The Solutions to Some Key Problems of Solar Energy Output in the Belt and Road

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Abstract. With the advent of the information age and the implementation of the national strategy of "The Belt and Road", more and more business management tends to be informative and automatic. Many solar energy companies find traditional rental management program cannot fully meet their needs. This article introduces a photovoltaic energy lease management and analysis system based on windows platform and puts forward some reasonable solutions to some key problems in the process of the software development. It tries to design a database to achieve the safe and reliable storage, transmission and management of data in the management of photovoltaic energy leasing by the combination of B / S mode and C / S mode. For the current difficulties of business in lease accounting, a scientific and reasonable photovoltaic energy lease solution is proposed. Through the design of an IC card, it is easy to control photovoltaic devices and data collection. According to collecting user data, it can make a statistics analysis of various customers, cards, equipment, power consumption, power generation and then generate different types of tables and charts; it can also provide data regression analysis, gray prediction, and analyze the potential demands for the products. With the proposed of "The Belt and Road" great strategy, photovoltaic energy equipment will soon go to the international market, and in order to promote the use of Photovoltaic energy equipment, it is necessary and urgent to design such a software with different languages version.

Introduction

Solar energy has been increasingly popular nowadays because of its abundance, cleanliness and no pollution to the Earth, and a large number of solar energy enterprises are booming. But at the background of Internet Plus and big data, many enterprises find that the traditional lease management schemes of photovoltaic energy cannot fully meet their needs. With the increasing number of customers, the traditional solutions cannot conveniently manage equipment, leading to a lot of problems, thus consuming a lot of human resources. For example, inaccurate billing systems result in inaccurate billing, and unpaid devices can also work normally, and so on. Nowadays there is not any standardized and efficient system to handle the business for customers, and even when customers lease some equipment, the data produced by the system cannot be collected and stored in real-time, leaving statistical analysis of existing data unmade, so the system cannot make a
reasonable prediction of the future data [1]. Therefore, it is very important to develop a new mode of photovoltaic energy lease management and analysis system to meet such needs.

Taking windows system as the platform, the paper presents an implementation scheme of photovoltaic energy lease management and analysis system by the combination of B/S mode which is based on J2EE and C/S mode on .NET. The scheme solves a series of problems faced in the solar energy companies, and facilitates the management process, saves manpower and time, and brings a new management mode at the background of Internet plus.

The Design of System Structure

There are two main problems in the traditional lease management mode: on the one hand, it is not effective to manage photovoltaic equipment; on the other hand, the data generated by PV equipment cannot be collected to be analyzed. To solve these two problems, the system designs an IC card specifically for data communication between photovoltaic equipment and rental recharging equipment. The rental recharging information is written into rental recharging equipment, while photovoltaic equipment reads the information to decide whether to start the equipment [2]. When photovoltaic devices run, the running data will be written into it; when recharging, the recharging devices read the running data and store them in the database for user query. The structure of the system is shown in Figure 1. The system is divided into three layers: the main station, the communication channel layer and the rental recharging layer. The main station is responsible for business application, data analysis, the management of database and so on, and it is easy to achieve these functions for a user by simply installing the client software and connecting it to the server; the communication channel layer provides communication channel between the main station and the recharging devices, ensuring normal data transmission; while rental recharging layer is responsible for system rental recharging, the information collection of customers’ power demands and provides the original information of the whole system. The IC card, as the medium of communication between equipment data and server data, is used to record the running of equipment, and to collect the real-time data.

![System architecture diagram](image-url)
The Solutions to the Key Problems of the System

System Software Architecture Design

Traditional applications are based on the two layer structure (client / server or browser / server) and two layer structure once was the mainstream development mode, but with the increasing application of business logic and the complexity, the structure’s drawbacks have been increasingly displayed, such as poor flexibilities, application programs occupying a lot of resources and cyber sources when they are running at client terminals, and increasing difficulties in development of softwares, etc[3]. Today, three-layer or multilayer structure has become the mainstream, and it is the development of the traditional two-layer structure, representing the future of enterprise applications, such as the application of MVC under Web structure. The software architecture of the project is shown in fig. 2:

![Software architecture diagram](image)

**Figure 2. Software architecture diagram.**

The structure of the software is characterized by the combination of B/S mode and C/S mode; and for the C/S mode, the business logic layer is added between front end and database to form three-layer client/server architecture; while for the B/S mode, classical MVC mode is used, which is used to process the business codes and data operation codes; and the view layer is to achieve the exchange and display of user's data; and the control layer is the bridge between the mode layer and the view layer.

The Data Reading and Writing of the IC Card

From the system software architecture design, it is known that the IC card is used for data interaction between the database and the client tools, and data are from various operations of clients’ ends, therefore, the biggest problem is the communication problem between the IC card and the computer system, and it is also the biggest problem of the system. To solve this problem, the system specifically packages a class used to solve communication problems, adopting MS Comm32 control...
based on serial communications and an IC card for data communication, and adding timers which can automatically send a serial port command to the IC card in the specified time and analyze the data returned, thus realizing the functions of writing data into the IC card and reading the data from the card. The realization of the specific process is shown in Figure 3.

**Data Prediction**

The actual business needs not only accurate statistical analysis of customer data, but also needs to provide the corresponding prediction. The system uses the unitary linear regression model and gray prediction algorithm. The unitary linear regression prediction is based on the least squares method in mathematics, finding empirical formula of the independent and dependent variables in the given data, and giving the prediction results. It is a method which establishes the unitary linear regression equation of X and Y according to the correlation between independent variable X and dependent variable Y. The parameters can be obtained by the following formula: $Y_t = a + bX_t$. Put the numbers a and b into the unitary linear regression equation, we can establish a prediction model[4].

The grey prediction is the correlation analysis by identifying the dissimilarities between the development trends of system factors. It processes the original data to find the regularities of system changes, and generates data sequences of strong regularity, and establishes corresponding differential equation models, and then predicts the future development trend of things. The effect diagram of software design and operation is shown in Figure 4.

![Figure 4. Prediction algorithm interface.](image)

**Permission Management**

The system also provides a dynamic permission management mainly by two aspects: data access and module permissions. Taking the complexity of business in the reality into the consideration, an administrator can create different login users and assign appropriate permissions according to different demands, thus making the system more flexible. We number each module of the software, and when a user sets module permissions, the system has stored the module number for each user in the database; when the user logs in the system, the program will read the user login information from the database and assign the module the user can use. Meanwhile, we also have added the data access control in the module permission, and there are four types of data access permissions for users. They are the permission of data read-only of its own, the permission of reading and writing its own data,
the permission of reading all the data and the permission of reading and writing all the data. When running the data, the system will check whether the user has an access to the data; if the user has no access, the system will give a hint.

The Solution to the Problem of Multi-languages

Because the system is for the most photovoltaic energy enterprises, to make the system more universal, we specially make the whole system in English for the convenience of users[5]. And considering the specialties of some customers in remote areas, although their official language is English, most people there can only read their local languages, therefore, when giving them the receipts of recharging, the contents of receipts will be templated and stored in the database, thus solving the problems of multi-languages.

The Control of PV Energy Equipment by an IC Card

Users can use PV energy by leasing it monthly. The system can supply power for users when the IC card is accessed to the system, recharging fees daily, and at the same time, the system control module is used to count power consumption per week, and to store it in the IC card; when the IC card is accessed to the terminal of rental recharging equipment, the information is automatically uploaded to the terminal equipment. When a customer recharges the rental recharging card, the recharging devices will write and store the information of time and dates in the database. When the customer inserts the IC card into the photovoltaic power equipment, the corresponding program in the equipment will read data in the IC card to achieve the control of PV energy equipment.

The Flexible and Diverse Recharging Design for Photovoltaic Energy Leasing

The system is similar to the one of cell phone calls packages, and each package includes the fees and days of consumption, and users can choose their own consumption packages according to their needs. The number of days and end date will be written into the user’s IC card for PV energy equipment to read.

The Design of the Functions of Web Terminal

The development language of Web is Java, because, on one hand, the Java language is of high security, using classic MVC mode and the framework of JSP+serlvet+JavaBean; on the other hand, on the web terminal read-only data are set to ensure the system security, so users can login in via the web to make multi-condition queries for the information of the IC card and all devices. The operation effect diagram of the software design is shown in Fig. 5.
Conclusion

Based on the internet plus, the paper presents a new PV energy lease management mode in the information age, which effectively solves all the problems of the traditional existing modes, makes full use of business data in reality, analyzes and forecasts relevant data statistically, and provides a safe and reliable reference for the decisions of enterprises in The Belt and Road for their international market.

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