

# Overview of the Application of Automatic Control Theory in Power Engineering

**Liang Chen**

*Department of Electronic and Electrical Engineering, Zibo Vocational Institute, Zibo 255000, Shandong, China*

**Abstract:** With the widespread application of power automation technology in power engineering, the development of power automation technology will definitely promote the development of power engineering. In the future, power automation technology will improve the security and stability of power supply, and provide better power supply equipment. Utilizing and promoting the development and advancement in the direction of greatly reducing operating costs, the application of this technology plays a decisive role and significance in promoting the further development of the electric power industry.

**Keywords:** Power Engineering Automation; Electric Power Thesis; Electric Power

## 1. Introduction

With the continuous progress of technology, automatic control theory has been widely applied in many fields, especially in power production. The theory of automatic control provides important technical support for power production, making the operation of the power system more efficient, safe, and stable. This article will focus on exploring the current application status and future development trends of automatic control theory in power production.

### 1.1 Application of Automation Technology in Power Grid Dispatching

Modern power grid dispatching and control systems generally begin to use computers as the core to carry out work. This is also the main feature of modern power grid dispatching. It can realize the functions of information collection, safety detection, screen display, working condition analysis and calculation, and real-time control. Command execution and information collection subsystem, control and information processing and collection

subsystem, human-machine contact, and information transmission subsystem are its main functions. Applying power grid dispatching to power grid engineering can not only realize automatic control of substations but also automate distribution network management and energy management. Power managers can timely and accurately grasp the information of the entire transmission network through power automation technology, manage and protect the entire transmission network promptly, and handle and resolve some emergencies promptly to ensure the safe and stable operation of the entire power grid system.

### 1.2 Application of Automation Technology in Power Supply System

The three main aspects of power supply system automation are substation automation, load control, and real-time monitoring, and regional dispatch. Among them, the main equipment for realizing real-time monitoring of regional dispatch is a small computer. The comprehensive use of communication technology and computer technology can automatically detect and control substations. On the premise of centralized use of computers and timely processing of various information, the allocation of power system resources can be optimized and the various resources of the power system can be optimally allocated. At the same time, this can also enable the daily maintenance and monitoring work of the power system to keep up promptly to ensure the safe and stable operation of the power system. Frequently used methods in load-based control are power frequency and audio frequency control, which mainly draw load curves through load records, and then analyze and study these load curves to monitor power usage in real-time[1].

### 1.3 Application of Automation Technology

### **in Hydropower Plants**

The main aspects of the implementation of the automated hydropower plant project include dam monitoring and maintenance, reservoir dispatching, and power plant operation. The specific hydrological information of the reservoir can be monitored in real-time through the automated system, and the rainfall of the hydrological information can also be automatically collected. These can provide a data basis for the subsequent mutual work of the reservoir so that maintenance services and related early warning measures can be followed promptly. Get on. The computer monitoring system can monitor and control the operation of the entire station promptly to ensure the safe and reliable operation of the power station.

#### **1.4 Automatic Transmission of Power System Information by Automatic Transmission System**

The power transmission system can realize the transmission function of power system information through the transmission of information between the dispatch center and substations and power stations. Telecontrol channels and telecontrol devices are the main components of automatic transmission systems. Telecontrol channels come in various forms, such as microwave, carrier wave, high frequency, light guide, and audio frequency communication. Telecontrol channels can be divided into different types according to different telecontrol functions. The functions of the device are divided into telemetry functions, remote signaling functions, and remote control functions.

## **2. Application of Power Automation Technology in Power Engineering**

Scientifically and rationally applying modern network technology, communication technology, and electronic technology to the power automation system can integrate online and offline data of power grid users in real-time, which can make the management automation control system more complete.

### **2.1 Fieldbus Technology**

Fieldbus technology is a comprehensive technology, and its main role is to connect automated equipment. Through the connection of Fieldbus, a multi-station and

multi-directional information network can be formed, and intelligent integrated control can be achieved at the same time. CAN, LONWORKS, HART, and PROFIBUS are several typical fields that are mainly used so far. By applying relevant equipment and sensors, information such as resistance and current can be transmitted to and from the host, and then some mathematical models can be used to organize, analyze, and study these data to obtain relevant results, saving the quantity and investment of hardware and some related maintenance and protection. Cost is the outstanding advantage of Fieldbus technology. In addition, the outstanding advantage of Fieldbus is that it enables users to achieve a high degree of system integration initiative, and users can independently choose brands. This shows that Fieldbus technology has huge market potential[2].

### **2.2 Automated Power Compensation Technology**

A single signal and three-phase capacitors complement each other. This is the main working method of the traditional reactive power and low-voltage compensation technology. A big flaw of this compensation method is that it is easy for those users whose main load is wires to have three-phase loads. Unbalanced phenomena, or even under-compensation or over-compensation, occur. This compensation technology does not analyze and consider the voltage balance problem and does not have the function of power distribution detection. The combination of dynamic compensation and fixed compensation is the biggest feature of intelligent reactive power compensation technology. It realizes the combination of three-phase common compensation and split-phase compensation, as well as the combination of steady-state compensation and rapid compensation. It can effectively overcome the shortcomings of single fixed compensation. It can effectively overcome load changes and has strong adaptability to load changes. In addition, the use of advanced switching switches can intelligently control capacitors, thereby maximizing the accuracy of compensation, and phase loss protection can also be implemented in this system.

### **2.3 Application of Optical Interconnection**

### Technology in Power Systems

Optical interconnection technology is applied in the field of relay protection devices and automatic control of power systems. The traditional basic technical requirements can be presented using optical interconnect technology.

Such as printing reports, printing topology, recording relevant data, calculating relevant content, collecting data in an all-around way, and automatically analyzing and processing data. In addition, it also has the functions of condition assessment, power grid analysis, human-machine interface integrated processing, advanced applications, and network modeling. Through the application of this technology in power systems, it can achieve more precise positioning, clearer pictures, and more flexible Operation skills are provided to power workers, and accurate and timely reference information can be provided to relevant workers. After that, technicians can analyze and process relevant data based on the measurement content, so that dispatch workers can make more accurate judgments on the power grid. At the same time, when this technology is used, the work efficiency can be greatly improved. Capacitive loads will not have an excessive impact on it, and the impact on capacitance can be effectively shielded, which improves the performance of the power system. Under the premise of ensuring safe operation and stability, relevant technical support can also be provided to relay protection devices. The application of optical interconnection technology in power systems can prevent faults to the greatest extent, manage the economic losses caused by the normal operation of equipment, and improve the economic and social benefits of power enterprises to a certain extent. It has an extremely strong anti-electromagnetic interference function and exists in optical fiber interconnection technology, waveguide optical interconnection technology, and free space interconnection technology, and the geographical environment will not affect it. Therefore, this technology has been very popular in power plant automation projects. Wide range of applications.

#### 2.4 Active Object Database Technology

The application of active object database technology has brought about tremendous changes in software engineering, directly

promoting the development, design, and packaging of software. Active object database technology has become the main form of automated monitoring of power systems in power engineering. Compared with traditional technologies, this type of technology has obvious advantages, which are mainly reflected in the active support of object technology and functions. In addition, due to the introduction of trigger mechanisms and object technology, automatic monitoring and control of the database has become possible, which improves the accuracy and utilization value of data after processing, and the relevant operations based on these data are more credible.

### 3. The Impact of Power and Electrical Automation on Power Engineering

#### 3.1 Improve Measurement Accuracy

my country's power engineering has planned to ensure automation and digitalization requirements in the process of building a strong smart grid. Our country has a vast territory and complex environment. For the smart distribution network in the strong smart grid, it also requires a high degree of autonomy. In particular, electrical measurement accuracy is required to be faster and more accurate than traditional measurement technology, to ensure digital relay protection of the power grid. High-precision operation of fault location, grid transient stability monitoring, phase separation technology of transmission corridors, grid real-time PMU, WAMS monitoring and measurement. The overall error of the traditional power engineering measurement system reaches 0.7 levels. Assuming that the CT and VT errors are both 0.2 levels, electromagnetic interference caused by signals during cable transmission will cause signal errors of 0.1 levels. After entering the A/D conversion process, the VT and CT that come with the energy meter will also introduce an additional 0.2-level signal error. Compared with traditional electrical measurement methods, electrical automation technology system errors that use EIT as the basic component can be reduced by 45%. The main reason is that the collected analog signals are converted into digital signals once and are transmitted through the all-fiber system. They are directly sent to the merging unit without

secondary conversion. It is also assumed that the error level of ECT and EVT is 0.2. Since the transmission signal is digital, there will be no electromagnetic interference during the all-fiber transmission process, eliminating the need for secondary conversion. Therefore, the error of the electrical automation measurement system based on EIT is only 0.4 levels.

### **3.2 Improve the Protection Performance of Distribution Network**

A large amount of actual operation data analysis and dynamic model experiments have shown that in the process of smart distribution network protection using traditional electrical technology, when a fault occurs outside the set range, once the traditional electromagnetic element becomes saturated, it may cause the relay differential to fail. Protection malfunction; when a fault occurs within the set interval, the harmonics appearing in the differential current of traditional electromagnetic components may cause the relay differential protection action time to be extended or even refuse to operate. After the adoption of electrical automation technology in long-distance power grid protection, since electronic current transformers do not have magnetic saturation, the secondary side voltage response waveform can better reflect the voltage transient process on the primary side and reduce the fundamental voltage amplitude error. , which expands the protection scope, is conducive to rapid, sensitive, and reliable relay protection, and greatly improves the protection performance of the power grid system[3].

### **3.3 Meet the Requirements of Transient Protection**

At present, relevant laboratories in my country have conducted transient simulation experiments on EIT. From the experimental graphics and data analysis, in general, EIT has a wide bandwidth and small phase delay and has good dynamic and linear characteristics. It can quickly measure the amplitude and phase of high-frequency signals to provide information for transient response. Reliable data meets the sensitive, safe, and efficient transient protection requirements of smart distribution networks. At the same time, my country's power system is developing towards high voltage and ultra-high voltage. Large-capacity and long-distance

transportation requirements require the selection of highly automated, precise measurement, and fully digital intelligent means to ensure safe and economical operation. Traditional power equipment is limited to its structure and technical characteristics and can only measure power frequency parameters. During system operation, it is easily affected by circuit oscillation, resistance damping, and magnetic saturation and causes distortion. Therefore, smart distribution networks based on Electronic information technology based on transient protection principles will gradually replace traditional measurement technology.

### **3.4 Accurately Measure Distorted Waveforms**

The advent of the era of large power grids and intelligence has resulted in more and more plug-and-play power electronic equipment, and many uncertain factors have also emerged. For example, more intelligent circuit breakers and closed switches have been installed on the power grid, which has increased the number of on-off The probability of opening and closing, as well as a large number of electronic equipment, will cause power grid waveform distortion, interfere with the operating parameters of the power grid, and make its distribution frequency complex. Traditional electromagnetic equipment has a narrow dynamic range and poor frequency characteristics, making it impossible to achieve measurement and protection under complex frequency conditions. Electronic electrical control technology solves the problem by recording the working status under transient and stable conditions and analyzing the value of a large current to ensure measurement and protection work under complex frequency conditions.

### **3.5 Increase the Safety of Smart Distribution Network Maintenance**

From a structural point of view, electrical automation technology represented by microcomputers, compared with traditional electrical technology, eliminates the need for complex insulation structures, does not require the use of insulating oil, avoids high-temperature failures, combustion, and explosions, and reduces a large number of unnecessary problems. Necessary hazardous inspection work and regular replacement of

insulating oil are cumbersome; at the same time, due to the extensive use of integrated circuits and optical fiber signal transmission methods, small current signals improve the impact on transmission channels and material quality and do not require high-frequency inspections and Detection greatly reduces the workload, and existing detection modes can also be optimized. Hidden dangers can be identified through online monitoring and background alarming, which is both safe and efficient.

#### **4. Analysis of Approaches to Power System Automation Technology Security**

##### **4.1 Realize the Rational Design of Power System Automation Technology**

Judging from the current power system automation technology in my country, to achieve safe management of power system automation technology, we should first conduct a comprehensive analysis of related factors during the power grid comprehensive automation design process, to achieve a comprehensive and reasonable power system automation technology design. Specifically, we can start from three aspects: in the design of power system automation, adopt a distributed design, that is, to separate the components of each power system from each other to avoid mutual influence within the unit; During operation, many places require secondary wiring. For these places, the power should be simplified, multi-functional relays should be used to replace the traditional secondary wiring, and then the distributed design of the main control and each switch cabinet should be realized. The main purpose is to simplify the wiring in the switch cabinet, thereby effectively preventing safety accidents caused by careless operation; to enhance the compatibility and scalability of the power system to ensure that automation technology can be applied to various equipment so that power equipment can Meet automation needs in various environments.

##### **4.2 Strengthen the Management of Power System Automation Technology**

Given the important role that power systems play in people's daily lives, to achieve safe management of power system automation technology, we need to pay more attention to

the maintenance and management of power system automation technology, thereby reducing safety problems caused by technical failures in power supply work and ensuring the normal operation of the power system. On the one hand, it is necessary to formulate a corresponding automation technology management responsibility system for the power system, realize the division of labor management of the power system automation technology, and assign specific responsibilities to people. Once any technical failures or safety issues occur, the responsible persons can be held accountable. To improve the staff's sense of responsibility and work enthusiasm; on the other hand, the state should increase financial support for power system automation technology, because automation technology has higher requirements for technology and equipment, so it should increase the use of power equipment funds for renewal and maintenance. For our country's remote and economically underdeveloped areas, more funds should be spent on improving power equipment, to achieve an effective combination of automation technology and power equipment and ensure the smooth development of power supply work. In addition, technicians are also required to regularly maintain and repair power equipment, establish corresponding inspection systems, and arrange for professional personnel to regularly maintain the equipment. Once equipment malfunction is discovered, timely solutions must be taken to minimize the risk of The number of power interruptions caused by the fault[4].

##### **4.3 Improve the Professional Capabilities of Power System Automation Technicians**

With the continuous development of science and technology in our country, information technology has been closely related to people's lives. This requires personnel engaged in related work to continuously enrich and update their knowledge in their spare time, thereby promoting themselves to meet the development of the times and the safety of power system automation. management needs. To sum up, we can start from the following three aspects: Staff should fully determine their responsibilities and obligations based on the actual development situation of their power grid enterprises so that they can be in a

dynamic learning and development process and continuously enrich their professional knowledge. ; As a power company, we should set up relevant training content according to the responsibilities of the positions to help technicians master advanced technical knowledge and improve their practical operation capabilities; as a power company, we should create a good learning atmosphere for the majority of technicians, to help Employees attach great importance to learning relevant knowledge ideologically.

### 5. Development of Power Automation

The development of power automation is mainly reflected in the following three aspects: Power grid dispatching technology. Power grid dispatching is based on information technology, which collects and organizes relevant information to achieve good operation of the power grid, enhances the overall control of the power grid, improves the stability and operability of the power grid operation, and greatly reduces the impact of emergencies on the power grid. The system can reduce the impact level and respond to various sudden situations in the power grid promptly to ensure stable operation of the power grid. Power automation is mainly reflected in the extensive application of substation technology. Substation technology uses communication technology and computer technology to centrally process and apply information data in power engineering. By processing various data information in the substation, it finds the optimal working mode of the power engineering system to make the operation of the power system more robust. Power automation is mainly manifested in the application of distribution network technology. The application of distribution network technology automation has effectively transformed the power grid system in cities and towns, thereby further improving the overall development of the national power system. The more networked it is, the better the power system can serve the people. Automation can improve the efficiency of distribution network technology and accelerate the development of power engineering. overall development trend. Judging from the overall development situation, the traditional open-loop monitoring is mainly changed to closed-loop control; the traditional relatively

single-function technology is transformed into a multi-functional all-round development, with the application of substation automation and distribution automation technology as the mainstay. Mainly; the direction of the whole system has also been realized by traditional single components, such as the application and development of data acquisition technology; high voltage levels have also been gradually replaced by low voltage levels; device performance has also been improved to a certain extent, technology, innovation and flexibility The reliability and digitalization have been improved to a certain extent, ensuring the efficiency, intelligence, and economy of the power supply system, especially the innovation of relay protection technology; at the same time, the goals of efficient, economical and safe operation of the power system have been achieved, and the The smoothness of the power transportation process, such as the application of management information systems in the entire process.

### 6. Conclusion

Electricity is an important resource that is indispensable in people's lives. With the continuous improvement of social and economic levels, people's demand and requirements for electricity are getting higher and higher. During the operation of the power system, the effective application of power automation engineering can not only well meet the overall needs of the power system, but also use power automation technology to respond to some emergencies that occur in the power system in a timely and accurate manner. Monitoring will provide certain help for taking effective compensation measures, promoting the reliable, stable, and safe operation of the power system, and introducing more excellent technical measures in future development to promote my country's power engineering in a better direction. develop.

### REFERENCES

- [1] Wang Xiaochen, Wang Jianhua. The Application of Automation Control in Electric Power Production [J] North China Electric Power Technology, 2019 (12): 5-9.
- [2] Li Jian. Application and Optimization of Power Plant Automation Control System [J] Power Technology, 2020, 38 (3): 89-94.

[3] Zhang Mingguang, Wang Xiaochen. The Application of Transmission and Distribution Automation Control System [J] Power System Automation, 2021, 35 (2): 38-42.

[4] Wu Jie. The Application and Development of Automation Control in Power Systems [J] Journal of Electric Power Science and Technology, 2018, 33 (2): 56-61.