch point has an address, any pitch point theoretically can be increased, deleted in the network based on CAN Bus. In the practical application, the CAN Bus network most access 110 pitch points. The network communication method may for the point-to-point way or for the broadcast way, May be the single host way or many hosts way. Therefore, the CAN Bus correspondence has the suitable flexibility. The transmission correspondence information frame can establish the different priority based on the CAN Bus and higher priority information frame can be transmitted first and promptly through the Bus information arbitration mechanism. This increase more important information can promptly transmit, increase the CAN Bus correspondence timeliness. The CAN Bus network suits the commercial processing monitor equipments by its remarkable characteristic, the inexpensive price, the extremely high reliability and the nimble structure.

The pitch point core component is CAN controller SJA1000 which is PHILIPS Corporation produced and CAN driver PCA82C250[3]. SJA1000 is the integrated independent CAN controller (is completely compatible with PHILIPS early CAN controller PCA82C200). It responsibly completes the CAN Bus correspondence protocol function of the physical layer and the data link layer. SJA1000 internal has the control register, orders the register, the condition register, the interrupt register and receives, sends the register and so on, the MCU realizes SJA1000 control through read-write these registers. The Chip of SJA1000 pins TX0, TX1, RX0, RX1 use to connect with the CAN Bus. PCA82C250 is 8 feet chip specially uses to drive receiving and dispatching in the CAN Bus. The SJA1000 pins of TXD, RXD separately receive and send signal after the drive; The twisted pair wire (coaxial cable) transmits the medium separately to meet to the chip of PCA82C250 pins CANH, CANL. Considered the scene has various disturbance, the high speed light isolation components (6N137) are added between the CAN controller SJA1000 and the PCA82C250[4].

2.3 The pitch point hardware design

The pitch point mainly includes the CAN Bus interface, the control module of the air gate of air-conditioning system and temperature sensor DS18B20, the system structure like figure 3 shows.

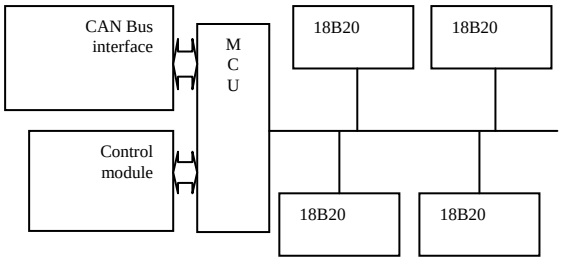

Fig 3. Pitch point hardware structure

The DS18B20 is DALLAS Semiconductor Corporation's newest 1-Wire Bus digital temperature sensor[5]. Its volume is smaller, suitable voltage is wider, and more economical. 1-Wire Bus is unique

moreover the economical characteristic. The user can set up the sensor network with ease. The 1-Wire Bus directly transmits scene digital temperature and greatly enhanced the system anti-disturbance ability. It supports the voltage of 3V~5.5V. So the system can be designed nimbly and conveniently. The ROM in the DS18B20 has stored 64 bits serial number .It was written with the laser before leaved the plants, it can be regarded as each DS18B20 address serial number. The 64 bits serial number arrangement is: the first 8 bits is the product type marking, the DS18B20 product series code is fixed is 28H; After that 48 bits are this DS18B20 own sequence numbers, and these 48 sequences number is only one in the whole world, finally 8 bits are the front 56 cyclical redundancy check code. So use the 64 bits serial number we can divide each DS18B20,and we can meets many temperature sensors of DS18B20 on one1-Wire Bus.

According to DALLAS Semiconductor Corporation's material, on each 1-Wire Bus can connect mostly 248 1 - WIRE components [5]. But we discovered. It was not so in practical. When one 1-Wire Bus meets more than 8 DS18B20 sensors, the system must to solve the question that MCU drive 1-Wire Bus, otherwise the MCU cannot correctly read and write to DS18B20 through 1-Wire Bus. Simultaneously the fastest 1-Wire Bus length which connect DS18B20 sensor in system is also limited. In full-scale test, when uses the ordinary signal electric cable as the 1-Wire Bus to measure, the length surpasses 50m, it take mistake that the MCU reads DS18B20 sensor through the bus. When the bus is changed the twisted pair cable with belt shielded, the correctly communication distance can reach 150m. Therefore in this system, each pitch point we most meets 8 DS18B20 sensors in one 1-Wire bus, and the bus is no more than 150m with the twisted pair cable with belt shielded. The system design like this is make sure the MCU can drive the 1-Wire bus, and can be satisfy with the communication and stability.

3 The system software design

In this system, the software design mainly includes two parts : The console software design and pitch point software designs. The figure 4 shows console software structure.

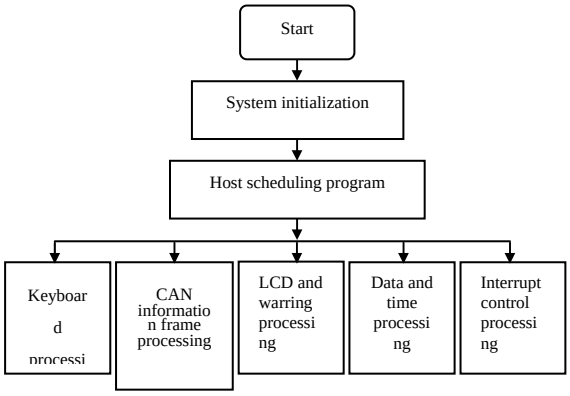

Fig 4. The console software structure

3.1 The console software design

The console software divides for the initialization module and the host scheduling program module In general. The initialization module is executed only power on or reset. The host scheduling program module includes CAN information frame processing processor, key processing processor, the LCD processing and warring processor, and so on data and time processing processor, interrupt control processor.

The host scheduling program module is responsible to manage the processors running. When the event occurred, the processors do it will be activated and executed, otherwise the processor will be jumped.

The system initialization module establishes the system's operating environment, including CAN interface initialization, clock chip initialization and so on. The key processor is handle to the key pressed and keyboard input. The CAN information frame processing module realizes the console and between each pitch point communication agreement using the CAN Bus. The LCD and warring processes is handle to delivers the data to the LCD display and control warring circuit to alarm according to the data-time processing module process result demonstration. The data-time processing module is handle to the data which accepts from the CAN Bus and preserved in AT24C128, and control warning circuit to alarm according to the system c time and the temperature value set each room. The interrupt control processor uses to realize the CAN Bus interface communication.

3.2 The pitch point software design

The pitch point receives the data frame from console through the CAN Bus. From these data frame the pitch point obtains each room temperature limit

which control. The pitch point reads temperature value through the temperature sensor DS18B20 in each room. Comparing with this room temperature limit value, the pitch point will control the gate of air-conditioning system if the value surpass the limit value, And report the room number and the temperature value through the CAN Bus to the console.

According to the DS18B20 communication protocol, That the MCU of pitch point controls DS18B20 to achieve the temperature transmission must include three steps: First, the MCU must be reset the sensor DS18B20 before each read-write. Then, after successfully reset, the MCU send a ROM instruction, finally the MCU transmits the RAM instruction, As this, the MCU can carry on the operation to DS18B20 which prearranges [5]. It must be attention that the MCU should put down the 1-Wire bus for 500μs at last to carry out reset. Then pull on to release the bus. After the DS18B20 receives the signal to wait for about 16 ~ 60μs, send out 60 ~ 240μs existences low pulses, the MCU indicate reposition successfully after receiving this signal [6].

When the MCU executes the program to flow diagram which the sensor DS18B20 measured temperature, it sends out the temperature transformation order. The MCU should wait for the sensor DS18B20 returns to the low signal. Once a sensor DS18B20 contacts with the bus not good or broken, the MCU will not read the low signal and will enters the endless loop for waiting. So we use a MCU's timer interruption to solve this problem in system.

4 Conclusion

After the field test, this system can realize the building temperature examination and control effectively.And this system can be applied to other equipments testing and control in order to realize building intelligent management. While CAN bus is an effective support for distributed industrial control serial communication network, the system can also be widely applied to other needs real-time multi-point measurement and control areas.

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