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DESIGN AND IMPLEMENTATION OF WIRELESS DATA AQUISITION AND CONTROLLING SYSTEM USING ARM PROCRSSOR

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ABSTRACT

In the process of short distance data collection, there have some problems, such as the duplication of work, the complexity of cable connection, the requirement of real time data processing and the electromagnetic interference and so on, so we design the system of data acquisition based on cortex-M3 and virtual instrument. The system uses Cortex-M3 core ARM processor to accomplish the data acquisition of the closed environment, use the serial port module to implement the data transmission, and use the virtual instrument to handle the received data in the host computer. Finally, the test shows that the system with the transmission rate less than 119200bps can ensure the stable and reliable data transmission. The system can be used widely in the wireless data collection, the wireless handheld meter reading and the industrial real time information collection.

Keywords: Cortex-M3, Data Transmission, Baud Rate, ARM Processor.

INTRODUCTION

With their continuous development, wireless communications technologies have been applied to life extensively. There are several common wireless communication technologies, such as Bluetooth, WSN [1], wifi, zigbee, IrDA, GSM et al. But there exist many problems in the data collection process, such as repetitive human work, complex cable connections, real-time requirement of data processing and electromagnetic interference. Taking into account the application range of various techniques, the cost of data transmission, security, reliability and other factors, Bluetooth communications and wireless sensor networks are the most appropriate method in short range wireless communication and data transmission [2]. Further, the Bluetooth technology can solve the problems mentioned above. The system shown in this paper uses the Bluetooth communication technology for wireless data transmission, uses multiple sensors for data collection, and uses the virtual instrument software to monitor and process the data of all nodes [3]. The advantages of this system are that the data acquisition is multi-channel, and the software based on the short-range wireless data collection runs fast. The system can be widely used in many fields, such as short-range wireless data collection, handheld meter reading and industrial real-time information collection.

2. THE PRINCIPLE OF THE DATA ACQUISITION SYSTEM

Wireless data acquisition system consists of two parts, the part of the data acquisition and the part of the data processing in the host computer. The data acquisition part of the sensor circuit is responsible for receiving the external signal, and these changeable signals can be amplified through the amplifier circuit. The amplified signal will undergo a process of AD conversion through the peripherals of the microprocessor LPC1768, which have a 12-bit high-resolution ADC. According to the requirements of the PC software, the converted data can be the collected data for real-time transmission, or stored in FLASH, waiting for the host computer to read. The wireless data collection systems also provide I2C serial bus interface, which is used to connect the serial bus

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sensor. Through the internal multiplier of LPC1768, the speed of the crystal oscillation circuit with external 8M crystal can be achieved 72M. The power of the Data acquisition system is provided by a 3.3V power. In the PC, there is a Bluetooth serial port receiver module, which is responsible for receiving all the data returned from the slave machine. The circuit of USB is responsible for the communication between the USB and the PC serial port. The block diagram of the Wireless data acquisition system is shown in Fig. 1.

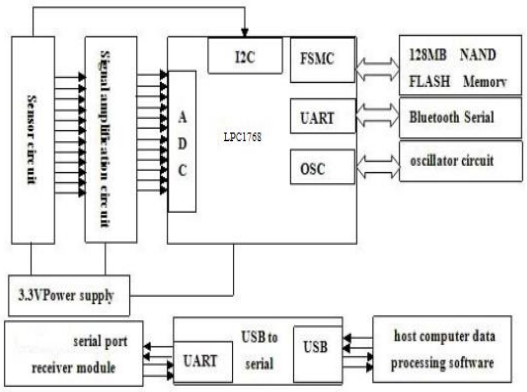


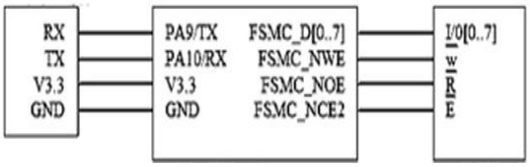
Fig.1. The block diagram of the Wireless Data Acquisition System

3. THE HARDWARE DESIGN OF THE WIRELESS DATA ACQUISITION SYSTEM

We use the LPC1768 Microprocessor as the host controller, which has 144 pins. The processor has a FSMC controller, whose data and address lines are separated. The FMSC controller can easily read and write the NAND FLASH. In order to store a large quantity of data in long time ADC conversion, the data acquisition module stores data through an external 128MB NAND FLASH. The LPC1768 has a 16-channel 12-bit resolution ADC converter, and the maximal conversion time is about 1.17us. The main controller has five USART asynchronous serial ports for serial communication. The Bluetooth serial module is the CSR's Bluetooth chip, BlueCore4-External. Its standard is the Bluetooth 2.0 protocol one with compact size, efficient antenna and transparent serial port. It also can be paired with the Bluetooth adapter and the Bluetooth cell phone, or be used as the master-slave mode [4, 5, 6]. According to the actual needs, we can choose the proper sensor or the sensor with an I2C serial interface as the sensor circuit and the signal amplifying circuit. During the tests, the selected sensor is the CAT6095 in this system, which is a digital temperature sensor with I2C interface, and measures the temperature ranging from -40 degrees to 125 degrees with the working voltage of 3.3V.

A. THE CONNECTION DIAGRAM OF THE HOST CONTROLLER MCU AND THE SERIAL MODULE

The main controller is connected with the NAND FLASH using the Samsung K9F1G08 FLASH Memory. The Bluetooth serial module has solidified the connection interface with the outside world, so we can simply connect the serial port of the host controller STM32 with the module. The interface of the Host controller, the serial module, the FSMC controller are shown in Fig. 2.



B. THE DESIGN OF THE UNIVERSAL SERIAL PORT

The serial module is the core part of the wireless communication system, which takes the important role in the entire wireless data communication system .We use the CSR's BlueCore4-External chip in the Bluetooth module. The chip provides USB, UART, SPI and external FALSH interface. In the hardware design, it is a modular design for the host control circuits. The main control circuit can communicate with the serial port.

C. THE USB SERIAL PORT MODULE

In the entire wireless communication system, there is a Bluetooth module connecting with a PC as the host node. The slave Bluetooth nodes obtain data collected by the sensor circuit through the serial port, and then send information by the

The nodes will receive information from the slave machine, and convert it to serial port information. In order to accomplish the communication between the PC serial port and the Bluetooth serial port, we have a level conversion. The common circuit is the MAX232 converter one. However, in our design we use the CP2102 chip, which can accomplish the communication between the PC serial port and the Bluetooth serial port through the USB interface. This method can also provide power for the Bluetooth host node. The entire module circuit is shown in Fig. 3 [7, 8]. As CP2102 interface shown in the figure, we only need to connect the USB data cable to CP2102.

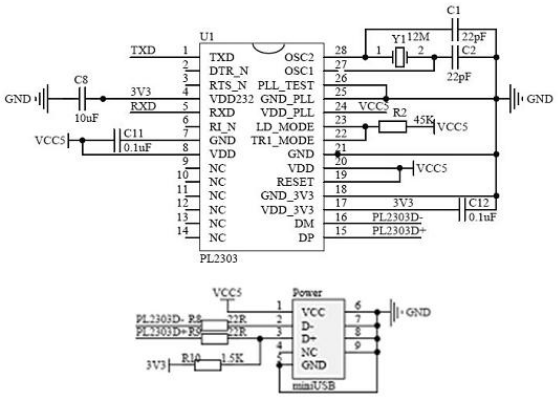


Fig.3. USB serial module connection diagram

D. THE DESIGN OF THE POWER SUPPLY

We designed two power supplies. Those are the USB interface power supply and the AC/DC adapter power supply. Both will eventually use the regulator circuit as shown in Fig. 4. The regulator chip ASM117 accomplishes the power supply conversion from 5V to 3.3V. The four capacitors accomplish the filtering of the power supply.

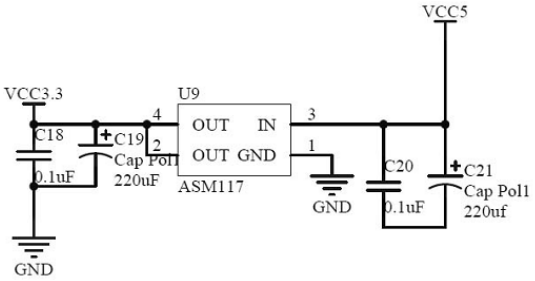


Fig. 4. The diagram of the power supply

4.SOFTWARE DESIGN

The wireless data acquisition software consists of two parts. The first one is the driver involved in the hardware, whichincludes the driver of the digital sensor, the LPC1768 and its peripherals, the USB controller driver configuration and the drive configuration of the Bluetooth Serial Module. In the hardware drivers, each one must be properly configured. The most complex drivers are the USB driver and the driver of the Bluetooth chip. The second one is the Labview PC software programming on the PC side. The host computer software controls each node and can enable data transmission and data processing. In the pc software design, the core is the VISI hardware interface driver. The wireless data acquisition system uses the VISI's serial port driver to communicate with the wireless transmission module**.**

A.THE HARDWARE DRIVER CONFIGURATION

In software design, the hardware drivers are very important. They determine whether the hardware can work normally and the system can run normally. The Driver configuration process is shown as the follows.

1) Configuring the system clock and enabling the peripheral clock.
2) Configuring the processor STM32.
3) Configuring the CORTEX-M3 peripheral, the SPI, the ADC and the I2C.
4) Configuring the FSMC controller and the NAND FLASH.
5) Entering the main loop until it receives the information from the Bluetooth serial port, and beginning data collection.
6) Sending the collected information via Bluetooth.
7) Turning off data acquisition, entering the loop and waiting**.**

THE DOT NET INTERFACE

As the topmost part of the wireless data acquisition system, the feature of the host computer software is processing the data collected by hardware in a PC. In order to accelerate the software development process, we have adopted the GUI to build software. For the complex architecture of the .net virtual instrument, VISI can connect with the common buses, such as GPIB, USB, serial an d Ethernet et al. The GUI also provides the bus VISI driver. The whole design process of the host software is the following,

8) Configuring the PC serial port.
9) Selecting the data collection node.
10) Enabling data transmission and reading the memory through the underlying hardware.
11) Data processing and preservation.

5. RESULT

The sensor part of the data acquisition system is connected to several temperature sensors. The following diagram is the temperature data collected by three nodes.

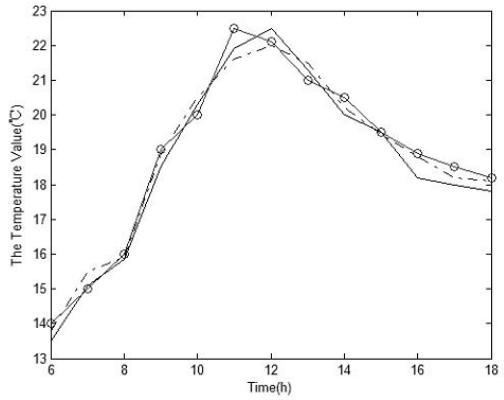


Fig. 5. The temperature data collected by three nodes

According to the actual needs of the project, the wireless data acquisition system can be equipped with multiple sensors for data acquisition. The LPC1768 has 16 ADC and multiple I2C, so the sensor and the entire system can be easily connected. Similarly, for the USB host computer software program, we can quickly upgrade it by increasing the corresponding handling events in the basic software program. This system can be used extensively in real-time information measure and collection and wireless handheld meter reading.

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