

Application of Wireless Sensor Network and GPRS Technology in Development of Remote Monitoring System

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Abstract

The paper presents application of wireless sensor network and GPRS technology in development of remote monitoring system. The remote monitoring system harnesses embedded technology, wireless sensor network and the GPRS mobile communication technology, to solve the problem of data transmission between data acquisition system and control equipment. This system is real-time, high reliability. This paper chooses ZigBee as protocol based on wireless sensor network. Wireless monitoring system using GPRS technology enables real-time, reliability has been greatly improved. Finally the successful application of intelligent home furnishing system proves the feasibility of this scheme.

Keywords: GPRS, wireless sensor network, ZigBee, remote monitoring

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1. Introduction

The rapid development of computer technology, communication technology and microelectronics technology, make the system domain also is undergoing a great change, network and information has become the development direction of measurement and control system. Integrated sensor network technology, embedded technology and industrial control technology, build a remote measurement and control system based on Web mode can make the measurement and control products in real time, security, maintainability, has been greatly improved, but also more conducive to the realization of centralized monitoring, unified scheduling and management optimization. In this paper, combined with wireless sensor network and GPRS technology introduced an embedded remote monitoring system based on Web mode.

This paper adopts single-chip microcomputer +GPRS+Zigbee control system, due to the restriction of single chip speed and overall performance, late reformation system subject to certain restrictions and constraints [1]. This paper mentioned an industrial monitoring wireless sensor networks and distributed network model based on mobile communication technology, the embedded technology, wireless sensor network and mobile communication technology organically. The two level networks, thus simplifying the physical link between the instrumentation equipment connection, not only simplifies the complexity of the system, but also can reduce the cost of. To solve the problem of data transmission is between data acquisition system and control equipment. This system is real-time, high reliability.

In the remote communication technology all, GPRS has many advantages. GPRS is in the GSM network based on the superposition of a new network, at the same time, increase the number of hardware devices in GSM network, and then through the software upgrade, thus forming a new network logic entity, providing wireless wide area P end to end, connection. Generally speaking, GPRS is a high speed data processing technology, is a kind of new GSM data service, it uses packet switching technology, GPRS users can use a variety of high-speed data services in mobile, including the transceiver. It provides a connection between the mobile user and data network, mobile users to provide high-speed wireless m and X.25 services. Can also take many wireless channel for each user, and the same wireless channel may be shared by multiple users, so that resources can be used effectively. Using GPRS to realize the data packet to send and receive, users will always online and billing according to the flow, time, reduce the cost of service.

Remote monitoring system has a very important significance in the field of industrial control. In many industrial applications, especially for the field and it is the need for regular data acquisition and monitoring. But with the development of digital instrumentation and wireless communication technology, remote monitoring technology field device can conveniently realize remote measuring, actuator and state monitoring, very beneficial to remote device data reading, data management and maintenance of equipment, greatly reduces the maintenance cost for users, more conducive to manufacturer's customer service quality, so the research and design of remote monitoring terminal device has practical significance. The paper presents design of remote monitoring system based on wireless sensor network and GPRS technology.

2. Using GPRS Technology to Development of Remote Monitoring System

GPRS communication has the following characteristics: high resource utilization GPRS introduced the mode of transmission of packet switching, users resources occupied only during the transmitting or receiving data, which means that multiple users can efficiently share the same wireless communication, so as to improve the utilization rate of resources, while the GSM data transmission for circuit switched mode, in the whole connection period, regardless of whether the transfer of user data will be alone occupied wireless channel. Charging for GPRS users is according to the data flow of communication for the charging standard.

This paper mainly to the Internet, broadband ADSL applications, the network camera to capture images, and digital compression, converted into digital signals, and finally through the switch or router or the ADSL video transmission to the Internet or LAN, remote users can directly watch home through the IE browser or mobile phone internet. The market of general GPRS module to send and receive information, use the Linux kernel PPP dial-up mode, and set up the web server to realize remote monitoring purposes in Linux system.

Analog input circuit comprises a sampling circuit, low pass filter, voltage, drive isolation and limiting protection. The sampling circuit to achieve the sensor of 4 ~ 20 mA signal current into a voltage signal; the voltage conversion circuit for sampling the voltage adjustment meet the microprocessor A / D channel input voltage requirements; low pass filter can eliminate power interference channel is simulated and the high-frequency interference; drive isolation impedance input channel matching; limit a circuit to make the A / D input voltage in a specified voltage range, the protection of A / D conversion channel.

GPRS module can clearly locate the malfunctioning of the equipment, the GPRS module as the wireless transceiver module can realize the high quality data transmission failure in a wired network, the embedded system is applied to remote measurement and control system provides a very realistic significance [2]. As the bridge is located in the middle of the local server, monitoring parameters of main control unit receives the upload, and stored in a database, query and analysis of state timing control unit, if it is found wrong, immediately notify the user message. At the same time, the server should also be the data in the database timely feedback to the remote manager, the user to the measurement and control equipment in the first case of monitoring, and realize the operation manager of each control unit.

$$s(t) = \sum_{m=1}^{2^L} c_{s,m}^L \phi_{L,m}(t) + \sum_{j=L}^{M-1} \sum_{m=1}^{2^j} d_{s,m}^j \psi_{j,m}(t) \quad (1)$$

Equation (1) is shown that $s(t)$ is the use of "packet switching" with $s(t)=Cs,m(t)+t$, by concept developed a wireless transmission mode in the ds,m . The so-called packet switching that encapsulates data into many independent packet, then sends the packet a transmitted, the form is similar to mail a package, the package exchange is good only when there is a bandwidth will occupy the data needs to be transmitted, and valuation for data transmission, this is charging mode reasonable for users, such as data transmission of this kind is idle most of the time band. In addition, in GSMphe2 standards, GPRS can provide four different ways of coding, the coding method is also providing different error protection capabilities respectively.

GPRS remote communication module mainly realizes the receiving and transmitting the remote information. The realization of remote is alarm function. And through the GPRS Internet can remote monitoring of home. Because I do not participate directly in the detailed design of the module, so here do not explain too much. The WEB server module provides a remote web

service, the user may through the Internet or GPRS network access to the Internet, remote monitoring at home.

Analog signal analog digital conversion module will be collected into digital quantity, it is regarded as the single chip processing information source, the circuit designed with AD0832 chip as the analog-to-digital conversion chip, the analog signal into the AD0832 into digital values, and then into the T89C55 chip for computing and processing. The display module is mainly taken into account when the site administrator perambulatory, you can easily understand the scene situation real-time, system uses a special intelligent management of the keyboard and LED display control chip HD7279A, using serial interface between HD7279A and processor, the interface circuit and the peripheral circuit is simple, interface line quantity occupied less, only 4, has the high price.

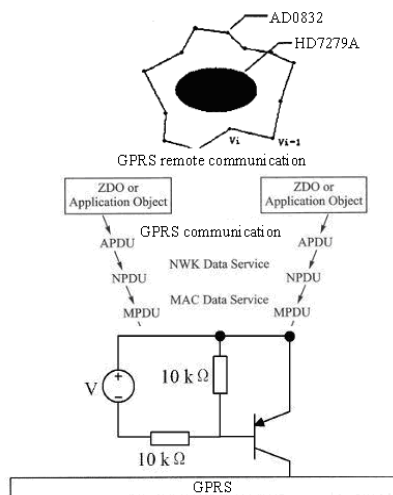


Figure 1. Structure of Using GPRS Technology to Development of Remote Monitoring System

Structure of Using GPRS Technology to Development of Remote Monitoring System is shown by Figure 1. The E5112 end of the RS-232 connected to the G18 interface, the other end is connected with the host computer through parallel port. E5112 provides transparent channel and non transparent channel two working modes. In a transparent channel mode, E5112 MCU data will not be processed directly to send data to the G18, the received data is transferred to the single chip wholly intact [3]. In this mode, short message and voice function by the user via the AT command to realize. In the non transparent channel mode, frame format and E5112 microcontroller through the serial communication.

External storage circuit with a non-volatile memory (power down data retention), is mainly used for the storage of terminal parameter and historical data. Memory chip for selection according to the capacity and the update cycle data, save a small amount of data, use the E2PROM to application update frequency (10000 times in theory erase), and in the application of large capacity and high frequency of update with FRAM (ferroelectric memory erased, theory of 10000000000 times) more appropriate.

GPRS is through the routing management for addressing and establish a data connection, and the routing management GPRS is manifested in the following 3 aspects: the mobile terminal transmits the data routing; routing in mobile terminal data receiving set; and the mobile terminal is in the establishment of roaming data routing. In the first case, when the mobile terminal generates a PDU (packet data unit), the PDU through the SNDC layer, called the SNDC data unit. Then through the LLC layer to LLC frame, to the mobile terminal in a GSM network in the SGSN through the air interface, SGSN sends data to GGSN. GsN received the news for packaging processing, conversion to be transmitted in a public data network format (such as PSPDN PDU), eventually gave a public data network users.

The system adopts B/S mode, in order to control the server or control machine through the browser directly to the intelligent measurement and control unit, the intelligent measurement

and control unit must have the function of Web server. In the embedded Linux platform, using Boa as the Web server can make the system run stably and efficiently in the target system, and convenient use and maintenance, high reliability. The embedded Web server Boa and common Web server, can complete the receiving client requests, request analysis, in response to the request, return to the client request results etc.

The micro kernel architecture core Linux operating system itself is quite simple. Network files system and a module on the top of the micro kernel. The driver and other components at run time as a loadable module compiled into or added to the kernel. This provides a highly modular component method for embedded system customization. But in a typical case of the system should be combined with the driver and application program tailored to provide additional functionality.

Embedded systems often require universal function, in order to avoid duplication of work, the realization of these functions with many off the shelf program and the drive program; they can be used for public peripherals and applications. Linux runs on most microprocessor peripherals on a wide range of applications, and has already ready library. Linux is embedded in the development field of steady development. Because Linux uses GPL, so any of the Linux custom PDA and it is handheld or wearable device to anyone who is interested that I can download the kernel and applications $R_w = (I - wL)^{-1} [wU + (1 - w)I]$ by for free from the internet, $(1 - W)$ as is shown by Equation (2).

$$R_w = (I - wL)^{-1} [wU + (1 - w)I] \quad (2)$$

GGSN and Modem communication based on PPP protocol, negotiation must first carry on the communication link and GGSN Modem dial, parameter configuration of various communication link is point-to-point, negotiation processes follow LCP, PAP, CHAP, IPCP protocol, which LCP is used to build, construct, test link, PAP or CHAP for the treatment of password verification part; the IPCP protocol is used for setting the network protocol, and IP address allocation. The Modem receives a IP stored in a data terminal configuration address field, data terminal to send configuration data frame data center, told the dynamic IP address and IMSI, data center storage information received, as the contact information of transmitting data.

The E5112 interface is the 5V logic, and G18 is the 3V logic, both to connect the use must be RS-232 interface input pin level conversion of G18 (TXD, DTR, RTS) with a tolerance of 5V, maximum voltage can receive 5.5V, so the three output pins of E5112 can be directly connected to the G18 pin. The maximum output value G18 cannot achieve the E5112 tolerant input, should the level conversion, we adopt the drain driver chip 74LVC07 is open to complete this function. It is the circuit level conversion for a signal, 74LVC07 power for the 3V, so you can receive 3V input; and the output end of the pull-up resistor is connected to a 5V, so the output is pulled up to 5V [4].

$$H = [u_1 \ u_2] \cdot \text{diag}(\lambda_1, \lambda_2) \cdot [u_1 \ u_2]^T \quad (3)$$

The Equation (3) is abulut $H=[u_1+u_2]$. The software system consists of the driver and the application software by $[u_1+u_2]T$. Terminal monitoring system software system with data acquisition, processing and storage, remote communication and system management functions, and it is to achieve on-site processing and remote transmission of field data. In addition, you can also use GPRS to access remote update system application system function expansion. It includes the following function modules: data acquisition module (A / D); switch input data acquisition module; output switch module; database management module (including data query and RTC Management); communication module; system module (extended function, support MCU).

GPRS the packet exchange transmission mode, the GSM data transmission original circuit switching mode has undergone fundamental changes, the scarce radio resources in case appears particularly important. According to the circuit switched mode, the entire connection period, regardless of whether the transfer of user data will own the wireless channel. But for a packet switched mode, the user only occupied resources only during the transmitting or

receiving data, which means that multiple users can efficiently share the same radio channel, so as to improve the utilization rate of resources. Charging for GPRS users to communication data volume as the main basis, reflects the "how much, how much" principle.

The basic principle of GPRS is, when users upload or Download Internet data, system is not used when carrying circuit using the service connection, but the use of packet data transmission in the network, can be shared among multiple users of the cyber source, at the same time, network operators can also maximize the use of existing GSM equipment, to avoid the investment GSM equipment waste. In addition, data transfer using GPRS, and the speech transmission using GSM, to download information and communication can be done at the same time. Therefore, it not only can provide all functions of GSM mobile phone communication for GPRS users, is more prominent for GPRS users to provide a more efficient, more convenient, cheaper way to access the Internet, mobile more durable.

Network negotiations can transmit data, supports the TCP/IP protocol GPRS network, so by sending and receiving IP packets to transmit the data, at the same time, terminal system to all contain the IP message PPP message sent by the GGSN will be transmitted to the IP address corresponding to the Internet network, to complete the terminal system to a remote monitoring center through the Internet data transmission.

3. Build of Remote Monitoring System based on ZigBee WSN

ZigBee uses the CSMA / CA collision avoidance mechanism, at the same time set aside special time slot for communication business fixed bandwidth, to avoid competition and conflict when transmitting data: MAC layer adopts fully confirmed data transfer mechanism, each data packet sent must wait for information receiver: network self-organizing strong. ZigBee self-organization function without manual intervention, the network nodes can perceive the presence of other nodes, and determine the connection, composition structured network; ZigBee self-healing function. Add or delete a node, the node position changes, node failure and so on, the network can achieve self repair, and the network topology are adjusted accordingly, without manual intervention, to ensure that the entire system can still work normally.

The RF module and microprocessor connected by RFW102 with matching RFW-D100. The products are mainly used for the transmitter and MCU (micro processing unit) provides a common interface. It can provide the synchronous parallel interface and the memory interface is transparent for MCU and RFW-102, as well as for other properties of performing wireless communication protocol. At the same time, can also converts input data for the 8 bit field MAC operation? In addition, RFW-D100 also has a special design of energy structure and working mode, and the power consumption is very low. Using the RFW-D100 interface chip, greatly reduce the difficulty of design, shorten the design cycle [5].

Query method for large-scale mobile sensor networks, this method uses the mobility of nodes to improve the query efficiency, and introduced the concept of Association (contacts). Its working principle is to first establish correlation between neighboring nodes, as they move, then adjacent nodes associated with new, thus improving the efficiency of the query. Query and traditional routing in different ways, the basic design goal is not to optimize routing or response delay, but to reduce system overhead communication, this point is very important in energy constrained environment, especially for the one-time query sensor number in the network (Communication survival time is very short).

Most applications in wireless sensor network is ZigBee and the RF chip. ZigBee is a wireless technology with short distance, low complexity, low power consumption, low data rate and low cost, a complete protocol stack only 32 kB, can be embedded in various devices, and supports for the geographical location. The above characteristics determine the ZigBee technology is very suitable for application in wireless sensor networks.

In a mobile sensor network model, operation model of static network topology control algorithm and network connectivity cannot be guaranteed. In fact, when nodes move, the value of energy transmission by the mobile topology control algorithm obtained before operation is not significant, which is required for the structure of the network topology is controlled, and $imf(x,y)+rL(x,y)$ so we need to take into account the variability of network topology control in time. Equation (4) is shown by $f(x,y)$.

$$f(x, y) = \sum_{i=1}^L imf_i(x, y) + r_L(x, y) \quad (4)$$

Time division multiplexing (TDMA) is the realization of channel allocation is simple and mature mechanism. TDMA mechanism is adopted in the sensor network, is distributed to every node independently for sending or receiving the data time slots, and nodes in other idle time slots into the sleep state. Characteristics of TDMA mechanism are very suitable for sensor networks to save energy demand: retransmission problem TDMA collision mechanism without competition mechanism; data transmission does not need to control the information too much; nodes during idle time slot to enter a sleep state. TDMA mechanism requires strict time synchronization between nodes [6]. Time synchronization is the basic requirement of the sensor network.

The realization of the basic parameters of node and port configuration parameter are configuration module, and the completion of the gateway node and the sensor node command. Data processing module for parsing and conversion on the received data, and it is when the received data from each sensor node, through the treatment to the data display, provide the data source queries and other applications. Topology display module to complete the display of the sensor network topology, dynamic display transmission path change of topological structure of wireless sensor nodes in the network and wireless data packets, from the topology graph, users can also obtain each node of the current time submitted to the sensor nodes detect data values.

In the ZigBee technology, the physical layer (PHY) and MAC layer using IEEE802.15.4 protocol standard, among them, the physical layer provides two types of services: the physical layer management entity interface (PLME) provides services to the physical layer data and physical layer management. The physical layer data services can be transmitted through wireless physical channel and receiving physical layer protocol data unit (PPDU) to realize.

The remote control system will realize small equipment up to Internet; can be timely monitoring the operation of each device. The monitoring system, network monitoring and flexible manner, system construction and maintenance cost is relatively low, the amount of data can be stored in the larger, more data storage mode, a higher degree of system integration. Remote monitoring based on the network of break time, geographical restrictions, as long as the network exists, user authorization; it can be unrestricted at any time according to need to monitor, plug and play.

4. Design of Remote Monitoring System based on Wireless Sensor Network and GPRS Technology

The communication of the remote measurement and control system mainly includes the wired network, wireless network, GPRS, GPS and custom communication protocol. Because GPRS has many advantages, is widely used in data communication service, so in the design of this system uses the GPRS MC35 module to transmit data. The MC35 module supports GSM900 and GSM1800 dual band network, receiving rate can reach 86.20Kb/s, the transmission rate can reach 21.5Kb/s, and easily integrated, UART1 interface and ARM2440 processor with TTL232 level conversion after connecting.

The user can the equipment data were obtained through two forms, the first kind of passive form, real-time acquisition equipment data terminal equipment of Zigbee, when the data is beyond the scope of the user setting, sends data to the Zigbee coordinator, Zigbee coordinator through GPRS module on embedded platform data by sending short information form to the user; second kinds of active form, users can send the short information form for the embedded system, embedded platform for Zigbee coordinator an interrupt signal, using the Zigbee coordinator read each terminal equipment of Zigbee data by using a query form, and to send a short message to user, make the user whenever and wherever possible understanding of industrial control field condition.

General packet radio service (GPRS) is the end to end packet transmission and switching mode set to send and receive data provide high-speed, low-speed data and signaling a variety of business. In this paper, to meet the basic needs of system, and fully considering the system scalability, remote monitoring terminal automatic instrument analog signals, digital

quantity, switch quantity and acquisition and fault status indication, timing acquisition field instrumentation data and various state and keep records. Communication control, terminal equipment and the remote server diversity, terminal local / remote real-time database query, and it is which saves the cost of communication.

The basic architecture of embedded remote monitoring and controlling system of Web as is shown in Figure 2. The remote measurement and control system is composed of Embedded Measurement and control unit, the local server and remote management of the host of the three parts. The embedded measurement and control unit is located in the bottom of the main distribution at each node, a central processor, sensor, actuator, a network interface, GPS module, GPRS module, the environment parameter for the acquisition of the scene, and the parameter is compared with the set value, if it is beyond the scope of the provisions, would make use of the alarm, and let each actuator to work, to obtain the normal range of parameters, and the test data by a custom protocol to transfer to the local server, so as to reach remote management display.

The software system is mainly considered the starting procedure, various drivers, operating system and application program. Linux operating system with open source code, you can cut the kernel, and has in Motorola, NEC, ARM and other hardware platform is stable, efficient operation, has the advantages of powerful network functions and excellent file system support functions. The choice of the Linux operating system, and according to the specific application, trimmed and cross compiled, forming a ARM executable file, using serial port and network port download to FLASH. The application of measurement and control unit includes data acquisition module, liquid crystal display module, keyboard control module, the network service module, communication service module and the control module, as is shown by figure2.

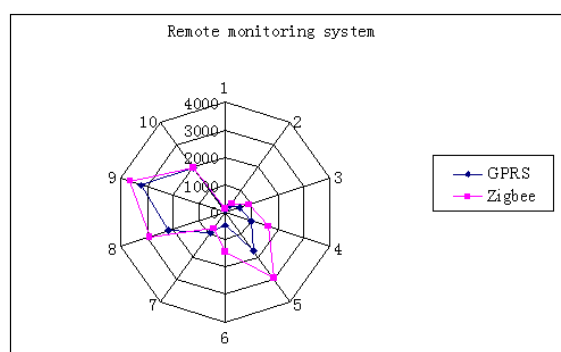


Figure 2. Comparison results of remote monitoring system based on wireless sensor network with GPRS technology

The Figure 2 of Comparison results of remote monitoring system based on wireless sensor network with GPRS technology is shown by this picture. This paper describes the design and implementation of embedded remote control platform for sensor network and GPRS technology, a universal remote control architecture based on Web, describes the key technology of the system structure and system, including the embedded technology, communication technology and Web server technology, and the successful application of an intelligent home furnishing system, validates the feasibility of scheme. The system has high security, low cost, with intelligent, timely alarm.

5. Conclusion

The paper presents design of remote monitoring system based on wireless sensor network and GPRS technology. The system structure of a small network uses 50 Zigbee nodes in the design process. In the Zigbee modules can be line of sight, not busy network, network quality is good and the amount of data sent is less than 128Bytes, the embedded platform to send the user to abnormal SMS, SMS receiving normal user, but the user sends a query

message to the embedded platform, automatic reply message with a short delay, but when many times within a short time to the embedded platform sends the query SMS, will cause the GPRS packet loss overflow or data. This is mainly because of the SIM500 module smaller buffer caused, need appropriate control network data flow.

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