

Research of Wireless Monitoring System in Power Distribution Transformer Station Based on GPRS

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Abstract—Because there are a large number of power distribution transformer stations and they are far away from city, wireless GPRS transmission provides a good communication solution to supervise power distribution transformer stations. The scheme of remote wireless monitoring system for power distribution transformer station based on GPRS wireless network was designed in this paper. A control terminal system implement was mainly given, which adopted LPC2132 as main processor, GR47 as the data communication module. The monitor terminal software and flow chart were also designed. At last, the way of configuring the GPRS module to connect network is analyzed.

Keywords— power distribution station; remote monitor system; general packet radio service (GPRS);

I. INTRODUCTION

Electric power distribution transformers is an important part of the electric power system, especially, there are a very large number of power transformer substations in rural China. It is difficult and expensive to construct the communication wires to monitor and control each power distribution transformer station. At present, methods of communication are used in power system are optical fiber communication, power line digital carrier, digital microwave, wireless spread spectrum and so on. It is necessary that physical wirings should be constructed if these communication types are used. It also brings about great difficulties and the cost of constructing and maintaining the communication system is expensive. Especially, in rural area, GPRS provides an ideal communication channel by using the network of mobile communications corporation. Above all, Wireless GPRS transmission data transmission is high efficiency, convenience and low cost and provides a good solution to meet the need of distribution transformer monitoring systems.

II. TECHNOLOGIES OF GPRS

GPRS is abbreviation of General Packet Radio Service and it realizes packet switched, GPRS combines mobile communication technology and data communication technology. GPRS makes full use of wireless resource and realizes broadband data transmission.

GPRS is a very good communication type for monitor system, GPRS has a lot of advantages^[1]. (1) Online forever: once a terminal is connected to GPRS, it will always be in

the state of connecting and online. It permits subscriber to receive and transfer data in packet-transfer mode without needing the network sources in circuit-switch mode. (2) Broadband: peak data transmission rate of GPRS can be up to 171.2Kbit/s, and average data transmission rate can reach 40Kbit/s. (3) Charged by runoff: the users pay for runoff of data in network, if a user has login in for several hours and its runoff is zero, it doesn't need to pay for this login. It is charged by the runoff of data transmission, so the cost is decreased. (4) Easy network construction: GPRS can provide high efficient and low cost wireless data service. It is very suitable for discontinuous frequent and small quantity of data transmission, as well as sudden large amount of data transmission. Because of lots of merits of the GPRS above, the remote monitor control system based on GPRS is a good scheme.

III. SYSTEM DESIGN AND ANALYSES

The monitoring system is mainly composed of the Data Terminal Unit (DTU), the transmission network (GPRS network and public data network), monitoring center stations. Monitoring terminal is mainly composed of MCU(micro chip unit) and peripheral circuit (liquid crystal display, keyboard functions, RS232 communications, A / D conversion), and GPRS wireless communication module. Monitoring Central Station is mainly composed of server, corporate intranet (Intranet), database server, printer etc. The connection between monitoring Center Station and the remote monitoring terminal is the GPRS wireless

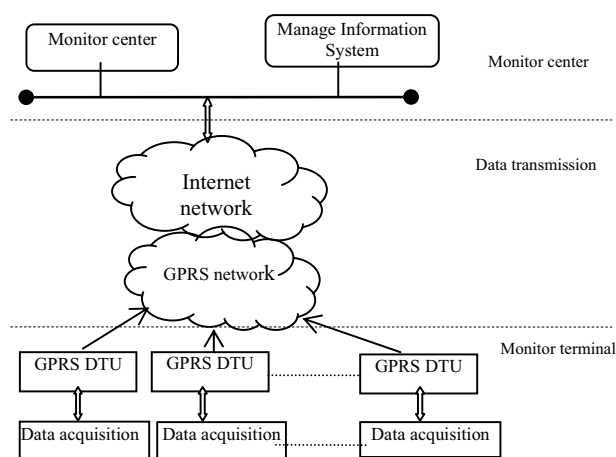


Figure 1. Structure of power monitoring system

telecommunications network, the structure of power monitoring system is as shown in Figure 1.

The network access includes two parts, data terminal access and data center access. Terminals use a polling architecture. It will work properly if the host knows the IP addresses of the I/O devices used by the system. The trouble is that the devices receive a different IP address every time. There are three kinds of data transmission methods have been developed to solve this question^[4]:

(1) Public Static IP Address

One way is to get a public static IP address; some company can assign a static IP address to a specific SIM card. All the I/O equipments will have they own static IP address and the entire system will operate in the same manner as a traditional monitoring system. However, not all carriers offer this kind of service, and when they do the cost is relatively high.

(2) *VPN Service Provided by Carrier*

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A VPN (Virtual Private Network) is a secure LAN solution. VPN has two major functions—security and grouping—and for the GPRS world the VPN grouping concept solves the dynamic IP address issues. The grouping of the devices into one private network prevents unauthorized persons from accessing the data. For this VPN solution, customers are required to buy a number of different GPRS on-line services, and to apply for access to a Virtual Private Network (VPN).

(3) *Dynamic Domain Name System*

Using dynamic IP addresses is another choice since many ISPs do not provide static IP addresses, or because the cost of obtaining a static IP address is too expensive. The Dynamic Domain Name System is used to convert a device's name into a dynamic IP address so that remote devices can communicate with the control center using a fixed domain name. The host can find a device's IP address from the DDNS's mapping table by looking up the device's hostname.

IV. IMPLEMENT OF HARDWARE CIRCUIT

The monitoring terminal is composed of main processor and GPRS modules and external interface circuit, Which include liquid crystal display, keyboard functions, RS232 communications, A / D conversion. The hardware architecture of monitoring terminal for distribution transformer station is shown in Figure 2.

The main processor is the ARM7 processor whose type is LPC2132 made by Phillips. It is a 16/32-bit ARM7 TDMI-S CPU micro-controller, with 8kB, 16kB or 32kB embedded high-speed Flash memory, 128-bit wide memory interface and a unique structure. With more than 250 ARM-based designs under its belt, Philips has experience with ARM and is already a major player in 32-bit Mucos with its LPC2000 family of ARM7 TDMI-based chips. The ARM7 TDMI processor supports operating systems including Windows CE, Palm OS, Symbian OS and Linux Synthesizable core.

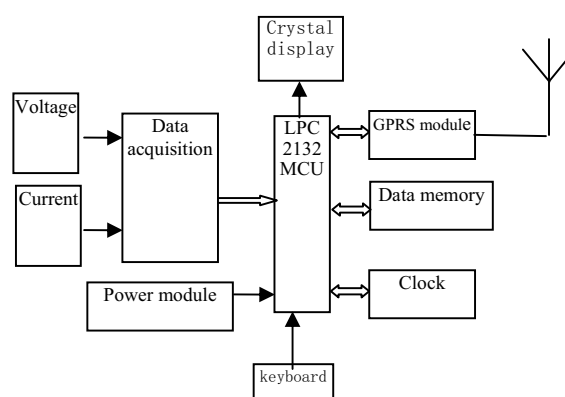


Figure 2. Architecture of Monitoring terminal hardware

The GPRS module that we select is the GR47 module provided by Sony Ericsson, which provides complete and comprehensive functionality. GR47 dual band GSM support for broadband 900MHz/1800MHz, It can send or receive data, can also handle voice and fax. It has built-in TCP / IP protocol stack, can be easily integrated into a variety of data terminals among the advantages of always-on connection, fast data storage and faster data transfer speeds. GR47 module has embedded applications and external micro-computer control applications in two ways, the difference lies in DTE (data terminal equipment) is the embedded mode or external mode.

GR47 has three standard UART data interfaces, that are UART1, UART2, and UART3, UART1 meets interface standard of RS232, and its communication rate is 9600bps; communication rate of UART2 is 115200bps, UART1 and UART2 are used for external programming (or use as external modem) and debugging, respectively. UART2 can also serve as a firmware update interface, as long as the module (Pin58) is service pin and effective. In the embedded mode: UART1 as the script input port, UART2 as a module to run the script debugging information in logs and output ports, this time can be UART3 as GPS data collection port.

In the non-embedded operating modes, UART1 is used as a system control port; UART2 is used via AT command set for the GPS data acquisition interface.

Its TCP / IP protocol stack can also be embedded applications through the AT command or a visit. Its TCP NDP can be a command to start the session, it provides for the uniform resource locator (URL) query IP addresses. GR47 offers a range of AT commands to complete the TCP / IP protocol features to simplify the application integration process. Related commands allow application designers to build and abolition of UDP and TCP protocol.

SIM card is an essential part of accessing the GPRS network. A SIM card is known as a subscriber identity module, which stores data for GPRS telephone subscribers. A SIM card and can be switched easily from one phone set to another.

E²PROM is used to store data, such as IP address of server in the control center, time parameter of the server connecting GPRS and so on. Users only need to configure one time. Even if the surveillance terminal reset or system power failure, it can preserve each gathering data and the user setting values. LPC2132 accesses E²PROM through the I²C bus. Storage system uses the 23 addressing modes. It's easy to use and very long service life.

V. SOFTWARE DESIGN

GPRS modules communicate based on TCP/IP protocol, when the main controller communicated with the network the data packet is sent according to TCP/IP protocol. So we choose the module embedded TCP/IP protocol or we can use the embedded operation system to build up a core to support the TCP/IP protocol^[3,4].

The software of the monitoring terminal is composed of the initialization, data acquisition and GPRS wireless communications module. GPRS wireless communication module, including establishment communication links of monitoring center, data transmission and command word analysis. Between the various modules associated parameters through a call. Application software development uses C language programming.

The flow chart of the monitor control terminal is as follows:

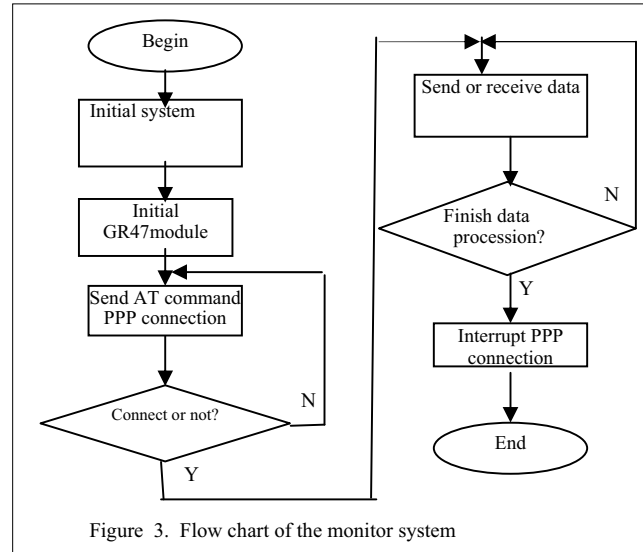


Figure 3. Flow chart of the monitor system

Workflow of the communication system is as follows: First, the system hardware and software is initialized, Second, GR47 module is initialized, GR47 module constructing application connecting to Monitoring Center, establish and configure PPP links. Finally, after PPP connection establishing, GR47 module is in the mode of data transfer, and can directly transfer data.

After the depiction we can conclude that the remote monitor control system based on GPRS is better than the traditional wire remote monitor control system.

During the whole system is built up, it is difficult to connect the GPRS module and the network. Before connecting the GPRS module and the network, first we should configure the module and initialize it. The AT command sequence for carrying out the above is as follows^[3,6].

(1) AT+CGATT=1 activate GPRS function command. If return OK, it shows that the GPRS function can be used and can connect the internet. If return ERROR, it shows that the GPRS service is not supported. You should ask the internet service provider and check the hardware, then insure the GPRS service can be used.

(2) AT+CGDCONT=1,"IP","CMNET"

The CMNET is the connection gateway of China Mobile Cooperation. If return OK, it shows that it is successful to connect the gateway.

(3) AT+E2IPA=1, "1" show active PDP, we can read the IP status of the module.

(4) ATD*99***1# return CONNECT, it shows that it is connected network successfully. At this moment we can login the internet through the GPRS gateway.

It is now in data mode, DCD is active and data can be sent. Now it is feasible to go to Port 80 on server, and any reply information will be received to the AT port.

VI. CONCLUSION

The scheme of remote wireless monitoring system for power distribution transformer station based on GPRS wireless network was designed in this paper. A embedded control terminal system design was mainly given, which is based on LPC2132 and GR47 module. The monitor terminal software and flow chart were also designed; a DTU software design and GPRS module configuring were given. The equipment has the characteristics of steadiness, reliability, fast data transmission and inexpensiveness. The running results show that the remote monitor system based on GPRS is a good scheme and acquire great economic and social benefits.

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