Design and Reliability Analysis on Client Intelligent Electricity Information System

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Abstract. In order to improve the quality of data collection, a method of dada collection with high reliability is proposed in this paper. Based on the data collection method, the software and system platform of client intelligent electricity information system (CIEIS) is designed to further analyze client electricity information. The plug-in calculation model is presented to improve reliability of the system, and the client electricity intelligent subsystem is designed subsequently. Moreover, the mathematical analytic model of reliability on CIEIS is built to analyze the reliability of the system. The research results provide theoretical guidance for the application of big data processing technology and research of reliability in power system.

Introduction

With the progress of science and technology and the change of energy development pattern, the dependence of the economic and social development on electric energy is increasing [1]. Relying on modern information, communication and control technology, smart grid is encouraged to develop to transform the power grid development mode, which has become the choice of international power industries [2-3]. In order to improve the competitiveness and attractiveness of the demand side of the client, it is necessary to acquire client information data, and to establish the client intelligent electricity information system (CIEIS) based on big data processing technology.

A data collection method with high reliability is proposed in this paper to improve the quality of data collection and enhance the operating reliability of the power system subsequently. Based on the data collection method, the software and system platform of client intelligent electricity information system is designed to further analyze client electricity information data. The plug-in calculation model is presented to improve reliability of the intelligent system. The mathematical analytic model of reliability on client intelligent electricity information system is built to analyze the reliability of the system. The research results provide theoretical guidance for the application of big data processing technology and research of reliability in power system.

Design of Client Electricity Information Data Collection System

Data processing system consists of preparation of the data collection based on the business requirements, collection of the power information of client side, data sharing and data publishing. The data collection process includes the data collection task, the execution of data collection, the quality assessment, the collection point detection and data release.

The preparation of data collection task is required firstly, then the collection task is implemented in the following step. Then, the quality of collected data is checked according to certain rules, if data collection is succeeded and collected data is complete, the qualified data is to release. Otherwise, the data collection task is needed to restart. During the data collection processing, the system detects the collected points in real time. Abnormal information is released immediately when an abnormality is detected. High reliability is indicated in this method and data collection efficiency is improved at the same time.

Design of Client Intelligent Electricity Information System Platform

Software framework structure diagram of the client intelligent electricity information system based on data processing technology is shown in Fig.1.

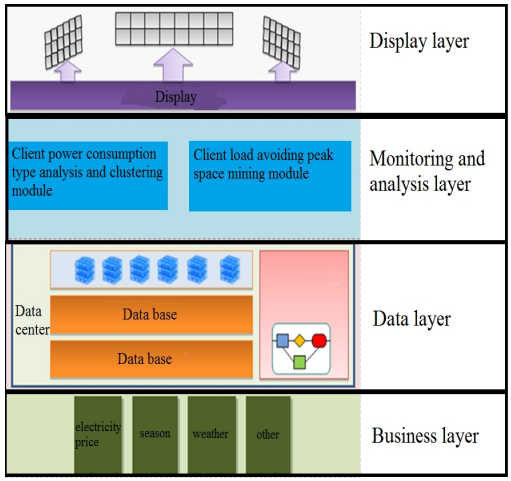

Fig.1 software framework structure diagram of CIEIS

Distribution Multilayer Structure is adopted in client intelligent electricity information system. And the software of CIEIS consists of business layer, data layer, monitoring and analysis layer and display layer. According to the design requirement, client power consumption type analysis and clustering module as well as client load avoiding peak space mining module are adopted in the monitoring and analysis layer to make deep analysis of custom power consumption analysis.

Client intelligent electricity information system is based on analysis of business layer. The sensitivity factor analysis of client load against different types such as electricity price, season and weather can be obtained in the business layer. The industry client power consumption type analysis and cluster subsystem is built based on the relevant factors such as the shape of the curve and shape of the electric power clients. Data collection and processing are carried out in the internal data center of data layer. Monitoring and analysis layer is the functional layer of the system and the core of the CIEIS which also sends the results and information to the operator. To achieve deep analysis of client power information, the monitoring and analysis layer realizes the service function of CIEIS through data analysis and communication technique, which consists of client power consumption type analysis and clustering module as well as client load avoiding peak space mining module. The client-side or interface of the system is display layer which realizes the visual display, and is responsible for dialogue function between the operators and business layer.

The system block diagram of CIEIS is shown in Fig.2.

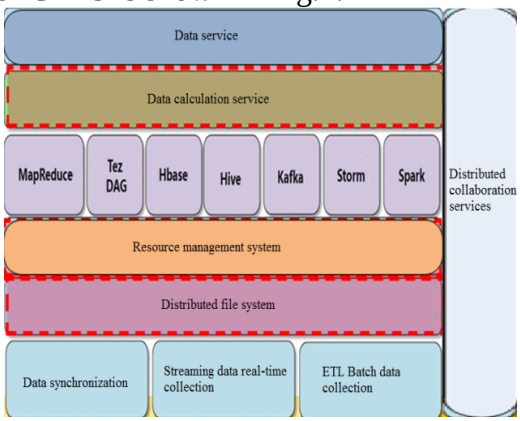

Fig.2 diagram of the system platform

The system platform is designed to contain the complete cycle of data processing, namely definition of data source, collection of data, calculation of data, definition of calculation result and data output service. The monitoring of universe data process which is from the original data collection

to the result data output is realized. The underlying mining model is packaged and defined through the unified computing service portal. The statistic, analysis and mining model which are frequently-used are plug-in packaged, making the calculation model easily used. And those seldom-used calculation models are developed and deployed to the computing model library.

CIEIS is built based on the main feature of industry clients. The block diagram of the cluster subsystem is shown in Fig.3.

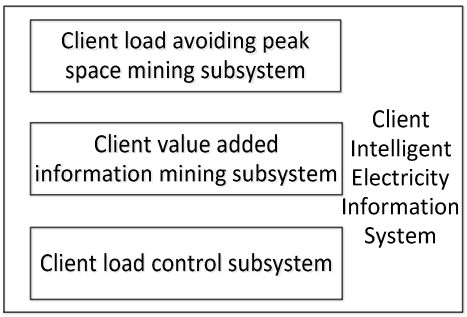

Fig.3 diagram of the cluster subsystem

According to the block diagram, intelligent mining of client load avoiding peak space can be realized through the establishment of client load avoiding peak space mining subsystem, and then load avoiding peak space size identification of industrial clients can be realized. Based on development trend of client electricity data history, prosperity index of the industry that client belongs to can be obtained through the development of client value added information mining subsystem. The extract of the industrial structure changing characteristics, as well as the analysis of the national economy development trend can be obtained. Thus the prediction of the government agencies and financial institutions national economy development trend can be realized through the system. Flexible control of the client load can be achieved through the development of client load control subsystem, which can enhance client's active control by the power grid.

Reliability Analysis of Client Intelligent Electricity Information System

In order to estimate the reliability of the client intelligent electricity information system, the mathematical model is built.

The usability of the system which indicates the CIEIS' probability of actual proper functioning under certain condition is important for estimating the reliability. Performing in the CIEIS, the functional contents of the CIEIS include the followings: the function of collection function, the function of communication system, function of data analysis and collection of CIEIS, communication system transmission function of CIEIS, collection and transmission functions of the facility and terminal.

In order to analyze the reliability of the CIEIS, the system is simplified as a simple parallel and series system. And the mathematical model of the parallel system is as follows:

$$A_p = 1 - F^n \tag{1}$$

where, F is the degree of unreliability of each parallel subsystem, n is the number of the subsystems consisted of the system.

While the usability of the series system is as follows

$$A_s = \prod_{i=1}^{n} A_i \tag{2}$$

where, A_i is the usability of the subsystem, and n is the number of the series subsystem.

In order to obtain the probability of completing the set of the function in the specified conditions and time, the survival function model is presented as follow.

$$R(t) = \frac{n_t}{n_0} \tag{3}$$

where n_t is defined as the usability during t, n_0 is the initial reliability, which is generally set to 1.

The function of the client intelligent electricity information system decreases with time, the decreasing trend presents more obvious with the increase of time. A re-planning should be done in five years to ensure the reliability of the intelligent system, according to the calculation.

MTBF (mean time between failures) mathematical model is proposed to calculate the mean time between failures of the power system and analyze the mathematical expectation of the random variables after working time *t*, the mathematical expectation can be calculated by (4).

$$MTBF = \int_0^{\infty} t \frac{dF(t)}{dt} dt \tag{4}$$

According to parameters of the client intelligent electricity information system, the system usability, survival function and mean time between failures can be calculated. The computation results of the system usability, survival function and mean time between failures are presented in Table.1.

Table.1 Reliability function of client information system

System usability A	97.3%
Residual function R [year]	5
mean time between failures $MTBF$ [year]	5.2

What can be concluded from Table.1 is the designed client information system has high reliability, and client electricity information can be further analyzed through this intelligent system.

The reliability of client intelligent electricity information system is closely related to that of hardware. The structure style of the system is determined by the performance index and functional requirements during the analysis procedure, thus the function of system unit is determined. In order to improve the reliability of the system, the structure is simplified as much as possible. As the reliability of CIEIS is determined by that of the components, plug-in calculation model is designed, which satisfies the requirements of the system as well as reduces quantity. At the same time, design cycle can be shortened through this design scheme. As the number of the subsystem is large, the functions of the software and hardware are divided properly, which ensure that the functions of system are mainly performed by software, thus make a further improvement of the reliability. The redundancy design of critical components is introduced to improve to usability of the CIEIS.

Conclusion

This paper presents an electricity consumption information gathering system with high reliability. On the basis of which, software and system platform of client intelligent electricity information system (CIEIS) are designed to make a deep analysis of client's information on power consumption. The plug-in calculation model is designed to improve the reliability of the system. Analytic and cluster subsystem of CIEIS is built based on the consumption feature of industry client. According to the calculation of usability ratio, survival function and mean time to failure, CIEIS is proved to be with high reliability. The research results provide theoretical guide for the application of data processing technique to power industry.

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