Application Research of Power System Automation Based on Electrical Automation Technology

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Abstract. Power is an indispensable energy in our daily life, and the power system is to manage and maintain the normal supply of electricity, which directly affects the stability of the entire power network. At present, China's power network is in an important upgrading stage, from the traditional power system to intelligent power system, in this process, automatic electrical technology plays an important role. Therefore, based on electrical automation technology, this paper puts forward the application research of power system automation. This paper deeply studies the power system and the application of automation technology in power system in China. It is considered that PLC and automatic power detection technology, which are extended from electrical automation technology, play an important role in the whole power system operation process. But at present, there are still many deficiencies in the power system based on electrical automation technology, including the problem of large measurement error. Therefore, this paper proposes an improved optimization method. The experiment shows that the maximum error of the improved method is 0.125%, especially in the case of synchronous current power grid frequency of 50 Hz, the error rate is 0. The results show that the optimized method has good measurement accuracy. According to the actual application of the existing electrical automation technology in the power system, this paper puts forward the optimization and improvement measures, and forecasts and analyzes the future application development trend.

Keywords: Electrical Automation Technology, Power System, Automatic Detection Technology, PLC Technology

1. Introduction
With the continuous development of the socialist political, economic and social civilization system with Chinese characteristics, the research and development of modern information network technology has made great progress. In the 21st century, with the rapid development of information network communication technology, all walks of life are carrying out intelligent transformation and upgrading [1-3]. Especially in the combination of the latest information technology and automation technology, the efficiency and quality of work can be effectively improved, the communication distance between different regions can be shortened, and the economic cooperation activities of different countries and
regions will be more frequent and closer, which will provide great help for accelerating the development of global regional economic governance integration [4-5].

In China's power system engineering construction, the commercial application prospect of electrical system automation manufacturing technology is very important. This is mainly because the main purpose of realizing the complete intelligence of China's power system can be effectively achieved through the use of electrical system automation management technology [6-7]. The development of traditional industrial human resource labor to modern automation industry can not only effectively improve the operation and management efficiency of China's power system equipment, but also effectively meet the current growing energy demand of China's power system, which is conducive to the further healthy development of the entire power industry [8-10].

This paper deeply studies the main design scheme of power system in China, and the practical application of electrical automation technology in power system. It is known that there are many technical deficiencies. For example, the error of traditional measurement method in sampling measurement is large, which will seriously affect the data processing and analysis, and bring certain risks to the security and stability of power system. Therefore, based on this problem, this paper proposes an improved optimization method. This paper simplifies the calculation steps and optimizes the formula structure of the traditional measurement method, which further improves the accuracy and robustness of the algorithm. In order to verify the actual effect of this method, this paper compared the traditional method with the optimization method, and carried out the corresponding comparative detection experiment. The experimental data show that the traditional method has better measurement error, up to 2.5%, while the maximum error rate of the improved method is 0.125%, which is obviously improved compared with the traditional measurement method. In order to better make the electrical automation technology applied in the power system, this paper analyzes the application advantages and importance of electrical automation technology in the power system, aiming at the shortcomings of the existing application, this paper puts forward the optimization and improvement measures.

2. PLC Technology and Automatic Detection Technology

2.1. PLC Technology

(1) Data processing.

In the power system, PLC technology is needed to complete the automatic acquisition and analysis of relevant data. Through PLC technology, the collected data is compared with the original stored data, and then printed in the form of a table. For operation, control and recording, the connection link and energy consumption are reduced, and the operation stability and safety are improved.

(2) Closed loop.

In the closed-loop system, it is necessary to simulate the changes of temperature, flow and other indicators, and carry out target control according to the data. In the simulation, the closed-loop PID control is needed, and the PLC technology can achieve better conversion efficiency.

(3) Change control.

In the special auxiliary power generation system of large thermal power construction enterprises, with the continuous progress of power generation technology, the auxiliary power generation system has gradually changed greatly. The new enterprise control management system design can effectively reduce energy consumption, improve the efficiency of enterprise operation and management, and increase the operating income of small and medium-sized enterprises. With the continuous transformation and upgrading of technology, the technical requirements of the power transformation plant and auxiliary equipment workshop for the enterprise automation process control management level are also constantly improved, so the PLC automatic control management system has been widely used in practice.

2.2. Automatic Detection Technology
Automatic fault detection technology is mainly used for the security risks or important faults that may exist in the normal operation and management process of China's power system, so as to effectively improve the normal operation and maintenance management efficiency of China's power system. For the power system, it greatly saves human resources and improves the error of traditional manual operation mode. From a professional point of view, the main purpose of automatic detection and processing technology is to study automatic information extraction and automatic information processing in automatic detection and processing system. It is a kind of signal, which can reflect some information of all kinds of signals, and choose the most appropriate expression to seek the best acquisition and conversion equipment. Therefore, in the application of power system, automatic detection technology greatly improves the measurement speed and accuracy.

3. Importance of Electrical Automation Technology

(1) Ensure the safe operation of the system

The production and power supply of electric power enterprises mainly depends on its power system. In today's society, electric energy has increasingly become a necessity for our social and economic production and service of people's daily life. In order to effectively ensure the normal and safe operation of power enterprises, it is necessary to make full use of the automatic monitoring technology of enterprise power system in the normal operation of the enterprise power system, so as to effectively ensure the safe and stable operation of the enterprise power system.

(2) Improve the service quality of the system

The wide application of power system automation management technology in enterprise power system not only helps enterprises realize the artificial intelligence process control of existing power system, but also significantly improves the technical service and quality of power system. This new technology product can automatically and real-time analyze all kinds of fault detection problems in China's power system, so as to find and solve the fault problems in time.

(3) Realize the real-time simulation of the system

When automatic simulation technology is widely used in the construction of power system, real-time automatic simulation of power system construction process can be carried out, so as to further optimize and improve the power system.

4. Discussion

4.1. Simulation Results and Analysis

The results are shown in Figure 1 and Table 1. Considering the time dispersion of interrupt response, the result is the mean value of 100 calculations. Under hardware synchronization, the amplitude and phase errors of the eighth harmonic are zero without considering the discrete interrupt response. Considering the interruption response time, the harmonic error, phase error and power measurement error increase significantly (see Table 1).

| Method              | 8th harmonic measurement | Measurement error (%) |
|---------------------|--------------------------|-----------------------|
|                     | Amplitude error (%)      | Phase error (%)       |                     |
| traditional method  | 0.0911                   | 0.0516                | 0.0962              |
| The method of this paper | 0.0                     | 0.0                   | 0.0                 |

The traditional measurement method mainly uses measurement software for synchronization, and the measurement error is large. As shown in Figure 1, in some special cases, the amplitude accuracy error and phase accuracy error can reach 2.5% respectively. It is important to note that the noise value of sampling may be far greater than 256 in high-precision signal measurement. At this time, the traditional measurement method cannot directly use the measurement software for synchronization, otherwise, due to the increasing error of software synchronization accuracy. We should consider using the improved online software system for online synchronous measurement and sampling. However,
the maximum error of the improved method is 0.125%, which is basically at a low level and can better meet the calculation requirements.

Figure 1. Simulation results of active power measurement

If the system adopts asynchronous sampling, the sampling cycle is determined according to the working frequency of China Grid 50Hz. When the actual working frequency of a power grid motor does not match the actual working frequency of 50Hz power grid, the measurement error is large. According to the results in Figure 2, in the current actual frequency of China's power grid, the optimization and improvement method in this paper can achieve a high accuracy rate of 0 errors. When it comes to the difference between the actual frequency and the sampling period, the corresponding adjustment should be made, otherwise the accuracy of measurement will be affected.
4.2. Optimization Algorithm of AC Synchronous Sampling

The signal $x(t)$ with period $T$ is sampled. The number of samples set in $M$ period is $N$, the sampling period is $T/\Delta T$, the actual sampling sequence is $t_0,t_1,t_2,\cdots,t_i=\Delta T,\cdots,t_{N-1},t_N$, and the corresponding sampling value sequence is $x_0,x_1,x_2,\cdots,x_i,x_{i+1},x_i,\cdots$.

$$\Delta T=(t_n-t_n-MT)$$ (1)

$$\Delta T_{i}=(t_{i+1}-t_i-T) \quad (i=0,1,2,\cdots,N-1,N,\cdots)$$ (2)

If $\Delta T=0$, it is called synchronous sampling; otherwise, there is synchronization error $\Delta T$, and the degree of asynchrony $\lambda_i=\Delta T/T_i$ is defined.

If $\Delta T_{i}=0$, it is called uniform sampling; otherwise, there is uniform error $\Delta T_{i}$ in the $i$ time. When it is uniform sampling, the sampling is not synchronous.

$$\lambda_i=\frac{\Delta T_{i}}{\Delta T}$$ (3)

If $\Delta T=0$ and $\Delta T_{i}$ are both 0, the sampling is called uniform synchronous sampling.

4.3. Application Advantages of Electrified Automation Technology

(1) Strong operability

Due to the increasing population size, the market demand for electricity is also growing. In the power system operation, transmission and other work projects, are inseparable from the support of electrical automation technology. The application of electrical automation technology has enhanced
the operability of the current power system, further helped the control and stability of the power system, which is conducive to the long-term development of the power system.

(2) Convenient maintenance

Once the power system breaks down, it will bring great difficulties to the maintenance of the power system. In addition, the application of electrical automation technology in China is not mature, which often causes corresponding safety accidents. Therefore, the improvement of electrical automation technology of power system can effectively help the power system to maintain effectively when the fault occurs, and help the power system to operate more scientifically and reasonably.

(3) Effective application of information technology

In the process of strengthening the actual operation and management of power system, the practical application of electrical engineering automation information technology must make full use of the advanced nature of modern information network technology. By automatically adjusting the settings, the efficiency of power system can be effectively improved and the sustainable development of power enterprises can be ensured.

4.4. Application Trend of Electrical Automation Technology in Power System

With the development and application of electrical automation technology, the national power system has entered the stage of intelligent automation development. However, there are still many shortcomings in promoting the development and application of electrical system automation technology in our country, which requires relevant scientific research institutions to constantly innovate and improve the relevant technology, so that China has always been in a global technology leading position in promoting the development and application of power system. It is necessary to improve the power generation mode of the power system and find a way to protect the environment, save energy and generate electricity efficiently. In dangerous operation, the intelligent safety device system can completely replace manual operation, thus effectively ensuring the operation safety of the majority of electric power engineering constructors.

4.5. Application of International Standards and Popularization of Modern Computer Technology

In recent years, IED Company has formulated a set of IEC61850 international standards under the guidance of International Electro technical Commission, and standardized the quality of its products. In order to make our country's technology in line with the whole world, we have gradually started to research and develop the integrated application automation management system of civil electrical equipment according to the national IEC61850 standard. Modern scientific computer information technology is not only a main basic technology of scientific information processing, but also an important basic technology of scientific information processing. At present, computer technology has been widely used in various fields. By means of communication management, information and control, it plays an important role in the intelligent construction of OAS, CNS, BAS and other systems. It is the main component of network technology, including fast FDDI, Ethernet and a variety of fast interconnection devices. It mainly uses Ethernet to exchange information with multiple objects. In China's power system, the combination of computer technology and electrical automation technology plays an important role in improving the comprehensive performance of the whole power system.

5. Conclusions

Compared with foreign countries, China's power system is still more imperfect. In recent years, the transformation and upgrading of power network put forward higher requirements for the design of power system and related technologies. Power system involves many high-techs, and electrical automation technology occupies an important position. The application of electrical automation technology will directly affect the comprehensive performance of the whole power system. Aiming at the problems of large measurement error in the current power system, the optimization and improvement scheme proposed in this study can better make up for the deficiencies in this aspect. And the optimization strategy proposed in this paper not only meets the actual needs of power system, but
also further improves the application scope of electrical automation technology, which has certain practical and innovative significance. The research in this paper has achieved ideal results and made a contribution to the research in this field.

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