Design of Remote Water Meter Reading System Based on GPRS Technology

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Abstract. With the rapid development of electronic technology and information technology, the management level of metering instruments continues to improve, and people hope that metering instruments can be automated as soon as possible. Therefore, it has become inevitable to realize the automatic transcription of various meters. The shortcomings of the traditional manual copying method have caused a certain economic loss to society. At present, most remote meter readings use SMS communication to report regularly. This meter reading method is relatively backward, high in cost, poor in real-time, and unable to accurately monitor the operation of on-site water meters in time. Therefore, this article first analyzes the advantages of GPRS and the characteristics suitable for remote meter reading of water meters, and then designs the overall structure of the remote meter reading system, and introduces the core implementation part of the remote meter reading software in detail, and realizes the design of remote meter reading system based on GPRS.

1. Introduction

Automatic meter reading technology first attracted attention in western developed countries. In the 1980s, the United States became the first country to deploy a smart meter reading system on a large scale. With the rapid development of wireless network technology, wireless communication becomes the primary mode of data transmission in intelligent meter reading system. Wireless transmission solves many problems such as difficult wiring, scattered equipment, and high maintenance costs in the wired meter reading system. Nowadays, based on microcontroller, the intelligent meter reading system which transmits data to the data management center through GSM, GPRS, CDMA and other wireless networks has been more and more widely used. In China, the research on intelligent meter reading system started relatively late. Since the 1990s, companies and institutions that conducted research in this area appeared. Therefore, compared with western developed countries, China's smart meter reading system technology is relatively still in a relatively backward state. With the rapid development of economy and the maturity of related technologies, various automatic meter reading systems have emerged in recent years, and the automatic meter reading technology in China is becoming increasingly mature.

Under the rapid economic development, the "one household, one meter" project implemented by rural and urban residents has greatly increased the current meter reading volume, which has brought challenges to water companies as well as users. In view of the current situation, manual meter reading is the main method of meter reading, which requires a lot of manpower, and there may be errors, which will have a bad impact on water companies. In addition, the manual meter reading method requires the meter reader to enter the indoor meter reading on some occasions, which will add trouble to the user and
affect the normal rhythm of the user. Therefore, the smart meter reading method will inevitably replace the manual meter reading method and will become the mainstream of the market.

2. GPRS Communication Overview

GPRS is short for General Packet Radio Service. GPRS uses the same frequency band, frequency bandwidth, burst structure, wireless modulation standards, frequency modulation rules, and the same TDMA frame structure as GSM (Global System for Mobile communications). Therefore, when building a GPRS system on the basis of the existing GSM system, most of the components in the GSM system do not need to be changed in hardware. All that needs to be done is software upgrade, which is a big advantage of GPRS network.

GPRS can be simply transformed on the basis of the existing network, so as to make the most of the existing equipment. GPRS is regarded as a 2.5G mobile communication system, and it is an important step in the evolution of 2G to 3G. GPRS mainly has the following characteristics.

a. Good real-time response and processing capabilities: using channel multiplexing technology to realize that every GPRS user is online in real time, and can simultaneously collect data from multiple monitoring stations;

b. Low construction cost: the existing GSM network can be fully utilized;

c. Wide coverage: GPRS technology appeared earlier, whether it is in cities, suburbs, rural areas or in the wild, it’s the public network communication technology with the widest coverage at present. Therefore, as long as there is a GPRS signal, the terminal can realize data transmission;

d. Large transmission capacity of the system: Due to the large number of monitoring stations, GPRS technology can well meet the needs of sudden data transmission;

e. Low communication cost: GPRS technology is charged based on actual traffic. In this way, for the long-term online but intermittent data transmission of the water meter reading system, the communication cost can be greatly reduced.

f. High utilization of channel resources: GPRS has a very obvious advantage in carrying and supporting data services.

The schematic diagram of the point-to-multipoint communication system composed of GPRS modules is shown in Figure 1.

![Figure 1. GPRS communication module networking mode](image)

3. General Plan of Remote Meter Reading System

The system is mainly composed of a host computer located in the monitoring center and a user terminal located in the monitoring slave station. The distance between the two is very far. And considering the wide coverage of the current mobile network, in order to reduce the construction cost, it is decided to use China Mobile or China Unicom’s GPRS network to realize the reading of the user terminal metering water meter. The user terminal is composed of the collector and the metering meter. In order to improve the reliability of the collected metering data, the communication mode from the meter to the collector is proposed to adopt the very mature rs-485 bus mode currently used in the industrial control system.
The remote meter reading system is mainly composed of pulse sending water meter, collector, GPRS communication module and monitoring host, etc. The overall structure of the system is shown in Figure 2. The whole system includes monitoring host, user terminal and GPRS wireless communication network. The monitoring host is the main station of the entire control system, mainly used for issuing commands and displaying information. The user terminal is distributed at each water meter, and its responsibility is to respond to the commands sent by the main station. GPRS wireless communication network is to transmit information between master station and slave station.

The GPRS network composed of the GPRS base station and the core network is only used as a channel for data transmission, without changing the data content, so the meter reading platform directly faces the water meter terminal. Users access the meter reading platform through the workstation to realize terminal data query and pipeline control, that is, the meter reading platform is a transfer station for users to interact with the water meter terminal. Through the WEB interface of the platform, the internal form of information is transformed into a form that can be easily accepted by human beings and the interaction of information is realized between the meter reading platform and the user. The platform's meter reading protocol is an agreement for information exchange between the meter reading platform and the terminal. It implements information conversion between the two information systems.

![Diagram of the overall structure of the remote meter reading system](image)

**Figure 2. The overall structure of the remote meter reading system**

4. **System Software Design**

The water meter software operates in a message event-driven manner. When no message needs to be processed, the MCU enters the sleep state. The MCU has multiple messages to wake up and enter the operating mode. Message sources include key interrupts, delay timer interrupts, RTC timer interrupts, serial port interrupts, etc. Among them, RTC is the main source of MCU messages, and RTC wakes up the MCU once every 1 second. The software main program flow chart is shown in Figure 3.
The communication tasks of the water meter mainly include the setting and query of the terminal by the platform, and the regular report of the terminal. The program flow chart is shown in Figure 4.

1) After the online time, the meter will automatically connect to the platform to report sampling data.
2) After receiving the data from the water meter, the platform will respond to the meter. If the platform has instructions in the instruction queue waiting to be issued, it will issue an instruction to prohibit the meter from going offline. If the platform has no instructions waiting to be issued, it will directly issue the offline command.
3) After the water meter end receives the platform offline command, if the platform does not issue an instruction, it will directly go offline. If the platform still has an instruction to issue, it will wait for the platform to issue the instruction.
4) The water meter end receives the instructions of the processing platform and responds to the platform.

The on-line process of the water meter can be divided into 9 steps: module power on, booting, baud rate synchronization, closing echo, SIM card decoding state detection, network registration, GPRS
attachment, passthrough mode setting, TCP/IP connection. The next step can only be started after the current step is completed.

The offline process of the watch end can be divided into 7 steps: TCP/IP disconnection, closed transparent transmission mode, closed GPRS connection, disconnected network, shutdown, and power off. The next step can only be started after the step. After an abnormal situation occurs, the power can be turned off after storing the fault information.

The water meter valve control task can be divided into two parts: remote control valve and overdraft valve. The execution process of the remote-control valve is shown in Figure 5.

1) The terminal goes online and receives the platform valve control request.
2) After the terminal goes offline, check the battery status to confirm whether there is enough power for valve control operation.
3) After confirming that there is electricity, the terminal will open, close or maintain the valve according to the valve control request command;
4) After the valve maintenance operation, the terminal connects to the platform again and reports the current valve status.

The execution process of overdraft valve opening is shown in Figure 6.

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**Figure 5. Flow chart of the remote-control valve execution process**

1) The terminal goes online and receives the platform valve control request.
2) After the terminal goes offline, check the battery status to confirm whether there is enough power for valve control operation.
3) After confirming that there is electricity, the terminal will open, close or maintain the valve according to the valve control request command;
4) After the valve maintenance operation, the terminal connects to the platform again and reports the current valve status.

The execution process of overdraft valve opening is shown in Figure 6.
1) When the water meter is in arrears for the first time, the user can press the human-computer interaction button for more than 10 seconds, and ZIM opens the valve, and the overdraft time is 2 days.
2) If the user fails to pay the bill within 2 days, the water meter will enter the state of secondary arrears.
3) The state of secondary arrears does not support transparent transmission to open the valve. The user clears the arrears after paying the fee.

5. Conclusion
This paper analyzes the current status of remote water meter reading and points out the current shortcomings. It is proposed to apply the GPRS network to the water meter reading work to realize the remote data transmission function. The article analyzes the system's networking mode and discusses the system's software implementation in more detail. The system has on-site query display, data transmission using the USB interface, and can read data according to the selected address through the GPRS/GSM network, and automatically read data according to the set time. It can realize automatic meter reading and data network management of the current residential area.

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