Design of Electricity Information Collection System Based on NB-IoT

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Abstract. Aiming at the problems of two-way information interaction and real-time and reliable transmission caused by the imperfect electricity information acquisition system, this paper proposes an electricity information acquisition system based on narrowband Internet of things (NB-IoT) technology. The system takes STM32 as the microcontroller, and uploads the data of electricity collector to the telecom cloud platform through BC95 wireless communication mode. The user terminal can connect with the cloud platform to realize the collection of electricity information. This paper presents the detailed hardware and software design method of the system. Compared with the traditional electricity information acquisition system, the system has the functions of low power consumption, simple wiring and remote control, and has good application value.

1. Introduction
With the continuous development of smart grid, electricity information collection system covers an increasingly wide range, and the demand for communication continues to grow. A variety of communication technologies have been applied to the electricity information acquisition system, such as the power line carrier communication and micro-power wireless communication used in the local communication channel between acquisition terminal and smart electricity meter, and the remote communication between acquisition terminal and the main channel using GPRS (General Packet Radio Service) and LTE (Long Term Evolution) network. With the going forward of communication technology, NB-IoT becomes another technical scheme to support data acquisition of electricity information acquisition system.

Therefore, this paper designs an electricity information collection system based on NB-IoT technology. The application of NB-IoT technology in the field of intelligent distribution of electricity is conducive to improving the reliable transmission and comprehensive coverage of electricity information acquisition services, and further meeting the local business access requirements of power communication terminals under the condition of smart grid.

2. The overall frame structure system
The electricity information acquisition system is implemented based on NB-IoT technology, and the system framework is shown in figure 1. Referring to the Internet of things hierarchical model, the system is divided into perceptual layer, network layer and application layer. The perceptual layer performs
sensor data collection, physical quantity regression, data transmission, data reception and other functions. The server in the network layer stores the data sent from the awareness layer into the database, checks the data changes in the database and sends it back. The application layer is used to display real-time and historical data of each meter on the computer or mobile phone. The perceptual layer meters of all kinds of data, using the NB-IoT technology to transfer data to the network layer of the server, on the application layer with the aid of cell phones, computer access data stored on the server.

Figure 1. System framework

3. System hardware structure
The system includes collector, microprocessor, power module, NB module, cloud platform of Internet of things, data server and user terminal, as shown in figure 2.

Figure 2. Hardware structure

Collector and meters through the shielding wire connection, according to the two-way communication RS485 protocol, realizes the electric meter data read the state of the electric meter control. The microprocessor is connected with the collector through the shielded wire, and the data acquisition module is used for two-way data transmission according to the asynchronous serial communication protocol. The microprocessor sends instructions to the collector to read electricity data and monitor the returned data of the electricity meter. The microprocessor compresses the received meter data and sends it to the NB module according to the protocol requirements of the NB module.

3.1. Microprocessor module
The STM32F103ZET6 chip is very suitable for Internet of things systems. The current is as low as 0.4μA in sleep mode. The working voltage range is 1.8-3.6V; the peripheral circuit of the microprocessor consists of clock circuit, reset circuit and power supply conversion circuit. The power conversion circuit reduces the input power of 5V to 3.8V to provide working power for the NB module.
3.2. Electricity collector module
The power acquisition module adopts IM1281B single-phase AC energy measurement module, which is superior to the national level 1 standard in accuracy. Through the corresponding interface convenience and 32 single chip microcomputer, ARM connection to achieve automatic data acquisition and monitoring functions. The S0C chip for industrial-grade energy metering is used to isolate voltage and current. The communication protocol uses DL/T 645-2007 protocol.

3.3. NB module
NB module using BC95-B5, module normal working voltage range of 3.1-4.2V, a dormant state work under the current as low as 10 μA; the signal sensitivity of NB module to realize data communication is as low as -135dbm. The UART interface is used for bi-directional communication between the nb module and the main controller and firmware upgrade of the NB module. BC95-b5 supports 900MHz frequency band, which is connected to the core network through mobile cellular network technology, and then connected to the public network through routing and firewall.

4. The software design
The system software design is mainly divided into three parts: communication design of acquisition module and microprocessor, BC95 communication design, cloud platform deployment and terminal APP development.
4.1. Communication design between acquisition module and microprocessor
This system uses KEIL5 software as development platform and C language as programming language.

- Complete GPIO port initialization
  GPIO port initialization mainly involves the following configurations: port and pin, input or output mode, rate, and pull-up/pull-down resistance.
- Complete serial port initialization.
  Serial port initialization mainly includes the following configuration, namely baud rate 9600 bps, 8 bit data format, 1 bit stop bit, not even check bit, no hardware data flow control.
- Complete ADC initialization.
  The collector outputs an analog signal of 0-5V from the collected power, and the system converts it into the corresponding digital signal and reports it to the cloud platform.

4.2. BC95 Communication Design
The operation instructions of BC95 communication module are shown in table 1. After the chip is powered on, BC95 module initializes its work first. It uses AT instruction to set the baud rate, IMSI number and IP address of the module. It is necessary to judge whether there is a SIM card and the intensity of the signal can meet the communication requirements. Then, according to the requirements of NB-IOT technology, data frames are formed and BC95 completes sending and receiving data. At last, the chip works in low power mode. In communication, the method of IP address + IMSI number is used to distinguish different devices.
Table 1. BC95 communication module operation instructions

|   | Command                          | Description                                      |
|---|---------------------------------|-------------------------------------------------|
| 1 | AT+NRB\r\n                      | Reset instruction                                |
| 2 | AT+CFUN=1\r\n                   | Turn on the full functionality of the module     |
| 3 | AT+CIMI\r\n                     | Check if it contains a mobile phone card          |
| 4 | AT+CGATT=1\r\n                  | Network attachment                               |
| 5 | AT+CSCON\r\n                    | The result is+CSCON: 0, 1                       |
| 6 | AT+CSQ\r\n                      | Read signal value                                |
| 7 | AT+NSOCR=DGRAM,17,3001,1\r\n    | Create port number 3001, Associated to UDP protocol |
| 8 | AT+NSOST=0, IP address, The port number, Number of bytes, Data content | send data                                       |
| 9 | +NSONMML: 0                     | Module return value                              |
| 10| AT+NSORF=0, 255\r\n             | Read return result                               |
| 11| AT+NSOCL=0                      | Close module                                     |

4.3. Cloud Platform Deployment

This system adopts the telecom Internet open platform, complete registration and binding on a cloud platform, by defining the Profile and plug-in development, terminal equipment is added in the user terminal and server information. Then connect the power supply to the acquisition terminal, power the terminal and the electricity meter, and the system starts to run. After logging into the cloud platform management interface and reporting data by the terminal, the cloud platform displays the online status of the terminal device.

5. Testing and results analysis

The test interface is shown in the figure:

![Figure 5. IM-S11 software test results](image)

6. Conclusion

The electricity information collection system based on NB-IoT realizing the collection of electricity monitoring. The acquisition system is connected to the NB network through the module, and the meter data is uploaded to the cloud platform and pushed to the user server and user terminal. Users can monitor and control electricity meter data management in the cloud. The acquisition system is connected to NB network and has very high sensitivity. The automatic collection of power data using this system avoids
the huge consumption of manpower and material resources in the traditional meter reading mode, and greatly improves the automation and intelligence level of the meter management system.

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