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Research Article

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Development of a web-based electric power quality monitoring system

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ABSTRACT

In order to effectively achieve the data of the power quality management, analysis comprehensively, network sharing and classification, a power quality monitoring system based on Web is designed and developed in this paper. This design combines communication technology and database technology, using the B/S (Browser/Server) model which isa layered distributed structure. Through this system, users can real-time monitor the index of power quality and realize the network sharing of power quality date. The basic features such as high monitoring precision, easy upgrade and maintenance and flexibility were its advantages

Key words: Web; power quality; database; monitoring

INTORDUCTION

As the further development of national economy, a large amount of electric power and electron equipments are put into production process. On the one side, the equipments bring about high production efficiency; One the other side, the participation of varieties of non-linear loads also results in increasingly poor power quality and seriously interferes with the safe production. Therefore, the realization of electric power quality monitoring has become a necessary means to ensure the power quality. Electric power quality monitoring system is an integrated application platform dealing with real-time monitoring, management, analysis and evaluation to on-site electric power equipments and power quality parameters, which is a key to improve the overall information level, integrated management and decision-making efficiency of electric corporation.

It is an integrated system which combines computer technology, information technology, control theory, artificial intelligence, management science, decision sciences and other disciplines. Since the power system is an important part to closely and inseparably link power generation, transmission and electricity employ, the power quality monitoring should not only exist in the electricity sector but also lie in power users. The power user should also be able to keep abreast of power quality in order to meet the needs of modern production processes.

With the systemization, networking, automation and intellectualization of the power system operation and management, monitoring power quality with the use of single-functional measuring instrument has been unable to meet the requirements of modern power management. Modern electric energy management should be an integrated management system which links systemization, networking, automation and intellectualization. Its main function is to transmit data to a remote monitoring center through a communication network and through the integration of decentral energy data of power supply system, based on the real-time status monitoring, fault diagnosis of early warning and other basic functions. In the remote monitoring center, the provided power quality monitoring system software platform can achieve a comprehensive analysis of multiple monitoring points of data, thereby achieving quality assessment of electrical energy, scheduling optimization to power loads and other integrated monitoring functions.

THE OVERALL SYSTEM DESIGN

As the development of integrated circuit technology and computer technology and increasingly sophistication of

network technology and embedded technology, power quality monitoring instruments is moving towards remote monitoring of on-line monitoring, real-time analysis, networking and intellectualization .Grid remote monitoring technology is a combining technology of computer, networking and remote monitoring technology and an important part of the power grid dispatching automation, which can achieve on comprehensive automation capabilities such as grid proactive monitoring, measurement, automatic control and protection, scheduling communication, etc. Monitor can analyze first-hand data of instruments operation timely, thus learning about the actual operating conditions at that time and achieving effective control to the system. Therefore, power grid remote monitoring has a strong vitality and broad application prospects. For a sound remote control system for power quality, it has to have the ability to promptly discover the grid voltage waveform distortion, voltage sags, voltage fluctuations and flicker, over-voltage, transient interference and other power quality problems, and the ability to have alarm signal and take appropriate measures to prevent the harmness. In recent years, China has successively promulgated five standards related with power quality, namely the supply voltage deviation, voltage fluctuations and flicker, the utility grid harmonics, phase unbalance and power system frequency deviation. Only if the five standards in the power system are real-timely and accurately measured, observed, analyzed and counted, a complete and effective monitoring system can be really achieved.

In summary, a complete power quality monitoring system consists of the following components: (1) the data acquisition section; (2) the data transfer portion; (3) the remote control center. Specific architecture are shown in Fig.1.

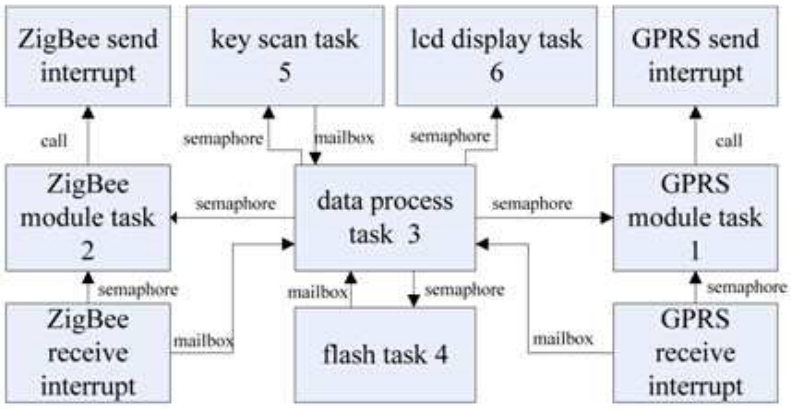

Fig.1 specific architecture

The first part is the data acquisition section, mainly constituted by PQM (Power Quality Monitoring Unit). Its main function is to collect all kinds of real-time information of electrical equipments and to transmit these information to a variety of monitoring systems.

At the same time, these devices must be subject to several of control commands from the monitoring system in order to achieve efficient acquisition of equipment operation data and effective implementation of control command.

The first part in this design is achieved by wireless sensor network. The wireless sensor network is a kind of self-organizing network with the capability to gather information, which combines the sensor technology, embedded system technology, wireless communication technology, microelectronics and distributed information processing technology. It can sense, monitor and collect the information of monitored object in monitoring area in real time and transmit the information to the users who need them.

Wireless sensor networks are not restricted by cabling and can coordinate system communication and equipment mobility and flexibility, which is a good networking. In order to ensure the reliability and transmission efficiency of data transmission, ZigBee technology is used to design an ad hoc network routing strategy and a reliable mechanism for data transmission. The second part is data transmission communication layer. It is realized mainly by GSM / GPRS wireless mobile communication technology. The technology depends on relay satellite and terrestrial mobile relay station networks to transmit data, with the feature of high transmission efficiency, high signal coverage, high reliability, and good anti-jamming performance. The data sent up by data acquisition section through wireless sensor network needs to be sent to remote monitoring center by connecting ZigBee network and GPRS. While, the connection of ZigBee network and GPRS needs ZigBee / GPRS gateway to realize efficient transmission of data.
The third part of the system is the remote monitoring center. Remote monitoring center sets up largedatabases and the corresponding control procedures. The center receives data of ZigBee / GPRS gateway via the GPRS network

and analyzes and counts these data through control procedures in order to acquire the running information of the equipment and take measures in time to ensure power quality.

The whole system is divided into four layers:

(1)Data layer: Based on SQL Server 2005, the data sent from the wireless sensor network is stored, and accordingly the corresponding database is designed. In the database, equipment operating parameters, equipment operation status table, historical data tables, statistical list and so on are established to support data system .

(2)Business logic layer: It is used to implement the corresponding business process design and business rules package. For the power quality monitoring system, business rules include device status calculation and analysis, early warning and fault diagnosis, power load analysis and forecasting, power quality assessment and other major business logic and calculations. These features are achieved relying on EJB components design. The mouth corresponding of Web components is also designed at the same time.

(3)Presentation Layer: Use JSP language design to generate dynamic web pages, and the specific content of the page is based on the user's request and calculated by calling EJB components and the results are fed back to the appropriate page.

(4)Client: end-users check and operate calculation results of dynamic pages from the presentation layer and business logic by visiting the Web site on the Internet and verify and submit users' requests, and submit the users' requests to the presentation layer in order to complete the appropriate remote monitoring.

THE LOGICAL STRUCTURE OF THE WHOLE SYSTEM

This system is a networked, distributed large-scale relational database application system, its design includes three parts, corresponding distributed relational database design, graphical user interface design (HTML) and application programming design. Distributed relational database are located in an end of database server, the graphical user interface is located in every business operator workstation (client) end, and the business process is located in the application server. The whole logical structure of the system is shown in Fig.2.

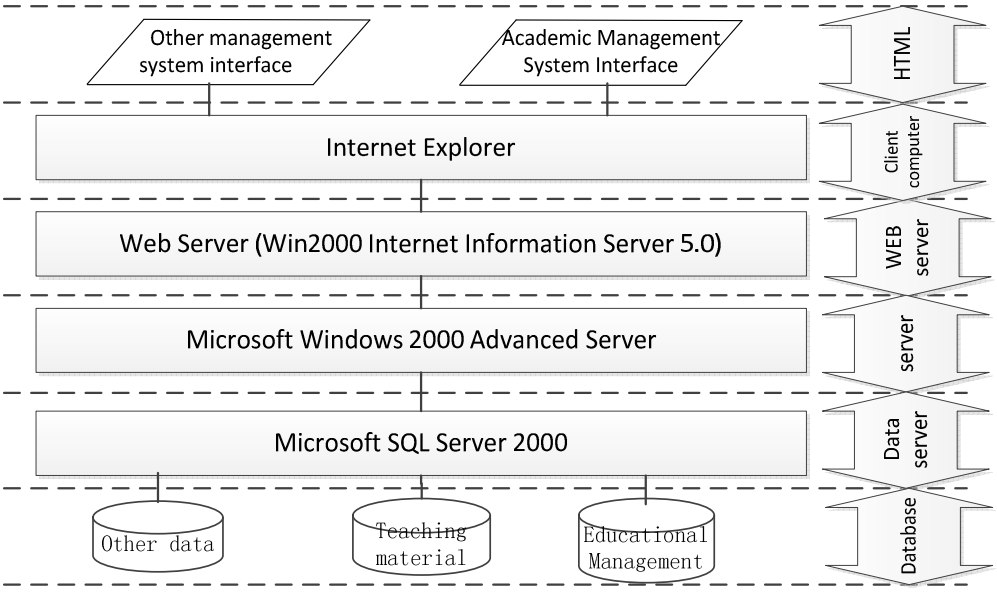

Fig.2 structure of the system

SYSTEM MULTI-LAYER BROWSER/SERVER ARCHITECTURE

Network platform of this system uses the patterns of multi-layer Browser / server, which is a network configuration scheme based on the world's most advanced technology and also a best solution to Internet / Intranet construction. This technology platform scheme maximizes the convenience of the user to deploy and maintain large-scale software systems, thus greatly reducing TCO (Total Cost of Ownership) of the target system of users.

Network is divided into four levels logically: data server, application server, web server and client. The different levels have very clear division and are object-oriented, without disturbing each other. The client is mainly responsible for human-computer interaction , including the operation of entry and modification of educational

faculties from different departments; Web server is mainly responsible for centralized management to client applications, such as teachers' recording scores through the website, students' inquiries, enrollment, teaching evaluation and other operations; Application server is mainly responsible for logical structure and the data relationship, namely transaction processing and can be divided into a plurality according to their specific business process; And data server is primarily responsible for storing and organizing data, distributed management, backup, synchronization, etc.

Multilayer Browser/Serve: Application architecture provides an advanced solution for integration of users' information resources. Its advantages are as follows:

Unified User Interface: The entire application logic and business rules reside on the middle application server layer, and only the presentation layer (Graphical User Interface) resides on the client so that the client becomes quite simple (just a generic browser) .Therefore, this structure is particularly suitable for a wide range of (WAN) network applications. Unified Communications Protocol: network communication protocols all use TCP/IP, therefore, information integration is not only possible but also convenient and economical. High application scalability: In this application architecture, upgrading of applications functions only in the middle of the application server, which can greatly protect the user's investment.

In short, B/S application architecture is technologically advanced multi-layer client/server architecture. It has unified user interface and unified communications protocol, therefore, it is proposed to build the system office network application platform with this application architecture.

CONCLUSION

With the further development of science and technology, power quality problems are arousing people's attention. Both power systems and power users need to effectively monitor the quality of electricity and at the same time assume significant responsibility on the power quality assurance and governance. Development of network technology makes it possible to monitor remote power system power quality without persons. This paper describes the design of power quality monitoring system based on Web technologies and achieves online monitoring and remote monitoring to electrical equipment operating status and user power quality through wireless sensor networks. On-the-spot experiments show that the system can not only achieve continuous real-time power quality monitoring, but also realize remote control to various of power equipment in remote monitoring center, which makes it come true for power quality monitoring and analysis to really monitor remotely without any person.

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