Design and Implementation of Intelligent Meter Reading System in Smart Power Grid

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Abstract. Design and research the intelligent meter reading system, collect electric energy data in real time, and realize the remote reading function through the wireless network. The intelligent meter reading system adopts a three-tier structure of meter reading data processing layer, meter reading data presentation layer and meter reading data storage layer to enhance the efficiency and stability of the system. The design includes the operator module, the operation management module, and the system database and logical structure of the data maintenance module to enhance data security performance. Design the user interface of the intelligent meter reading system to complete functions such as task management, data review, and line data analysis. The design and development of the intelligent meter reading system enhances the accuracy and real-time performance of meter reading and reduces manual workload.

1. Introduction

With the reform of the electric power enterprise system, the long-term meter reading system of the electric power enterprise must also be reformed. According to relevant research, every power company has electricity consumption data of thousands of users. At present, some companies still can only rely on a large number of manual operations to complete manual transcription, and then enter the data into computers. Meter reading adopts manual mode, which is a very traditional method, which is time-consuming and laborious, and often inaccurate. In general, manual meter reading has a large workload, low accuracy, and poor timeliness, which cannot meet the requirements of modern enterprises to improve efficiency and reduce costs.

The intelligent meter reading system means that the real-time data of each meter can be obtained directly in the computer room without manual intervention. The intelligent meter reading system not only improves the requirements of power management, but also meets the requirements of automated office. It is also network technology and the inevitable trend of the development of computer computing. Through the intelligent meter reading system, on the one hand, the data of each meter can be viewed in real time, and the working conditions of related equipment such as transformers can also be monitored. At the same time, the transmitted data also has the advantages of high accuracy, stability and reliability.

All the data collected by the smart meter reading system are real-time data. Through the analysis of linear data, the user's electricity consumption habits can be accurately understood, and corresponding
measures can be taken to reasonably adjust the relationship between production electricity and domestic electricity. In addition, the smart meter reading system can be further connected to the power distribution automation system, the electricity bill management system, etc., to realize the remote reading function through the wireless network, and the meter reading can be implemented anywhere. It is simple, flexible and convenient, and provides automation for the entire power enterprise stand by.

2. Architecture Design of Intelligent Meter Reading System

The structure design of the meter reading system should complete the related operations through the simplest operation and the least workload. The system should be able to monitor all meter reading operations, keep up-to-date relevant information and feedback on the effect of operations. The system can automatically record each operation, count the frequent operation steps, and simplify the operation process. The user interface is designed to provide multiple functions such as query and printing, so that the operator can quickly master the intelligent meter reading system.

The system network topology refers to the physical layout of interconnecting various devices with transmission media. The various devices participating in the work of the local area network are interconnected together, so that the communication lines and sites in the network are connected to each other, and the basic deployment of system software and hardware and the network link are completed. The network topology of the intelligent meter reading system is shown in Figure 1.

![Network topology structure diagram of intelligent meter reading system.](image)

The intelligent meter reading system adopts a three-tier structure, which are the meter-reading data processing layer, the meter-reading data presentation layer, and the meter-reading data storage layer. The three-tier structure can maximize the efficiency and stability of the system. The meter reading data processing layer is located at the interface, which mainly displays the results after the meter reading data is imported and processed. It can provide managers with an interactive operation and can intuitively see the entire meter reading process.

The meter reading data presentation layer mainly realizes the formulation of meter reading rules, the import and export of meter data, and the system design related to the data management requirements of the meter reader. In the system architecture, the meter reading data processing layer is located between the meter reading data presentation layer and the meter reading data storage layer. It processes data from the meter reading data storage layer and pushes the processed data to the meter reading data presentation layer.

The data layer is mainly responsible for the access to the database, and can realize the access to the data in the form of binary files, text documents, etc.
The power concentrator adopts a high-performance main control chip, built-in carrier communication dedicated chip to realize three-phase power line carrier communication, and can realize automatic carrier meter reading for all terminals under the same substation. The concentrator uses a large-capacity flash chip, so that the data in the meter library and the power data copied back will not be lost if the power fails. The concentrator can support wireless or infrared meter reading, connect a telephone line to communicate with a remote upper computer, and realize remote meter reading through the upper computer software.

The data collector is one of the main components of the meter reading system, which realizes the connection between the whole system and the electric energy meter, and acts as a bridge and link. The main function of data collection is to transfer the operating instructions issued by the system to the control unit of the electric energy meter on the one hand to complete remote power outages and restore power transmission. On the other hand, read the meter reading, and import the meter reading data into the system host through satellite positioning meter reader or other methods to realize remote meter reading.

3. Database Design of Intelligent Meter Reading System

The system database is designed based on the actual needs of the enterprise and represents the graphical language mechanism of data objects and their relationships. When designing a database management system, according to user needs, drawing the overall framework of the database and designing the relational model of the database system from the current mature technology, we must fully consider the universality and standardization of the model.

The implementation of the meter reading system database of the electric power company refers to the establishment of database tables and daily operation and maintenance, mainly for the daily maintenance and optimization of the intelligent meter reading system database after the realization, including the optimization, expansion or replacement of the database structure. Represents its objects and attributes. The database and logical structure design of the meter reading system is shown in Figure 2.

![Figure 2. Design drawing of database and logical structure of intelligent meter reading system.](image-url)
data, records various operations of each operator, and records the number, title, word count, content and other tasks of the data obtained from the meter.

The security performance of the intelligent meter reading system database is relatively high. When the same database is used by multiple users at the same time, the integrity of the database will not be damaged. Using the database to store the data of the meter reading system can ensure the safety of the data reliably.

4. User Interface Design of Intelligent Meter Reading System

Design the user interface of the smart meter reading system. First, design the user login interface. For the first login, you need to register as a system user. When registering, the operation authority will be set for the registered users to prevent unauthorized behavior, while ensuring the normal operation of the system, and recording the information of the login. The user needs to enter the user name, password and verification code when logging in. After passing the system verification, the user can enter the smart meter reading system.

After logging in to the smart meter reading system, click Task Management to enter the task management interface. The system automatically displays the selectable related operations according to the user's authority. The task management interface is shown in Figure 3.

![Figure 3. Intelligent meter reading system task management interface diagram.](image)

In task management, the meter reading business classification is set up into several sub-modules, first of all, it has the ability to add meter reading tasks and modify meter reading tasks. In the meter reading task module task, the meter reading information data is mainly loaded and improved, including basic meter reader information, meter reading section name, number of meter boxes and number of meters, etc.

After the meter reading data is imported, the data can be rechecked by searching for relevant conditions. The main content of the review includes: meter reader, meter reading time, meter reading section number, the number of the last reading, the current electricity, the type of electricity, whether there is any abnormality, etc. According to the query conditions, you can query the meter reading data that meets the conditions. The reviewer can manually determine which data is the data that needs to be modified. The data review interface is shown in Figure 4.
Figure 4. Smart meter reading system data review interface diagram.

The line data analysis interface includes meter reading analysis, abnormal data analysis, error correction analysis, and electricity distribution statistics. Meter reading volume analysis queries the meter reading volume information of the designated person in the specified time period according to the query conditions, abnormal data analysis queries the abnormal data information of the designated person in the specified time period according to the query conditions, error correction analysis According to the query conditions, you can query the corresponding error correction Record, power distribution statistics can query the power distribution data. The line data analysis interface is shown in Figure 5.

Figure 5. Intelligent meter reading system line data analysis interface diagram.
The task report module includes multiple functions. Task reports are divided into comprehensive reports, normal/abnormal reports, standard meter reading efficiency reports, standard electricity consumption ladder statistics, meter reading track reports, and revised statistics reports. The comprehensive report is mainly to understand the important information of the entire report, such as the basic information of the meter reading task. The normal/abnormal report combines charts and data to give the auditor an intuitive understanding of the distribution of positive abnormalities. The standard meter reading efficiency report shows an analysis chart of the over-standard rate. The standard electricity consumption ladder statistics also reflect the standard electricity consumption ladder statistics through a combination of graphs and data. The revised statistical report module realizes the recording of relevant personnel and time information for this revision. Through all the above operations, the corresponding correction report form can be generated. The task report interface is shown in Figure 6.

![Task report analysis interface](image)

**Figure 6.** Smart meter reading system task report interface diagram.

### 5. Conclusion

During the "Twelfth Five-Year Plan" period, with the State Grid Corporation of China in the construction of power grids, the construction of smart grids, in terms of reforming management models, promote the "three sets and five major" reform. The intelligent meter reading system is an important part of the power enterprise, and it has a great influence on the business model and reform direction of the enterprise. The intelligent meter reading system designed in this paper realizes the automation and intelligence of the meter reading work of electric power enterprises, and improves the production efficiency. The intelligent meter reading system saves the labor cost of the meter reader. There are no special requirements on the restricted distance. The meter reads quickly, reads the meter data in real time, the data is accurate, has a stable structure network, and can also analyze the meter reading. The design purpose of the intelligent meter reading system is to provide better quality services to customers who use electricity. The collection of electric energy meter readings has developed into a smart way. The design of the intelligent meter reading system provides for the development of long-distance contactless meter reading technology. New design ideas and design methods.

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