Design of Intelligent Lifting System for Real-Time Monitoring Data Expansion in Distribution Station Area

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Abstract. In view of the fact that the monitoring data in large-scale distribution network has the characteristics of quantifiable, real-time, dynamic and so on, and the data storage capacity is insufficient, this paper puts forward the design of the real-time monitoring data expansion intelligent upgrading system in the distribution station area. Realizes the monitoring data expansion capacity intelligence enhancement. Through designing the hardware module of expanding capacity and installing the data acquisition interface, the hardware design of intelligent upgrading of monitoring data expansion capacity is realized. On this basis, the hierarchical extended storage mechanism is used to store the data node information. The real-time reading and querying function of the data is realized, and the capacity ratio of the monitoring data is calculated. Finally, the intelligent upgrading system of the real-time monitoring data expansion capacity is realized.

Keywords: Distribution network · Data storage · Data acquisition interface · Capacity expansion

1 Introduction

The demand for electric energy is increasing day by day in modern society, at the same time, the demand for power quality is higher and higher. Electricity is a special commodity, can not be stored on a large scale, flexible, can only use as much electricity as possible. However, electricity is very important in modern human civilization. If a long period of blackout occurs, it will bring serious damage and influence to human life and production [1]. At present, the information construction level of the distribution network is relatively high. A large number of liquidity data generated during the operation of the power network are recorded in the dispatching, operation and maintenance, marketing system, the storage amount is in the TB level [2], the data types are diverse, and the variables are various. The storage and monitoring data capacity of distribution network is not enough. Based on the existing problems, the design of real-time monitoring data expansion and capacity-expanding intelligent upgrade system is proposed. With the increase of the distribution network data, it is more and more

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important to design the real-time monitoring data expansion and capacity enhancement system in the distribution station area. There are a lot of complex and abnormal power network data in the distribution network. If there are loopholes or errors in the transmission process, the big data structure of the power network will tend to become infinitely complicated and reduce the generation efficiency of the distribution network. Therefore, it is extremely necessary to enhance the capacity of the distribution network.

Distribution network real-time monitoring data expansion intelligent promotion, with the intelligent lifting system as the core, through the use of a variety of communication methods to complete the distribution system capacity expansion intelligent upgrade, and through the integration of relevant application system information, To realize the scientific management of power distribution system capacity expansion. So as to improve the data storage space and power supply quality, strengthen the reliability of power supply data storage, and increase the amount of monitoring data storage [3], increase the economic benefits of power supply enterprises and strengthen the level of enterprise management, and optimize the operation of the power grid. Through the design of the expanded capacity intelligent upgrading system, the data storage capacity [4] has been improved, the work difficulty of the overhauling personnel has also been reduced, and big data's storage and demand information extraction has been realized. Therefore, the intelligent upgrade system for data expansion in the distribution station area is designed, and the hardware design for the intelligent upgrade of monitoring data expansion is realized by designing the expansion hardware module and installing the data acquisition interface. And use a layered extended storage mechanism to store data node information. Real-time data reading and query functions are realized, and the capacity ratio of monitoring data is calculated. Realize the intelligent upgrade system of real-time monitoring data expansion capability, and conduct experimental verification.

2 Hardware Design of Intelligent Lifting System for Real-Time Monitoring Data Expansion

The real-time monitoring data expansion intelligent upgrading system should have a certain good monitoring performance and excellent stability. The hardware configuration of the monitoring data expansion intelligent upgrading system is as follows: 2 data acquisition ports, 7 analog signal isolators, master plate, power board each, computer host computer, upper computer, scanner, serial port, keyboard, AD conversion interface, printer, etc., mainly complete the adjustment and operation of each signal. Among them, the power supply module adopts input 220 V AC, output 12 V, 5 V and 3.3 V DC, to provide the other modules with the power supply required for the stable operation of the system. The main control module communicates with the switch data module and the man-machine interaction module through the 422, 485 interface, receives the data of the switch quantity module, at the same time, judges the data and stores the data. If the fault is found, it will be recorded in the memory. If the request command of the human-machine interaction module is received, the data is sent to the human-machine module for display. The main control module provides fieldbus communication interface, communicates with other devices through CAN, MODBUS or Ethernet [5], and provides remote operation and management functions. The electric life can be calculated by using the circuit breaker breaking current, and the double functions of collecting and fast calculation can be realized, so as to ensure the speed and accuracy of the signal processing. The system module composition is as follows (Fig. 1):

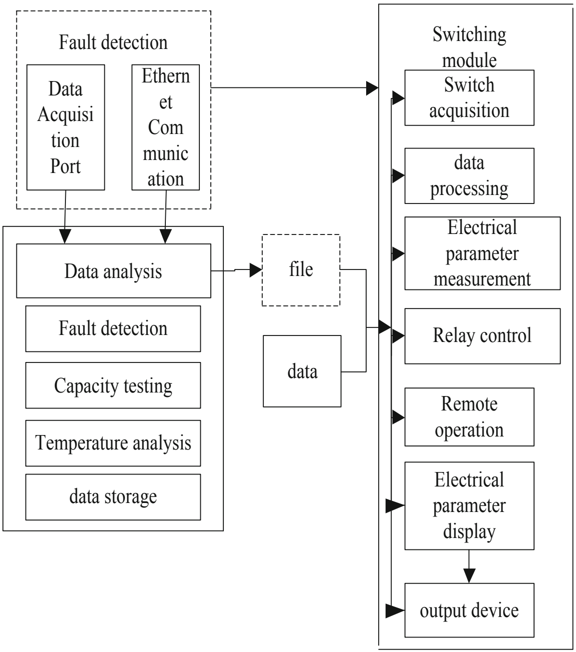


Fig. 1. Expansion hardware system module composition diagram

The hardware module of the expansion capacity is shown in the diagram. In order to realize the data expansion capacity safely, stably and quickly, the data acquisition interface is installed, through the data collection interface, the user electric meter and the data collection work in the intelligent station area are realized. The platform provides all interfaces for current mainstream production control systems, consumer meters, and power-related systems [6]. Considering the possible network failure of WAN, the data caching mechanism is established at the sending end of the interface. When the transmission of the network is interrupted, the field data can be stored online for more than 1 month. After the hardware system is powered on, the data is read from the sensor through the serial port, the corresponding frequency signal is collected, and the digital input is used to process the data. Adjust the voltage to the specified range for data input, carry out frequency conversion in the hardware system [7], analyze the data, and finally send the results of the analysis and diagnosis through the serial port.

3 Materials and Methods

The software design should take into account the real-time, reliability and maintainability of the control system. In addition, as a powerful and complete system, the software design should take into account the real-time performance, reliability and maintainability of the control system. Real-time monitoring system also needs to exchange information with remote equipment for remote control. The information between the system software is transmitted and exchanged, and the data size of the power network is judged, and the communication between the system software and the remote equipment is discussed.

3.1 Store Data Node Information

The hierarchical extended storage mechanism is used to realize the real-time reading and querying of data so as to improve the availability and storage ability of the system and make the intelligent control of the power grid more rapid and accurate. In a grid, when the sensor node perceives the data, the Data message is generated and sent to the computing IED node in the grid. An intelligent electronic device is placed at the center of each grid, which is defined as computing the IED node, receiving the sensing data sent by the sensor node in the grid, calculating the purpose of storing the grid and forwarding the data. The data matching the storage type of the grid is received and forwarded to the appropriate storage node, the storage IED node in the grid is managed, and the dynamic expansion of the storage node is realized.

3.2 Calculating the Capacity Ratio of Monitoring Data

On the basis of storing IED node information, data integration or access to the same grid of computing IED nodes through sensors, all-round, multi-angle data collection, so as to improve the accuracy of data acquisition. Start the judgment, carry on the sampling data in the sampling interval to carry on the calculation, judge whether the detection data exceeds the bearing range, and carry on the inquiry to the status of the main control board, when there is no data transmission, Continuously carry on the data query [8], when the capacity is insufficient, will monitor the data to carry on the data debugging. Through the establishment of relational database HBNDU for data programming, using database modeling, circuit breaker and motor operation data acquisition, real-time transmission and timely recording of the capacity ratio of data [9].

The power monitoring data and queue output rate are denoted by $y(t)$ and $r(t)$. The power monitoring data flow arrival rate and interference flow arrival rate are $Z_y(t)$ and $Z_d(t)$, respectively. The power monitoring data and interference data entering the buffer queue form the data flow arrival rate expressed by $Z(t)$, And $Z(t) = Z_y(t) + Z_d(t)$.

Let A denote the output link bandwidth when the time is t, and the output rate meets the link bandwidth constraint. D_w discrete random dynamic process is used to represent the change in the length of the output queue. At this time, the change in the queue can be expressed as an expected value. According to the balance of the queue, the change formula of the length of the information data queue $p(t)$ is as follows:

$$\frac{dp(t)}{dt} = Z(t) - r(t) - G(t) \tag{1}$$

$$r(t) = \begin{cases} D_w, p(t) + Z(t) > D_w \\ \min\{D_w, (t) + Z(t)\}, p(t) + Z(t) \leq D_w \end{cases} \tag{2}$$

Let the large amount of power information data be transmitted in the form of a single packet. When the maximum buffer of the queue cannot accept the information packet length, the new information data is lost. Select the Droptail data packet loss strategy; set the new data packet to be completely discarded when the queue length is maximum, and the time is t. When using this power information data transmission technology to transmit the power system packet loss rate formula is as follows:

$$G(t) = \begin{cases} 0, \quad p(t) + Z(t) - r(t) \leq p_{\max} \\ p(t) + S(t) - r(t) - p_{\max},\ p(t) + Z(t) - r(t) > p_{\max} \end{cases} \tag{3}$$

The online real-time transmission of massive power information data is described by formula (1)-formula (3).

The minimum support $F_{\min}$ and the maximum confidence $F_{\max}$ of data association rules are set as constant functions, and the maximum capacity of distribution network is taken as standard to record the data capacity presented by $F_{\min}$ and $F_{\max}$, as shown in Table 1.

Table 1. Distribution network monitoring terminal data

Thread	Transformer substation	Transformer substation	Interactive terminal	Monitor
$F_{\min}(1)$	1	1	1	0
$F_{\min}(2)$	0	1	1	0
$F_{\min}(3)$	0	0	1	0
$F_{\max}(1)$	0	0	1	1
$F_{\max}(2)$	0	0	0	1
$F_{\max}(3)$	1	1	1	1

For expansion intelligence enhancement, first calculate the capacity ratio of the received data [10], retain part of the aggregation attributes of the data during the calculation, and then use the line evaluation protocol to calculate its support. Furthermore, the accuracy of real-time monitoring data of distribution network is improved. The data processing calculation is as follows:

$$w(j) = \sum AjeG(t) \tag{4}$$

In the formula, $w(j)$ represents the query target parameters of monitoring data and A represents the original data set. $w(j)$ is formally defined. If and only if $w(j)$ contains transaction item x_i, the form of its capacity ratio can be recorded as $w(j) \Rightarrow x_i$.

According to the relevant requirements of calculation, without considering data missing and quantity value, $w(j) \Rightarrow x_i$ is taken as the minimum support rule coefficient of monitoring data, and then the capacity ratio of monitoring data of distribution and substation is obtained. The formula is as follows:

$$F = \frac{B_0/f(t)}{w(j)^2 \Rightarrow x_i} \tag{5}$$

In the formula, point F is the association rule of large data in distribution network; point B_0 is the constant of data capacity; and point $f(t)$ is the total amount of data mined in t time. This calculation does not do directional analysis.

On the basis of calculating the capacity ratio of monitoring data, the capacity expansion of intelligent lifting monitoring data is realized.

3.3 Realizing the Intelligent Improvement of Monitoring data expansion capacity

In view of the phenomenon of large monitoring data in distribution network, combined with the characteristics of real-time monitoring data, the transmitted data are sorted out, and the POL technology [11, 12] is put forward. The principle is that when the received data exceeds a certain fixed value, The capacity of the distribution network can be increased by automatically starting the capacity expansion function and storing the excess data in another database. The distribution network terminal is used to monitor the distribution station area in real time, collect its operating parameters, and take these data as the basis for expanding the capacity. The specific capacity expansion process is shown in Fig. 2.

In Fig. 2, x_0, x_1 and x_2 represent the process of data expansion, V_0, V_1 and V_2 represent the process of data transmission and exchange, and F_1 and F_2 represent the process of data clustering.

Using a simple expansion capacity calculation function, the expansion capacity enhancement calculation formula is as follows:

$$Enc(D_i) = \bmod m + c_i \tag{6}$$

$$Dec(D_i) = c_i - k \bmod m \tag{7}$$

In the formula, $Enc(D_i)$ represents the normal data transmission parameters; $Dec(D_i)$ represents the expansion capacity parameters; this calculation does not do directional analysis.

Through the software calculation, the real-time monitoring data expansion capacity is improved by a deduction calculation [13, 14], and the excess data is inversed on the computer to solve the capacity problem.

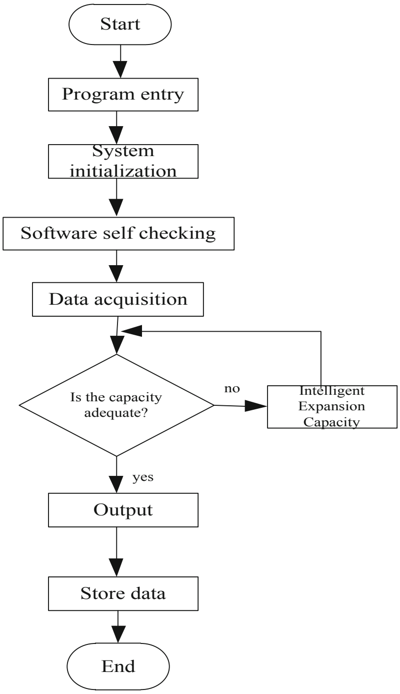


Fig. 2. Data expansion capacity Intelligent lifting proc

4 Results

In order to test whether the real-time monitoring data expansion intelligent lifting system in distribution network distribution station meets the requirement of capacity expansion intelligent upgrading, and to verify the feasibility and effectiveness of the system, an experiment is carried out on a certain platform. The traditional intelligent capacity expansion system is compared with the hardware system and software system designed in this paper.

4.1 Parameter Setting

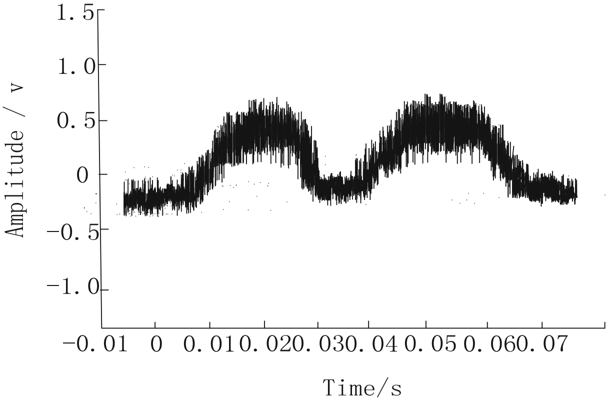
Sequence $f(u)$ is used as the intelligent lifting function for capacity expansion. The higher the value, the stronger the expansibility of the representative system. The calculation formula is as follows:

$$f(u) = \frac{1}{c}\left(\sum_{s=0}^{k} \gamma^k u_s\right) \tag{8}$$

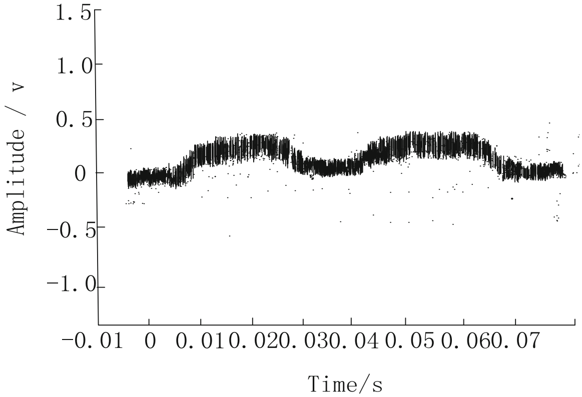
In the formula, c represents the data parameters of the basic capacity, γ represents the parameters to be estimated, and u_s represents the expanded capacity parameters.

4.2 Result Analysis

Before the contrast experiment of the proposed system, due to the weak stability of the collected data, it is necessary to normalize the collected data, and the processing process is shown in Fig. 3.



(a) Pre-processing



(b) After processing

Fig. 3. Data normalization process

As shown in Fig. 3, by normalizing the data and removing some incomparable data, the amplitude of the data tends to be zero, the activity is reduced, and the stability is higher, laying a good foundation for experimental verification.

On this basis, taking the data expansion as the test index, comparing with the traditional method, the data expansion ratio of different methods is tested. The test results are shown in Fig. 4.

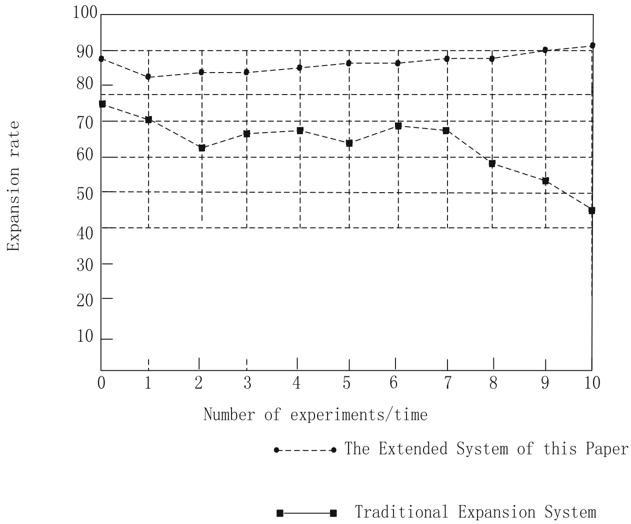


Fig. 4. Expanded capacity comparison results

As shown in Fig. 4, As the number of experiments increases, the expansion ratio of the traditional method decreases, while the expansion ratio of the proposed method increases with the number of experiments. When the number of experiments is 10, the expansion ratio of the traditional method is 45%; The expansion ratio of the proposed method is 91%, which is twice that of the traditional method. The extended capacity system proposed in this paper has high expansibility and high stability, and the traditional expansion effect is not very satisfactory. After a period of testing, the expansion degree shows a decreasing trend. The capacity of real-time monitoring data cannot be expanded.

5 Conclusion

In order to effectively improve the real-time monitoring data expansion capacity of distribution network distribution station, an intelligent lifting system based on real-time monitoring data expansion is designed. The technology realizes the intelligent enhancement of real-time monitoring data expansion capacity from both hardware and software, and reduces the amount of data loss in the process of data upgrading. Based on the intelligent enhancement of real-time monitoring data expansion capacity, the capacity expansion efficiency of distribution network is improved effectively. The experimental results show that this technique can improve the capacity expansion of real-time monitoring data and ensure the stability of the expansion. Therefore, it can be said that in the real-time monitoring data expansion process of distribution network distribution station area, the real-time monitoring data expansion process can be achieved. The design of the expansion system proposed in this paper is suitable for the data expansion of the distribution network.

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