Reliability Analysis of Power Side Information Acquisition Model Based on Wireless Sensor

Wen-Lin Xu[1(✉)], Xin-Ze Guo[2], Zi-Peng Hu[3], Chao Li[3], and Kai Liu[3]

[1] Marketing Department, State Grid Hunan Electric Power Co., Ltd, Changsha 410000, China
dsf2541521@163.com
[2] Changsha Electric Power Technical College, Changsha 410131, China
[3] State Grid Hunan Integrated Energy Service Co., Ltd, Changsha 410000, China

Abstract. In order to improve the remote monitoring capability of power users' power consumption information, a reliability analysis method of the power side information collection model based on wireless sensor is proposed. Through collecting and screening the operating data of the power side information collection model, detecting the running state of the information on the power side, and modifying the abnormal information by using the adaptive distributed characteristics of the wireless sensor nodes, The vector quantization method is used to process the information fusion of data acquisition, and the attribute classification of power user information is classified by pattern recognition technology. The quantitative fusion tracking method is used to mine and modify the power user information, so as to improve the reliability of the power side information acquisition model. The test results show that the reliability analysis method of the power side information acquisition model based on wireless sensor has higher accuracy in the practical application.

Keywords: Wireless sensor network · Power side · Information distribution · Information collection

1 Introduction

With the continuous development of power grid, power information intelligent management technology is also improving. The research on the reliability of information collection model based on wireless sensor is of great significance to realize the optimal management and control of electric power and improve the intelligent dispatching performance of electric power information for power users [1]. Research on reliability optimization method of power side information acquisition model based on wireless sensor has attracted much attention. In order to improve the intelligent management and service level of power user information, it is necessary to collect and identify the power user information intelligently, improve the accuracy and reliability of the identification results, and realize the effective monitoring of power user information combined with wireless. Sensor network technology, using adaptive information scheduling method to improve the reliability of power information management and control [2].

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This paper studies the collection results of power users' power consumption information, combined with the design technology of wireless sensor network, optimizes the reliability of power users' power consumption information. The remote data acquisition method is adopted to effectively collect the power consumption information of power users, and the collected power consumption information is input into the intelligent information processing terminal to realize the remote reliability control and analysis of power users. Consumption information, improve the real-time processing ability of power users' telecommunication information. It shows the reliability and superiority of the model.

2 Reliability of Distributed Data Acquisition Model in Power Side

2.1 Reliability Information Collection of Distributed Information Collection Model in Power Side

According to the different types of users and business requirements, the comprehensive collection of power reliability information is realized. At present, the wireless sensor network and single-chip microcomputer control method are mainly used to collect the reliability information of power users. The collected reliability information of power users is intelligently stored in the data memory. Combined with big data management technology, the power user information collection and information management are carried out, Improve the reliability of power users' information and intelligent dispatching ability. Aiming at the disadvantages of traditional methods, this paper proposes a dynamic acquisition method of power users' power consumption information based on wireless sensor network reliability information recognition, constructs a wireless sensor network reliability model of power users' power consumption information acquisition, and carries out the adaptive distributed optimal positioning design of power users' power consumption information acquisition sensor nodes [3]. The vector quantization method is used for the reliability fusion processing of the collected data information, and the pattern recognition technology is used for the classification processing of the reliability feature attributes of the power users' power consumption information. The quantitative fusion tracking method is used for the power users' power consumption information mining and feature extraction to realize the automatic mining of the power users' power consumption information, and then the reliability feature design and development of the model are carried out, Finally, the test and analysis of information collection are carried out. The current distributed collection model of reliability information on the power side still has the problems of low utilization rate of a large number of power consumption information data in the practical application process, and the information of power supply enterprises at the provincial, municipal and county levels can not be fully interconnected and shared, which is easy to become a data island phenomenon, It can not meet the current design goals of data fusion and model reliability [4]. In order to solve the above problems, it is necessary to optimize the reliability category of power consumption information collection data (Table 1).

Table 1. Reliability index of power consumption information collection data

System name	Total number of systems	Coefficient table of provincial companies	Proportion of provincial companies	City company coefficient table	Proportion of city companies	Number of district and County company systems	Proportion of district and county companies
Centralized meter reading system	248	2	0.40%	210	55.02%	112	44.58%
Load management system	268	7	3.00%	138	78.65%	50	18.35%
Power consumption information acquisition system	1	1	…	0	…	0	…
total	518	10	1.93%	348	67.12	162	30.95%

Based on the data in the above table, the power consumption information collection data is coordinated by the master station, terminal and watt hour meter. According to the different main body of the control logic that executes the calculation of the user's remaining electricity charge and sends out the control tripping command, the way to realize the charge control includes three modes: the master station implements the charge control, the terminal implements the charge control, and the watt hour meter implements the charge control for reliability processing [5]. With the increasing demand of residents for electricity in China, the construction of distribution network in some areas has been unable to adapt to the economy. At the same time, there are many outlets in the distribution network, and the power consumption environment is relatively complex. It is necessary to adopt modern monitoring methods to collect and intelligently monitor the power consumption data, so as to improve the reliability of the model. According to the results of operation and maintenance intelligent monitoring information collection of power consumption information collection system, it is necessary to integrate the reliability characteristic information of marketing business based on the massive data of power consumption information collection, and use the integrated application of marketing and distribution to conduct real-time monitoring on the reliability status, power quality reliability and equipment operation and maintenance engineering reliability of distribution network equipment operation and maintenance. The power consumption information collection system is the main data source of the monitoring system, and it is also a comprehensive just in time information collection and reliability analysis and processing system integrating modern electronic communication technology and power marketing technology. However, the traditional operation and maintenance monitoring has some problems, such as inaccurate monitoring data, poor system redundancy and so on, which can not achieve efficient monitoring of power consumption information collection. Based on the above problems, the optimization design of reliability analysis method for power consumption

information collection, operation and maintenance monitoring based on big data is proposed. This paper analyzes the reliability of power consumption information collection, information preprocessing, information management and information analysis, analyzes the reliability characteristics of database and telecommunication, optimizes the reliability model and active early warning function of power consumption information service according to the characteristics of users, and maintains good reliability performance. According to different cost control methods, the corresponding terminal equipment and electric energy meter are selected for data processing. The electric energy meter includes remote charge control electric energy meter, local charge control electric energy meter and electric energy meter without charge control function, so as to realize data acquisition and improve the reliability of data acquisition. Based on this, this paper optimizes the information reliability acquisition process of intelligent power side, as shown in Fig. 1

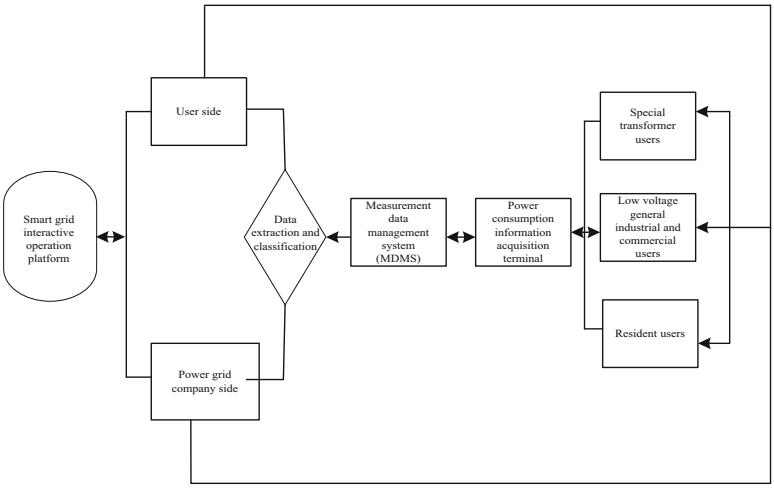

Fig. 1. Power side reliability information acquisition process

Based on the above steps, it is judged whether the user ends the electricity management behavior, and the time is based on the instantaneous stop value of the electric equipment. However, in the actual situation, the normal operation of electrical equipment through human or its own characteristics, there is a pause time gap, which may cause error to judge the end time [6]. Based on this, the maximum interval time parameter is considered to solve the problem of poor reliability of the model. When the power consumption behavior ends, it will wait for a period of time for the next calculation and reasoning, and the waiting time for data collection will be less than TIG. If the power consumption behavior does not conduct data screening again in the TIG period, it will automatically determine the end time of equipment operation [7]. Because different electrical equipment have their own operating characteristics, it is necessary to extract the corresponding operation scenario information from the basic

electricity consumption information data automatically. The characteristics of electrical equipment are extracted from the ontology of electrical equipment, and the tasks are classified by the activity characteristics of electrical equipment. The reliability characteristics of the model are also obtained from the ontology, so as to ensure the research effect.

2.2 Reliability Algorithm of Information Distribution in Power Consumption Side

In order to achieve the reliability of power user information collection, the power user information distributed wireless sensor network structure model is used to design the array network structure. The power user information collection wireless sensor network array adopts the distributed Internet of things networking design method, and the sensor nodes are arranged in the power user information monitoring area, The multi-sensor quantitative detection and recognition method is used to collect the dynamic characteristics of power user information

$$x(k+1) = A(k)x(k) + \Gamma(k)w(k) \tag{1}$$

$$z_i(k) = H_i(k)x(k) + u_i(k)x(k+1) \tag{2}$$

Where: $\mathrm{x(k)} \in R, \mathrm{n*1}$ is the reliability matrix of monitoring state information of power users, $\mathrm{A(k)} \in R, \mathrm{n} \times \mathrm{n}$ is the reliability characteristic distribution matrix of non-stationary power users' power consumption information, the background interference noise of information collection is w(k), $u_i(k)$ is a Gaussian white noise with zero mean value and variance u, and $\Gamma(k)$ is the reliability sample correlation matrix of dynamic sensing information of power users' power consumption information [8].$\mathrm{z_i(k)} \in R, \mathrm{p} \times 1$ is the mixed data of power user reliability information collected by the i-th wireless sensor network node, $\mathrm{H_i(k)} \in R, \mathrm{p} \times \mathrm{n}$ is the impulse response of wireless sensor network information collected by power user information, where the interference noise $\mathrm{u_i(k)} \in R$, $\mathrm{p} \times 1$ of data collection process is Gaussian white noise with zero mean value and variance $\mathrm{D_i(k)}$. Based on the assumption that there are association rules between the weighted matrix w(k) and the reliability matching vector $\mathrm{u_i(k)}$, the fuzzy information weighted control technology is used to process the multi-mode feature reliability of power consumption information, and the multi-sensor fusion tracking identification method is used to obtain the node distribution structure expression of reliability information collection

$$\begin{cases} E\left\{W(k)z_i(k)/u_i^{\mathrm{T}}(k)\right\} = B_i(k), i = 1, 2, \cdots, N \\ E\left\{u_i(k)u_j^{\mathrm{T}}(k)\right\} = D_{ij}(k), i, j = 1, 2, \cdots, N,\ i \neq j \end{cases} \tag{3}$$

Considering the sensor network composed of N sensor nodes, the output structure model of power user electricity information sampling network is constructed by using sensor node array, and the node location of power user electricity information data acquisition sensor network is obtained

$$\begin{cases} x_{i,t+1} = \left(x_{i,t} + x'_{i,t+1}\right)/2B_i(k) \\ y_{i,t+1} = \left(y_{i,t} + y'_{i,t+1}\right)/2D_{ij}(k) \end{cases} \tag{4}$$

The feedback equalization filter is constructed based on the average value of the measurement information of wireless sensor network nodes. In $t+1$ monitoring node, the coordinates of the origin moment o_i of the monitoring data distribution of the power user reliability information are obtained as $(x_i, t+1, y_i, t_i+1)$. the multi-sensor network is used to integrate the reliability information of the remote monitoring of the power user power consumption information, The dynamic statistical characteristics of the monitoring data of power user reliability information collected by output are as follows:

$$E[\overline{V}(k)] = \Delta E \tag{5}$$

$$E\left[x_{i,t+1}\overline{V}(k) - y_{i,t+1}\overline{V}^{\mathrm{T}}(k)\right] = R(k) \tag{6}$$

The quantitative noise $w(k)$ and $\overline{V}(k)$ of power user information collection are not related to each other. The information fusion processing of power user information is carried out by combining reliability information matching detection method. Frequent item detection and association rule feature extraction are carried out for high-dimensional fusion data, thus the association rule feature extraction and information fusion processing of power user power user information are realized. In order to realize the optimal collection of power user information, it is necessary to build a distributed data structure model of power user power information under wireless sensor network mode. A quad G is used to represent the fuzzy distributed structure storage center of power user power information. It is C. suppose I is the phase space embedding dimension of the interaction of power user information, The information flow model of the power user information expressed by the constraint equation of the association rule term is as follows:

$$R(k)\Delta E + E\left[\overline{V}(k)\overline{V}^{\mathrm{T}}(k)\right] = \Delta R(k) \tag{7}$$

The model reliability evaluation algorithm also plays an important role in the design of power consumption information collection. In order to ensure the reliability of the model, it is necessary to collect the power consumption information and calculate the reliability under normal conditions

$$W(a)_{\min} = \Delta R(k)\sum_{i=1}^{n}\lambda_i\left(k_i^t a\right) + \delta y(a) \tag{8}$$

The reliability judgment function of information collection can be expressed by formula:

$$W(\mathrm{b})_{\min}=\sum_{i=1}^{\mathrm{m}}\lambda_i(-b_i)-\delta y\left(\frac{1}{\delta}\sum_{i=1}^{m}k_i b_i\right) \tag{9}$$

Where: $\mathrm{k}_1,\cdots,k_{\mathrm{m}}\in 2^m$ is the vector of m information; $\lambda_1,\cdots,\lambda_{\mathrm{m}}$ is the loss quantity of reliability information; y is the reliability coefficient of information collection; δ is a conjugate function; a is the original information variable; b is the variable of distributed information function; $t\geq 0$ is the function parameter. Each information variable c_i corresponds to the D_i of a storage variable

$$\lambda_i\left(\mathrm{c}_i^t a\right)=\frac{\left(c_i^t a-D_i\right)^2\cdot y(a)}{2}=|a|_i \tag{10}$$

The constrained function model can be obtained from the formula

$$f(a)_{\min}=\|Fa-r\|_3^3+W(\mathrm{b})_{\min}t|a|_i \tag{11}$$

Where: F belongs to the matrix of n term distributed information; $t\succ 0$ is the parameter of information constraint. Based on the above algorithm for power side information distribution data acquisition and processing, can better improve the effect of data acquisition.

2.3 Reliability Optimization of Distributed Data Acquisition Model in Power Side

The purpose of reliability design of distributed information collection model based on overall architecture is to make the collected information accurate. In the environment of Internet of things, information collection has the characteristics of strong distribution and wide range. Therefore, the design needs to be divided into different levels: storage layer and access layer [10]. The storage layer can store a certain amount of distributed information of power equipment. After information collection, the command is given to the collector, and the collected information is combined with logical thinking to accurately determine the distributed location of power equipment. Through the determination of location information, the command is sent to the access layer, so as to realize the distributed information collection in the Internet of things environment, Acquisition logic architecture is mainly from the logical point of view of electricity information acquisition management from the master station, channel, terminal, acquisition point and other four levels of reasonable logic classification, in order to ensure the reliability of the model. The logic architecture of power consumption information collection and management is shown in Fig. 2

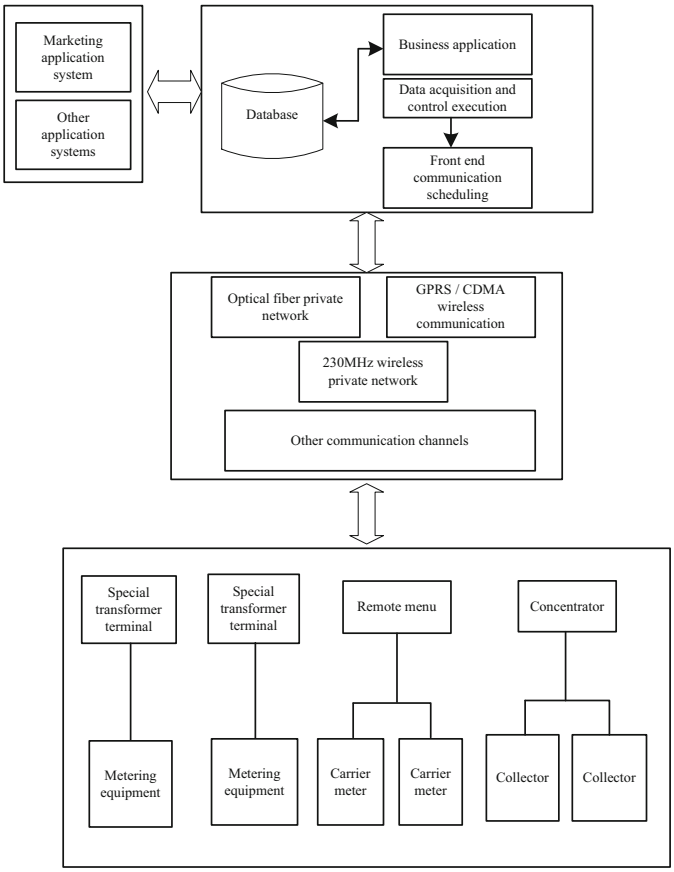

Fig. 2. Structure framework of distributed information collection model at power consumption side

The management of power information collection can be divided into three levels logically: the main station layer, the communication channel layer and the acquisition equipment layer. Besides the reliability of marketing information, it is called other application information. Through the interface, acquisition management can effectively connect and screen with marketing applications and other applications. The main station layer is composed of business application, data acquisition, control execution, pre communication scheduling and database management. Data acquisition is responsible for collecting user power information and protocol analysis, so as to improve the reliability of model motion. The application of distributed data collection model of electric side information is used to realize the optimization goal of logic reliability of various applications. The communication management and scheduling of various terminals are carried out through remote communication, and the related control operations are performed on terminals with control function. Communication network is the carrier of information interaction. The main ways of connecting the main

station and collecting and transmitting table network are cable communication, optical fiber communication and carrier remote communication information management structure as shown in Fig. 3

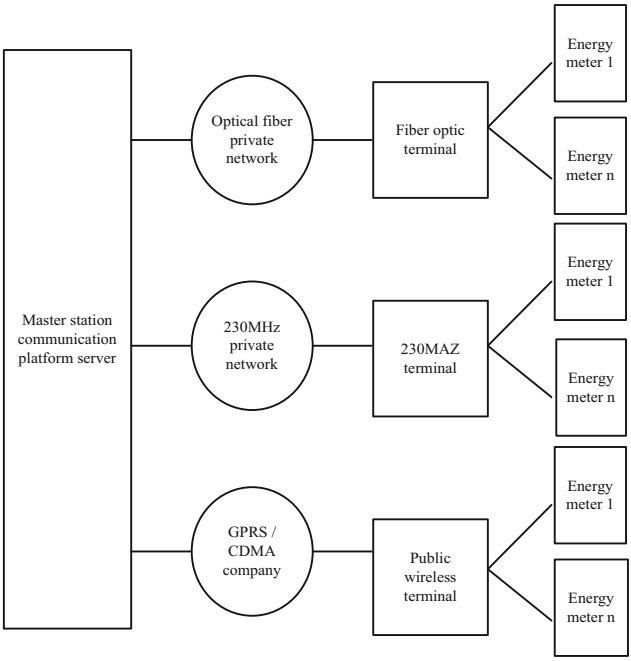

Fig. 3. Description of remote and local information processing

Because the data needed for power consumption information collection, operation and maintenance monitoring is real-time, the system needs to quickly and accurately judge the operation position, intelligently diagnose all data, model information, graphical information and a series of unstructured data, and process the data reliably in real time. The model structure is used to analyze whether the change of charge characteristics in distribution transformer area meets the monitoring standard. Combined with the load and circuit monitoring in distribution transformer area, the reliability of power distribution under the line is analyzed. HBase is used to store the data of power consumption information and analyze it quickly and reasonably to improve the operation reliability of the model. Based on part of the difference information, it needs to be optimized in combination with low-voltage power line carrier communication technology. The most important way of local communication for power consumption information collection is relatively mature technology development. The industry has a certain scale and can support large-scale construction of power consumption information collection. Low voltage power line carrier communication has incomparable advantages over other communication technologies, One is to use low-voltage power line as communication medium to naturally form information distribution network with

clear boundary, which is conducive to the overall planning of network layout of remote channel and local channel. In the design of data acquisition, the user information and equipment information are managed macroscopically according to the user's requirements; At the micro level, the sampling time is designed. The design is carried out in strict accordance with the real business process of data acquisition under the state of security environment. The order is: equipment reliability correction, reliability parameter setting, reliability data storage, reliability data calculation, data display and export. The specific steps are shown in Fig. 4.

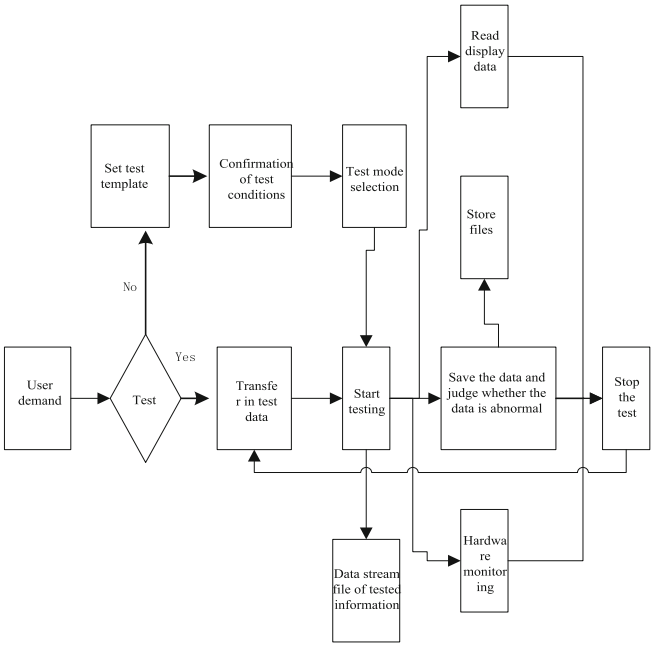

Fig. 4. Power consumption information reliability management process

The collection and monitoring of reliability characteristics of power consumption information is established according to the characteristics of users and the situation of distribution network users. According to the established business analysis model library, different kinds of models are designed, including market development analysis, multi-dimensional analysis, line damage analysis, power quality analysis, operation and maintenance pre control analysis, work efficiency analysis and user recovery risk analysis. Different business models have different data sources and algorithm libraries, and each information integration and publishing needs to be combined with the actual application scenarios to complete the business model design. In the big data environment, the design of power consumption information collection, operation and maintenance monitoring system is based on the assumption of market development and business expansion.

1. ① Obtain the capacity, voltage level, power supply address, charge characteristics and other information of the capacity increasing transformer;
2. ② By locating the position of power supply station, the operation and distribution integration of lines, switching stations and stations is carried out;
3. ③ According to the data obtained from electricity statistics and the charge of each dimension of the line, combined with the marketing business process and power grid model information, the big data analysis method is introduced to monitor the new power supply location. The model design is shown in Fig. 5.

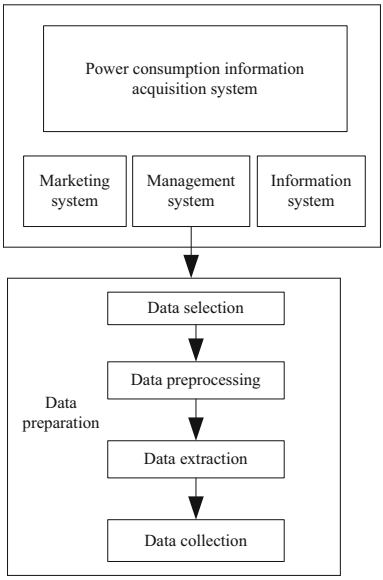

Fig. 5. Power consumption information business information management model

In this model, there are relational database and non relational database, relational database is the mainstream database, which is widely used in system design. The advantage of this method is that it can collect and store the power consumption information by using two-dimensional structure storage mode, and its rich integrity reduces the probability of data inconsistency, which is suitable for dealing with relatively complex online analysis system. In the current big data environment, due to the influence of I/O hard disk, the problems of difficult expansion and complex query, the use of relational database can solve the problem of unstructured data storage [5]. Non relational database has the advantages of high reliability and strong scalability, which is suitable for distributed storage system. It follows the principle of data storage, stores data with key value, and the structure is uncertain, which makes the stored data not limited to fixed structure, and saves monitoring time. The main functions of the model are as follows: to initialize the data acquisition and set up each acquisition channel;

Setting the collection environment and parameter information; Control the automatic process of data acquisition; In the process of acquisition, the data of each acquisition channel needs to be stored, calculated, analyzed and displayed to be processed synchronously; Strict management of user groups, improve security and confidentiality. In the design process, it is set to record the change of centralized information communication operation data every one minute, the time interval is 50 ms, and the upper limit of acquisition cycle is 10 min. when each collector is connected, it is easy to lose 10 data [8]. Therefore, we need to use multi port collector to collect the lost data.

Based on the wireless sensor network model of power user information collection and the adaptive distributed optimal positioning design of power user information collection sensor nodes, the optimal design of power user information dynamic collection technology is carried out. The distribution function description of power user information distribution structure model is as follows

$$X_p(u) = \begin{cases} p\sqrt{\frac{1-j\cot\alpha}{2\pi}}e^{\frac{1}{2}\cot a}\int_{-\infty}^{+\infty} x(t)e^{\frac{1}{\sec t\alpha - jtus(\alpha}}dt, \alpha \neq n\pi \\ x(u), \alpha = 2n\pi \\ x(-u), \alpha = (2n \pm 1)\pi \end{cases} \tag{12}$$

Where: p is the characteristic order of the reliability structure of the power information storage of distributed power users, and the reliability regression analysis model of big data to be mined is constructed:

$$\begin{cases} \min \sum\limits_{1 \le i \le Ke} \sum\limits_{Ck|\, e} \frac{f(e(i))}{C(e,i)} \\ 0 \le f(e,i) \le C(e,i) \\ F = \text{ const} \\ \sum\limits_{1 \in i \in K, e \subseteq k(e)} \frac{f(e(i))}{C(e,i)} + \sum\limits_{e \subseteq k|\, e} \frac{f(e'(i))}{C(e',i)} \le k(v) \end{cases} \tag{13}$$

A multivariate statistical characteristic equation is used to describe the reliability information of power users

$$\begin{pmatrix} X \\ P(X) \end{pmatrix} = \begin{cases} a_1, a_2, \cdots, a_m \\ p(a_1), p(a_2), \cdots, p(a_m) \end{cases} \tag{14}$$

In order to realize the accurate and real-time acquisition of power users' power consumption information, the embedded technology is used for reliability information acquisition and development design. VXI bus scheduling and embedded information reliability acquisition technology are used for wireless sensor network structure design and reliability adaptive information processing of power users' power consumption information, PXI trigger bus is used to control the clock sampling reliability of power users' power consumption information to improve the integrity and reliability of power users' power consumption information collection. Data playback is carried out in the application layer module to realize the dynamic monitoring of power users' power

consumption information, The overall structure of the power user reliability information collection designed in this paper is shown in Fig. 6.

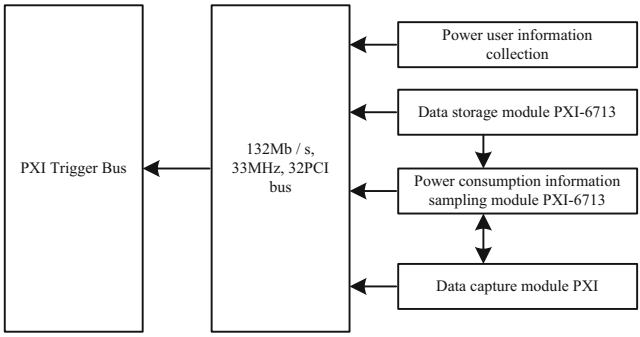

Fig. 6. Overall structure optimization of power user information acquisition system

Power users' power consumption information collection uses multi-sensor distributed in the power users' power consumption information monitoring area for data collection, and uses wireless sensor network networking technology for sensor networking reliability design. Wireless sensor network networking is divided into physical layer, data link layer and data transmission layer. In order to ensure the security and reliability of the information collection model, the application service layer of wireless sensor network for power user information collection is constructed, the reliable scheduling of data bus transmission is carried out, and the multi-mode embedded control method is used for adaptive transmission and reliability control of power user information.

3 Analysis of Experimental Results

In order to verify the reliability of the distributed collection model of power consumption information based on the wireless sensor network, experiments were carried out. First, set the experimental parameters based on the overall structure of the distributed information collection design framework to provide data for the experiment; select a power company, and let the company employees upload the distributed information of the power equipment at the same time, record the information collection speed in time, and conduct data analysis; The quantized noise w(k) and V(k) collected by power user electricity information are not correlated with each other, and the matching correlation detection method is used for information fusion processing of power user electricity information, and frequent item detection and correlation of high-dimensional fusion data Rule reliability feature extraction, which realizes the association rule feature extraction and information fusion processing of power users'

electricity consumption information. The experiment uses hierarchical iterative collection of multi-source feature digital information as the test environment of the experimental group, and Deep Web collection as the test environment of the control group. With the support of the Google Play platform, the change trend of the coverage area of reliability information and the iterative drive loading capacity is recorded. As shown in Table 2.

Table 2. Experimental data

Acquisition frequency (Hz)	Duration (s)	Number of experiments (Times)	Overflow or not
500	2400	3	no
800	1130	3	no
1200	850	3	no
1500	150	3	yes
110000	15	3	yes

According to the experimental conditions and the experimental environment in the table, the data is read every one minute. Based on this, the experimental equipment and parameters are further standardized and designed, as shown in Table 3.

Table 3. Experimental equipment and parameters

Parameter	Upper computer	Detector
Number of equipment	1 set	10 sets
Sampling interval	1s	80ms
Cycle/ms	5000	7000
Actual time	500000 ms	(data loss)

Based on the above experimental environment, the main test end organization, experimental group end organization, and control end organization are open at the same time, making the Google Play platform enter a stable iterative operation state. Under the condition that the number of icons in the display interface box remains unchanged, open OriginPro2018 and use the built-in numerical statistics function to record the experimental indicators. According to the specific experimental results, the experimental group and the control group are analyzed and applied, and then the digital information is iteratively driven on the basis of the load. According to the change of capacity, the distribution of electricity consumption information is collected on this basis, as shown in Fig. 7. Show.

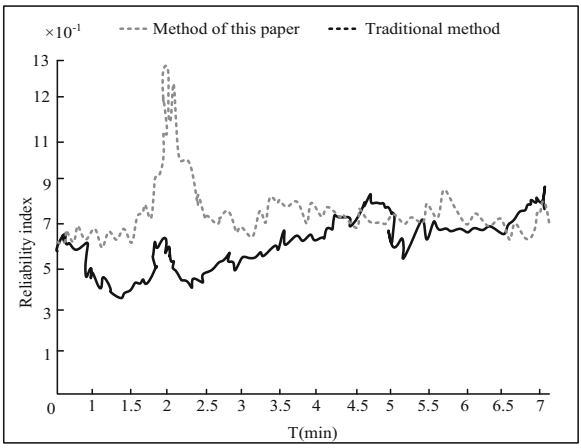

Fig. 7. Comparison diagram of model reliability index changes

In order to test the design performance of the power user electricity information collection designed in this paper, a simulation experiment was carried out. In the experiment, 32 sensor nodes were used to design the reliability effect of the power user electricity information collection. The low trace noise of the data collection: 0.00 4dB/rms, frequency option: from 9 kHz/100 kHz (with biased T-type connector) to 4.5 GHz/8.5 GHz, configure VisualDSP, perform hardware simulation, set two D/A channels to output a maximum of 5V at the same time, power users use electricity The pulse width of the information output is 2 μs. According to the above parameter setting, the power user electricity information collection is performed, and the stability and collection accuracy of the test are tested. The comparison result is shown in Fig. 8.

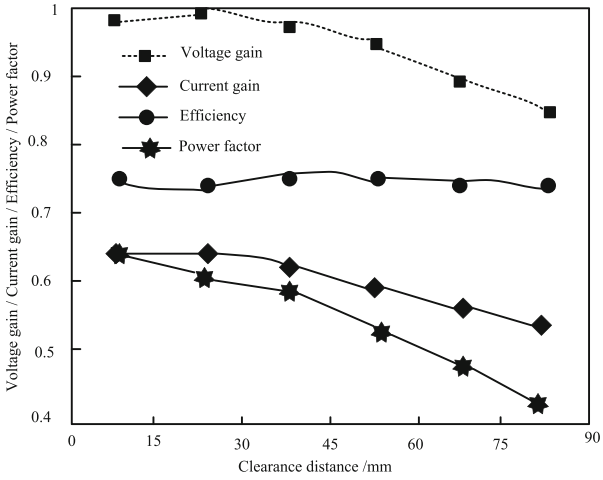

Fig. 8. Reliability detection of electricity consumption information distribution collection model

Analyzing Fig. 8 we know that the automatic control performance designed in this paper for the collection of power user electricity information is better, and the collection results are accurate and reliable.

4 Concluding Remarks

Combining wireless sensor network technology and realizing the effective monitoring of users' electricity consumption information according to the results of user electricity consumption information collection, the adaptive information dispatching method is adopted to improve the power information management level and the reliability of the model. A method for dynamic collection of electricity consumption information of electric power users based on distributed array wireless sensor network network and quantitative detection and identification is proposed, and a wireless sensor network model for collecting electricity consumption information of electric power users is constructed. The acquisition sensor is used for the adaptive distributed optimization positioning design of the node, the vector quantization method is used for information fusion processing on the collected data, the pattern recognition technology is used for the attribute classification processing of the electric energy information of the power user, and the quantitative fusion tracking method is used for the power user's Electric energy information mining and feature extraction have realized the reliability of automatic mining of user electricity information. Studies have shown that the reliability and reliability of collecting electricity consumption information from electricity users is high.

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