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ARM9-based pipeline wireless monitoring and positioning system design

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ABSTRACT

In order to solve the heating during transport pipeline segments, the leak detection and localization data collection method defects,we developed S3C2440 as the core platform for embedded industrial control hardware and software based on the ARM9 core processor features, studied the use of GSM network modules of pipeline wireless monitoring and positioning systems and detailed the design methods of the hardware and software. The system uses a wireless data communication method to solve the data acquisition of crude oil in the pipeline transportation process remote real-time temperature and heating equipment, remote areas even is the point of no man's land pipeline leak detection and precise positioning.

KEYWORDS

AMR9; Pipeline; GSM module; Embedded.

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INTRODUCTION

Pipeline transportation of crude oil is an important channel. Pipeline transportation system is a large and complex integrated system of transportation pipelines and oil stations, tank farms, pumping stations, manifolds and monitoring instrumentation, control equipment. Especially wide pipeline distribution lines long, away from the city, through the complex environmental conditions, the sparsely populated mountain, swamp or undersea. Some pipeline through areas of low temperature must be heating the pipeline to open circuit. Pipeline along the distribution of heating equipment in the field, the central control room can not know the real-time pipeline temperature and heating equipment is working properly or not, only to rely on the manual inspection of the pipeline safety management, send someone along transcribe data and view the state of equipment a day, efficiency is verylow,can not protect the pipeline transportation security and stability effectively. In addition, due to corrosion, geological disasters and man-made factors, but also the pipeline leakage and other accidents, the great hazards to the safe operation of the pipeline. How to build the economy, reasonable monitoring system, the implementation of effective monitoring and management is an important topic of today's petrochemical field research.

The means and methods of artificial intelligence, surveillance, and full use of modern communications technology, control technology, computer and security management technology, the establishment of a pipeline monitoring system resolves crude oil pipeline transportation process real-time temperature and heating equipment data acquisition, monitoring pipeline crude oilleaks and positioning, timely detection and treatment of anomalies that have emerged, and can effectively improve the security capabilities of the oil transfer operations, enhance the level of automation and control, business management level, savings in operating costs, improve work efficiency, improve the economic efficiency of enterprises and competitiveness.

As a special use of the wireless network, wireless digital surveillance comprehensively pushes forward with the process of information gradually favored by the majority of users. Its easy installation, flexibility, and cost performance characteristics make more industry monitoring system using wireless means, to establish the connection between the monitoring points and monitoring center. In this paper, based on ARM9 embedded development platform, pipeline wireless monitoring and positioning system design using GSM network resources. The system is used in place of the data collection and testing of artificial methods in the oil and gas pipelines, is not only safe, reliable, easy to control, and high accuracy, very useful.

STRUCTURE AND HARDWARE MODULES OF OVERALL SYSTEM

The structure and function of overall system

The systemcomponents by the end of data acquisition, I/O interface, ARM9 core module, GSM module and remote control terminal. It allows field data from the transmission to the front-end collection ARM9 core module for processing, wireless transmission via GSM module to the remote control terminal to monitor the processing set of digital remote control process. The overall structure of the embedded remote pipeline monitoring system is shown in Figure 1.
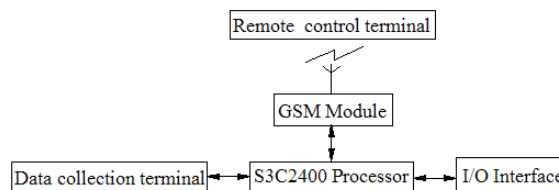
Figure 1: Overall system structure

As industrial field controller, embedded ARM9 core module is able to meet the needs of remote monitoring systems. The ARM9 internal integrated system equipment required for a variety of communication interfaces. For example, ISA bus interface is responsible for the A/D conversion chip device communication; RS232C serial interface is responsible for the GSM module and GPS integrated receiver communication and flow metering module communication, as well as program debugging, parallel communication, responsible for the alarm anddata exchange interface. ARM9 internal integrated interrupt control systems, and real-time data acquisition and processing for GPS school, providing a to establish reliable real-time task scheduling conditions,contains an internal real-time clock standby power support through the system command to get the current system time and date; while conducive time correction. It as a mature industrial product isable to work in tougher conditions, high reliability, and a large number of resources available.

The system has the following functions and features:

1) With the data collection capabilities, in order to get the pipeline operating parameters of pressure, temperature and flow field instruments;

2) The signal from the field instrument or sensor output signal conditioning, to satisfy the follow-up system for signal analysis, processing of the request;

3) The signal is processed locally, to complete the analysis and alarm conditions;

4) Data analysis to the central monitoring system to provide accurate flag having a high time pressure, temperature and flow rate signal;

5) As a long-running industrial equipment, systems should have the characteristics of low power consumption, high reliability;

6) With the real-time clock and time calibration mechanism;

7) With a data backup storage function.

Hardware structure of overall system

The Samsung embedded S3C2440 processor as the core, it is a 16/32 bit RISC microcontroller ARM920T core, clocked at up to 400MHz, 289-pin FBGA package, the rich chip set, for embeddedtype equipment to provide a low-price, low-power, high-performance micro-controller solution. Designed in a modular design concept extends the UART interface is used to help complete the product design during debugging; configuration JTAG interface, user-friendly download debugger completed procedures burning; equipped with a GSM module interface, it through the RS232C serial ARM exchange information using standard AT commands and remote control terminal to achieve a variety of wireless communication function. SDRAM program memory meets the requirements of the LINUX operating system running on a large program memory, and is equipped with a LCD display interface, the interface used to complete the humane. SDRAM program memory with FLASH data memory, used to permanently save the collected data. The system hardware structure is shown in Figure 2.
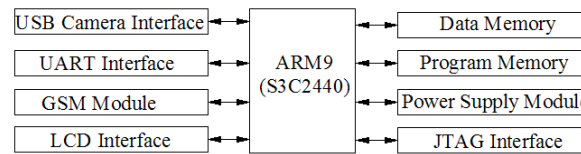

Figure 2: System hardware structure

The frequency of the main processor is about 400MHz, belonging to the high-frequency circuit board. In the design process, reduce the line asked interference and EMI to become the focus, the focus is to use a good part of the EMI conduction, bypass capacitors and decoupling capacitors. Bypass capacitor must be arranged in the shortest connection to the chip power supply pin and ground lines. Decoupling capacitors on the current demand changes where the greatest noise coupling from the power supply and ground lines out. Of course, reasonable series using magnetic beads, you can "absorb" these noises. For the same signal line through the different layers, the characteristic impedance of the signal continuously rules linewidth to be consistent between the different layers. For the interference of the different layers of the question, to ensure alignment between the two adjacent must follow the principle of vertical alignment will reduce interference. Through the application of the above measures, the entire hardware circuit stability is greatly enhanced.

GSM module

Based the GSM module product development is often based on the ARM platform, using the embedded system development. Some GSM module has "open embedded platforms" function allows the user to program embedded software platform module.

SIEMENS, VECOM, SIMCOM industrial grade GSM module manufacturers in the marketcurrently. The TC35i new industrial GSM Siemens module is a support Chinese SMS industrial GSM module, can work in GSMg900 and GSM1800 dual band power range dormant for DC 3.3V ~4.8V, the current consumption of 3.5mA, idle state 25mA transmitter state 300mA (average), 2.5A (peak); transmit voice and data signals, power EGSM900 (4 classes) and GSM1800 (1 class) for 2W and 1W, respectively, through the interface connector and antenna connector connecting the SIM card reader and antenna.

The TC35i module mainly components by the GSM baseband processor, the GSM RF modules, power supply modules (ASIC), flash memory, ZIF (zero insertion force) connector, antenna interface. As the TC35i core, baseband processor to handle voice and data signals within the GSM terminal, and covers all of the analog and digital functions in the cellular radio equipment, FR, HR and EF voice channel coding support the premise of no additional hardware circuit. TC35i data interface (CMOS level) via AT commands can be bi-directional transfer instructions and data, optional baud rate of 300bit/s~115Kbit/s, automatic baud rate for of 1.2Kbit/s~115Kbit/s. It supports SMS (Short Message Service) Text and PDU format, available through AT commands or off signal to restart and Recovery.

Data communication circuits complete the short messaging software flow control, with ARM9 communication, and other functions. The TC35i of data access ISI Serial Asynchronous Receiver in accordance with ITU-TRS 232 then IS1 circuit standard CMOS logic level 2.65V Data interface is configured for 8 data bits, 1 stop bit, no parity, can run 300bps~115kbps baud rate support automatic baud rate of 4.8~115Kbps (14.4 kbps and other than 28.8 kbps). The TC35i module also supports RTS0/CTS0 hardware handshaking and XON/XOFF software flow control. Data communications circuit MAX202E to TI's chip as the core, to achieve the level of conversion and serial communication functions.

GPS checking the clock module

When positioning the pipeline leak required along the pipeline processing system of the monitoring station has the same time base, in order to mark on the acquisition time. The time base in the system from the embedded ARM9 processor's

internal real-time clock, after the day after the error may reach 1S in practical engineering applications, which may bring about 1km positioning error, so the school when the mechanism should be established. Method usually off-site school can use the GPS system to eliminate the system timing cumulative deviation.

Global positioning system GPS (Global Positioning System), working satellites do not ask the time and ephemeris information off the transmitter. Users can take advantage of the integration of the receiver to receive this information, to complete the system of local positioning and school. GPS system monitoring station system based school to the world when, in order to reduce the accumulated error of each system clock and the time base and bring the system deviation.

The system uses GPS integrated receiver the GSU36 module, and cycle 1S pulse, the pulse front with Greenwich Mean Time difference of no more than 1µS. Directly out of the real-time considerations, system, the embedded ARM9 internal COM1 serial port GPS integrated receiver module serial port connection, so that the serial interrupt service routine reception and processing the serial time sent by the GPS receiver module information; module external interrupt port line receiver module the 1PPS seconds pulse connected to the pulse transition triggered external interrupt service routine, write the exact time the system real-time clock to complete the checking clock.

DRIVER SOFTWARE OF DATA COLLECTION TERMINAL

The front-end of the embedded industrial monitoring and control system for the information collection end. The environmental information acquisition is completed, primarily through the sensor and camera. Information collection end of the field information collected, including temperature, pressure, and on-site video information acquisition. The collected information is sent to the controller for processing. In order to complete the exchange of the controller of the sensor data must S3C2440 GPIO interface. The S3C2440 processor system uses the 130 general-purpose I/O interface, 24 external interrupt source can be connected to a wide variety of hardware sensors and actuators. As the Linux system, the application is not directly on the hardware operation, it is necessary to build a communication bridge between the hardware and the application, which is the driver.

Linux operating all hardware abstraction pairs file operation. The write drivers such as open (), read (), write (), close () function in debugging drivers can compile them into modules in the form, and then use the *insmod* command will register driver into the kernel. The following two functions is the driver module load and unload functions.

staticint_initSensor_init(void){}
staticvoid_exitSensor_exit(void){}
module_init(Sensor_init);
module_exit(Sensor_exit);

Such driver loaded into the kernel, the application calls the driver using *insmod* command to load the driver has been assigned to it by the name of the device. During system commissioning, use *insmod* command and *rmmod*commands can easily drive module loading and unloading, when the end of the system development, large quantities applied to actual industrial control, they can be compiled into the kernel. In this way, by calling the following function sensors, video cameras, peripherals, data acquisition and control.

int open(const char * path,intoflag,…);
ssize_t read(intfd,void* buffer,size_t count);
ssize_t write(intfd,void* buffer,size_tcount);
int close(intfd);

These are the few drivers to complete function to open and close the device entry point for people to read and write data to the device.
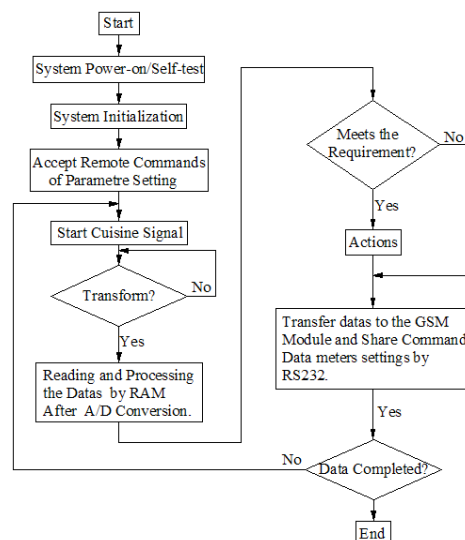

Figure 3:System main program chart

MONITORING SYSTEM SOFTWARE

Any system requires close coordination of hardware and software, the hardware can increase the stability and flexibility of the system software, the software can reduce the cost of hardware, the two are complementary. The embedded RMON positioning system software including the ARM9 microprocessor software design, network interface communication software design and control data acquisition software design. The various parts of the software complement each other to achieve all the functionality of the entire system. The system main program flow is shown in Figure 3.

CONCLUSIONS

The design is based on ARM9 (S3C2440) embedded development platform, the Linuxoperating system for the center to expand the Internet network intelligent embedded industrial control system to solve the problems of the industrial field RMON. And install embedded network server monitoring system will be an important part of the future of industrial modernization, the use of the ubiquitous network performance embedded technology can be done anytime, anywhere to monitor the entire process of industrial production. After tests showed that the monitoring system has high reliability, and low cost, to achieve high positioning accuracy, using wireless data communication, saves a lot of wired resources in remote areas and can realize even the no man's land of the pipeline leak point detection and location, has a high practical value to popularize.

ACKNOWLEDGMENTS

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