Power marketing and distribution network remote visual control system based on big data architecture

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Abstract. As the main power transmission system connecting power supply equipment and power customers, whether the distribution network is safe and reliable in production and operation directly determines whether the work capacity of power supply equipment and power consumption equipment can be improved. The application of big data centralized control system can help us timely and accurately grasp the reasons for the decline of security and reliability of distribution network, and provide safe and stable power energy for power customers while improving the operation efficiency of power supply system. On the basis of previous research results, the author systematically analyzes the role of big data centralized control system in distribution network production and operation management, and puts forward some suggestions on applying big data centralized control system to distribution network production and operation management according to his many years of work experience. The comparative experiment proves that the fault location accuracy of the system designed in this paper is higher than 90%, which effectively increases the fault detection accuracy.

1. Introduction
Under the joint action of the continuous innovation of power supply equipment, the gradual improvement of power grid construction capacity and the increasing improvement of power grid construction technology, China's distribution network has been significantly improved in construction scale and operation quality. But at the same time, the problems existing in the traditional distribution network production and operation management mode are also becoming increasingly prominent, which seriously restricts the improvement of distribution network production efficiency and operation quality in China[1]. For example, with the continuous increase of the scale of the distribution network, the coverage area of the distribution network, the number of users and the type of users are also increasing rapidly, so that when we use the traditional distribution network management mode and management concept to manage it, the management is often not timely and in place. Therefore, the application of big data centralized control system to the management of distribution network production and operation has become the only way for the development of China's power enterprises[2]. It is of great significance to study the related problems of distribution network production and operation of big data centralized control system. In the process of continuous development of distribution network operation management, an information resource sharing platform
will be gradually established. The platform covers the fields of distribution equipment and network management, daily production management and so on. It has the characteristics of wide application range and high practicability. The main functions include power grid data acquisition and monitoring system, asset equipment management system, safety production management system, etc[3]. Gradually upgrade the operation management of distribution network to the information management benchmark. In view of the fact that the traditional two-dimensional visualization method is a two-dimension projection of N-dimensional data, for big data, the traditional dimensional flattening visualization method will compress too many dimensions onto the plane, losing the spatial information of the dimension itself, and cannot be effective Reflect the characteristics of the data. In order to ensure that the operation management of distribution network can be unified and coordinated, it is imperative to establish a set of distribution network safety risk assessment system. The risk management of distribution network also needs to gradually become the main line of management, including not only the traditional defect management, operation analysis and risk assessment, but also the analysis and evaluation of the power supply capacity of distribution network operation, the grid structure of distribution network and the ability to deal with emergencies, so as to improve each link process from the details and foundation. Form closed-loop management processes such as risk assessment, risk prediction, risk grading, control means and comprehensive scheme for distribution network operation management to improve the management level.

2. Power marketing and distribution network remote visual control system

2.1. Hardware configuration of remote visual control system for power marketing and distribution network

Distribution network is an important part of smart grid. With the increase of working time and the change of environmental conditions, there will be lightning stroke, icing, external force damage and other fault risks and a variety of transportation losses, which has brought immeasurable losses to the national economy. In order to ensure the safe operation of distribution network system, at present, it is mainly through the establishment of reasonable distribution network condition monitoring system to promote the development of transmission link work[4]. The design purpose of distribution network fault monitoring intelligent management and control system is to build a distribution network information management and application platform and implement online monitoring and control according to the actual operation environment of combined distribution network[5], including lightning strike, icing, pollution, meteorology and other environmental factors. The overall architecture design of the system is shown in the figure 1.

![Overall hardware architecture of the system](image)
According to the figure, the intelligent control system of distribution network fault monitoring is mainly composed of CPU processor, wireless sensor, monitor, power module, wire temperature measurement unit, fault location equipment, intelligent voice alarm equipment, etc[6]. CPU processor is used to analyze data signals transmitted by wireless sensor modules. When the system fails, the system analyzes the causes of the fault through CPU processor, and the fault location equipment accurately locates the fault occurrence point, and displays the causes and information on the LED display screen.

2.2. System software function optimization
The risk of distribution network system lies in the probability characteristics of its behavior. The occurrence of random faults in power grid system is often beyond the control of operation managers, and there is uncertainty in the occurrence of faults, so it can not be well predicted. The method of risk assessment can link the safety level with the impact or benefits brought by adopting the level for assessment[7]. After the analysis and judgment of the single chip microcomputer, if the parameters exceed the standard, the voice information will be sent to the user through the wireless transceiver module and voice module. The main program flow of system software design is shown in the figure 2.

![Diagram](image_url)

**Fig. 2 Main program flow of system software design**

The vulnerability assessment process of distribution network is shown in the figure. Firstly, confirm the purpose of distribution network safety risk assessment, put forward the risk factors of distribution network safety assessment from the two aspects of distribution network operation management and production management through on-site investigation, screen the risk factors, select the assessment method, analyze and layer the risk factors, and then construct the assessment system, optimize the risk factors, and finally evaluate the vulnerability of distribution network.

2.3. Realization of remote visual control of distribution network
The probability superposition effect of vulnerability risk index can effectively evaluate the whole distribution network system. It is also an important basis for the comprehensive evaluation of distribution system safety. It can also be combined with the safety risk assessment of production and operation module of distribution network, and take vulnerability index as an important index of safety production evaluation, and incorporate it into the distribution network safety risk assessment system, which will have an impact on star level assessment of production projects. The life of the energy storage system of the battery is inversely related to the life loss under different charging / discharging depth. The charge / discharge depth is different, and the influence on the life is $M_{y,n}$. When calculating the depth $R$, the life of the energy storage system is

$$L_i = \frac{1}{\sum_{y=1}^{i} M_{y,n}}$$  \hspace{1cm} (1)
Where $y$ is the maximum number of cycles under full charge / discharge, and $M$ is the $i$-th charge / discharge life loss with depth $n$ of energy storage system. However, due to the inconsistent discharge depth each time, the calculation error of the formula increases. In order to improve the accuracy, the charge / discharge coefficient is defined as:

$$
\beta_y = \frac{N_y}{N_0} \quad (2)
$$

Where, $N_y$ is the maximum number of cycles under full charge / discharge corresponding to the $y$-th charge / discharge, and the range of charge / discharge coefficient $[0,1]$. At different charge / discharge depths $R$. The life loss of can be expressed as:

$$
M_{y,R} = \frac{\beta_y}{N_y} \quad (3)
$$

According to the above algorithm, the charge / discharge times $N_x$ of the energy storage system can be fitted, and the specific expression is.

$$
L_x = \sum_{R=0}^{N_x} N_y \beta_y \quad (4)
$$

Among them, the value range of $R_x$ setting is $[0,1]$. If the influence of discharge depth on the service life of energy storage system is considered, the setting range shall be continuously reduced. According to the SOC of the energy storage battery system and the power output of the energy storage system, the attenuation function of the adjacent two charge / discharge life of the energy storage battery system can be expressed. The specific expression is as follows. The SOC of energy storage system is.

$$
SOC_{ES, k}(t+1) = \frac{1}{E_{ES, k}} \quad (5)
$$

Where SOC is the state of charge of the system at time $t$, and $E_{SC}$ is the capacity of the $k$th super capacitor energy storage system. When the power density is high and the charge / discharge times are frequent, the cycle times of power type energy storage system (super capacitor) is much higher than that of battery, so the application of super capacitor is becoming more and more widely.

### 3. Analysis of experimental results

The purpose of this test is to verify whether the functions of the sub modules of comprehensive display, analysis and auxiliary decision-making, marketing routine work management, assessment and evaluation, marketing work standard management and auxiliary management achieve the expected results. The following is the test software environment and test results.

| Serial number | name                        | edition                  | quantity |
|---------------|-----------------------------|--------------------------|----------|
| a             | Server operating system     | RedHat Linux 5.5         | 1        |
| b             | Database operating system   | RedHat Linux 5.5         | 1        |
| c             | Function test and operating system | Windows XP SERVER PACK3 | 1        |
| d             | Performance test and operating system | Win7 ultimate | 1        |
| e             | Test platform system        | Windows XP SERVER PACK3 | 1        |
| f             | Web Services                | Weblogic 9.2             | 1        |
| g             | database                    | Oracle 11.2              | 1        |
Take Line 1 and line 6, i.e. lines 1 and 6, for example, input lines 1 and 6 into "address input", i.e. x10001 and x6001, click the three-phase current button to collect the three-phase current and zero sequence current of the line, as shown in the table 2.

| Control area | Line 1  | Line 6  |
|--------------|---------|---------|
| Address input| X10001  | X60001  |
| Configuration setting | 21      | 21      |
| Phase current | A
|                | B       |
|                | C       |
|                | 1.2     |
|                | 4.5     |
|                | 3.7     |
|                | 1.1     |
|                | 3.6     |
|                | 5.6     |
| Zero sequence current | 3.15A   |
|                | 3.0A    |

In order to effectively improve the consumption of new energy, the example is set as the maximum cost of energy loss such as abandoning wind and light. The execution time of daily rolling plan is 4h, the decision-making cycle of setting tie line is 1h, the response time interval is 15min, the tie line is updated 4 times in one cycle, and the microgrid control center is updated 16 times in one regulation cycle. The output limit of dual microgrid distributed power supply is shown in the figure.

![Fig. 3 Extreme output control scenario of distributed generation in microgrid 1](image1.png)

![Fig. 4 Tie line 1 power flow control results](image2.png)

According to the diagram, the intra day rolling correction method can correct the deviation of the affirmative regulator and adapt the dynamic load flow plan of the tie line to the output of the distributed power in the microgrid. In the regulation period of 1-16min, with the difference of distributed generation output still existing, the tie line power flow between microgrids shows a form of continuous increase. In this case, 7 lines are selected to compare and analyze the fault location accuracy of the two systems, and the results are shown in the table 4.
Table 3 Control accuracy of two systems /%

| line | Traditional system | Paper system |
|------|--------------------|--------------|
| F1   | 57                 | 92           |
| F2   | 61                 | 95           |
| F3   | 63                 | 94           |
| F4   | 58                 | 91           |
| F5   | 49                 | 97           |
| F6   | 46                 | 96           |
| F7   | 43                 | 94           |

In order to more accurately correct the error of the day ahead regulation and achieve the goal of preferentially reusing renewable energy, the instantaneous response power fluctuation of super capacitor in centralized composite energy storage is taken into account. In the example, the energy loss cost of abandoned wind and discard light is taken into account, and the time window of the intraday rolling plan is set to be 4h, the decision-making period of the tie line is 1h, and the control time resolution is 15min. The fault location accuracy of the system designed in this paper is higher than 90%, which effectively increases the fault detection accuracy. This is because the rolling correction method takes into account the uncertainty of distributed output fluctuation. In order to prevent the problems of insufficient downward rotation reserve capacity and high power generation cost caused by output fluctuation in microgrid, rolling correction method reduces the tie line power between microgrids.

4. Conclusions

In the era of big data, traditional visualization methods are no longer intuitive due to the rapid increase in the amount of data and the increase in data dimensions. For this reason, this paper proposes a remote visualized management and control system for power marketing and distribution network based on big data architecture. To sum up, the safe and reliable operation of distribution network is not only related to the operation quality and efficiency of power supply network and power supply equipment, but also affects the improvement of economic benefits and market competitiveness of power supply enterprises to a certain extent. The application of big data centralized control system helps to accurately grasp all kinds of potential safety hazards existing in the production and operation of distribution network, and plays a very important role in enhancing the safety and stable operation of distribution network, which is worthy of continuous promotion and use in our future work. However, affected by the imperfect big data processing technology, the weak professional knowledge of staff and the imperfect relevant working mechanism, the value of the centralized big data control system in promoting the development of the power industry has not been fully tapped, and we must continue to learn and improve in our future work.

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