

Research on the Security and Stability Control System of Power System Based on Artificial Intelligence

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Abstract: The continuous interconnection of power grid and the gradual implementation of power market make the operation environment of power system more complex, and the requirements for the safe and stable operation of power grid are higher and higher. With the rapid development of China's economy, society and the national power grid, people's demand for electricity is increasing, and the daily operation and management mode of the power grid is more complex and changeable. Once there is a safety problem, it will usually seriously damage the relevant power generation equipment and cause large-scale power outage, and even directly lead to the loss of the overall function of a regional power system. In recent decades, power failure has caused huge economic and social losses all over the world. In order to avoid such problems as much as possible, China has high requirements for the stability of the circuit transmission system. In order to ensure the stability and safety of China's power system and meet the needs of energy conservation and environmental protection, the power system is deeply analyzed and discussed.

1. Introduction

Power system is a very complex dynamic system (it is strongly nonlinear, high-dimensional and time-varying[1]). Because the development of power system security and stability theory lags behind the development of the scale and complexity of the power system itself, and the power system is closely related to the production and life of the people, it is an important foundation related to social stability and economic development[2]. However, it can also cause major catastrophic accidents in an instant, because power operation faults lead to large-scale power failure, which will cause huge losses. Especially As the scale of power system becomes larger and larger and the structure of power system becomes more and more complex, the safe operation of power system becomes more and more important and can not be ignored[3]. In the current power system, control security technology directly affects the security and operation stability of the whole power system. Therefore, power companies need to take effective methods to improve stability, ensure production quality, reasonably simplify the analysis of specific problems, adopt appropriate models and calculation methods, arrange reasonable operation modes, formulate control strategies to improve the safety and stability of the system, and plan and optimize the power grid structure[4]. Effectively ensure that power system staff work in a safe and reliable power working environment, and promote power enterprises to obtain good social and economic benefits.

However, with the acceleration of the process of urban-rural integration, the load borne by the original power grid system becomes heavier and the unreasonable power grid structure becomes more prominent, which leads to the decline of the stability of power quality, harm to electrical equipment, increase unnecessary power loss, and even cause overcurrent, directly damage electrical equipment, affect the stability of power grid operation, and cause incalculable losses[5]. At the same time, artificial intelligence is an important branch of computer science and a very active research field[6]. It has attracted more and more attention. Intelligent control is an advanced stage of the development of control theory. It is mainly used to solve the control problems of complex systems that are difficult to be solved by traditional methods. Intelligent control has the characteristics of learning function, adaptive function and organization function, and plays an

important role in power system stability control. With the advent of the era of big data and the improvement of computer performance, the application of machine learning algorithm represented by deep learning has achieved great success, indicating the possibility that artificial intelligence exceeds human naturally acquired intelligence. Human civilization is the product of human intelligence, and obtaining higher intelligence through artificial intelligence will affect human history[7].

2. Security Guarantee System and Stability Control of Power System

2.1 Security System of Power System

The security guarantee system of power system is the basic guarantee for the safe operation of the system. Generally speaking, it is the guarantee measures taken before abnormalities occur. Build a strong smart grid network node structure to ensure the safe and stable operation of the power grid; The optimized automatic control system improves the reliability of the system. Safe operation of high-power equipment; Safe operation of power system. The security system of power system is shown in Figure 1.

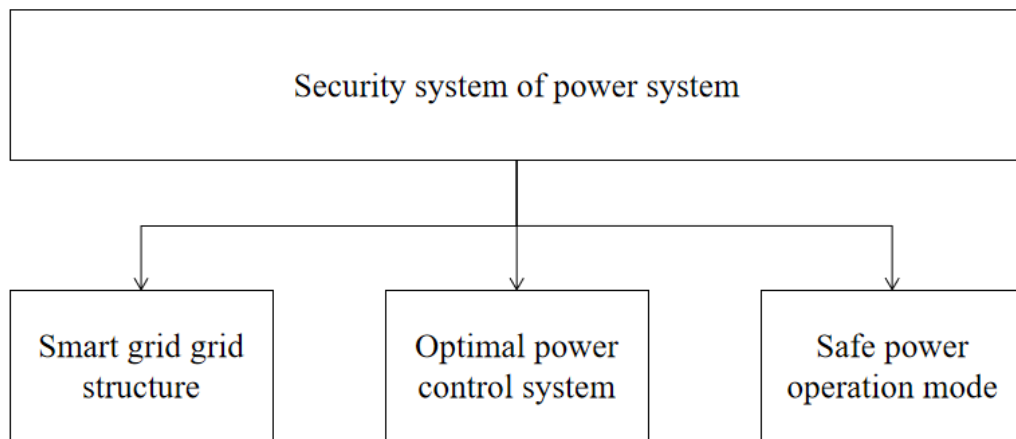


Fig.1 Security System of Power System

From the perspective of the safe and stable operation system of the whole power system, a strong power grid structure is the basis to ensure the safety and stability of the power system, so as to provide strong, safe and reliable power transportation and power supply, improve the operation and transmission efficiency of the power system and reduce the operation cost. If the grid structure is not scientific and reasonable, all subsequent security systems are meaningless. The powerful power network structure includes six aspects: power generation, transmission, transmission, distribution, power and dispatching[8]. In planning and construction, we should achieve unified standards, unified plans, establish power grid support stations, establish a sound physical power network and establish a sound power network infrastructure; System, unified information support, integrated knowledge support and composite communication support; Power grid operation is safe, efficient and economical. In order to ensure the safe operation of the power grid, the calibration must be maximized or minimized in order to achieve the best control. The best state is to minimize exceptions. Generator set is a key link in the power grid, and many of its performance indexes are non-linear. Improving the automatic control of power system ensures the safety of the system. Scientific planning and dispatching of power grid operation mode is the guarantee of power grid safety[9]. At present, with the continuous development of UHV AC/DC hybrid power grid, the scientific planning and dispatching of power grid operation mode has become the guarantee of power grid security. Through dispatching automation system and power system, realize the overall planning and operation of line mode, and put forward corresponding suggestions.

2.2 Stability Control of Power System

In the operation of the power system, once there is an abnormality or disturbance, it is necessary to start the stability control system. First, isolate the fault components in the power system in time to avoid the escalation or expansion of the fault. Secondly, implement stable control methods to avoid the instability of the system. Finally, once the instability of the system occurs, take measures to avoid large-scale power outage and protect the stable operation of the power system as much as possible. The stability control of power system is shown in Figure 2.

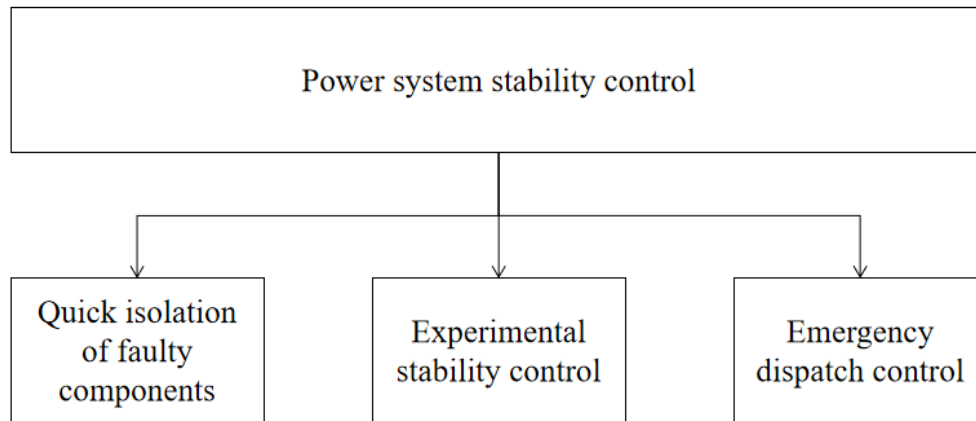


Fig.2 Stability Control of Power System

When the power grid equipment is greatly disturbed, it is necessary to reasonably set up safe and stable control equipment to ensure the normal operation of the equipment. Managers must correctly use and implement the corresponding safety control, so as to quickly reduce the interference in the shortest time and meet the stability needs of the whole power grid. At present, the interconnection and security control of domestic regional power grids and other regional power grids have been widely used to realize the unified management and hierarchical security control of equipment. The stability control system of power system includes three parts: main station, substation and terminal station[10]. Through the data acquisition of each terminal station, connect each terminal station with the power network of the substation, and upload the data of each terminal station to the substation. In the stability control of power system, hierarchical control mode is mainly adopted. The main station directly controls the safety of each substation according to the data and information uploaded by each terminal station connected to it. In addition, the substation can also send the correct safety control command to the main station through the data and information uploaded by each power supply station connected with each substation. During the operation, the safety control can be carried out independently in each working area, and the hierarchical control technology is adopted, which greatly reduces the working load of the system and improves the operation efficiency of the system. Since the failure or power failure of the system equipment has less impact on the next stage, it will not cause the failure of the next stage, so the stability of the system can be improved.

3. Characteristics and Design of Artificial Intelligence Control System

3.1 Characteristics of Artificial Intelligence Control System

Stochastic control, adaptive control and self-learning control have the ability to make corresponding decisions in unknown environment, but their analytical structure limits their application in unpredictable environmental relationship change systems. Taking process control as an example, with the realization of multi-level centralized control of computational control and the elimination of intermediate library, such a processing flow is becoming larger and larger, coupled with the complexity of chemical and physical processes. In the highest level control, it is difficult to solve the practical mathematical model. The promising way is to apply the comprehensive achievements of artificial intelligence, establish a huge knowledge base and corresponding rules,

and make corresponding decisions according to the given indicators and the judged working conditions. Therefore, the control system adopts the architecture of distributed system, with “1 ton” as the main and subsystem, and forms an intelligent control system by exchanging information through multiple CPUs and multiple subsystems. Its structure is as follows: (1) the basic unit composed of hardware, that is, one sub machine to one; (2) It includes three modules: data acquisition module, control decision module and man-machine interface module. Through reasonable hardware structure and precise software design, the automatic control system can identify the working mode of the power system, predict the possible accidents, and predict the faults of the power grid in 0.25 seconds. There are four levels of remote control commands, and the host can be accurate to each feeder. According to the size of the load and the importance of each line, the CPU can divide it into different priorities. In addition, it also includes accident review, printing, alarm and other functions to carry out different operations, different faults, different levels and different faults for different loads or units.

3.2 Design of Artificial Intelligence Control System

In order to meet the requirements of the development of the power industry and ensure the safe and stable operation of the power system, major enterprises should actively introduce modern information technology to promote the automation of the power system and realize the intelligent development of the power system. Before intelligent control, its structure and design should be reasonable. The intelligent control system of power system refers to the transformation of fuzzy logic language variables and reasoning through fuzzy method, so as to form a complete intelligent reasoning system. In the automatic control of power system, the fuzzy control of simulation object is realized by using fuzzy intelligent method, artificial fuzzy reasoning and control method in enterprise production decision-making. In the intelligent control system, the intelligent scheme of the expert system is adopted, and the expert experience and knowledge are used to reasonably predict the automatic operation state of the power grid, which provides a reliable theoretical basis for the automatic control of the system, so as to improve the overall control ability of the intelligent control system. In the intelligent control system, the intelligent algorithm of artificial neural network is used to simulate the most basic neurons of human body and connect them together in a certain way. On this basis, the neural network composed of multiple neurons is used to store different power information, and has good learning and fault tolerance ability. It can realize the personalized processing of various information according to the actual situation of the power industry, and develop to the integrated, open and distributed comprehensive information support, from centralized host to distributed multi computer. The system can verify and audit the setting value of relay protection and safety automatic device on line, as well as the definition of safe, stable and fuzzy relay protection, so as to realize the unity of protection and control.

4. Conclusions

With the continuous improvement of China's science and technology and people's demand for electric energy, power enterprises have entered a new stage of development. There are many disadvantages in the traditional power dispatching operation, which can not meet the development requirements of the times. Artificial intelligence security system and control system play a significant role in the improvement of static stability, dynamic stability and transient stability, and are the most simple, economical and effective measures. In particular, it can realize the real-time monitoring and tracking of large regional power system, make the security and stability control of power system timely, accurate and transparent, and greatly improve the security and stability of the operation of the whole power system! Therefore, it is necessary for relevant managers to actively introduce intelligent control system. With the improvement of computer computing power and the progress of machine learning algorithms, the rapid development of artificial intelligence technology has been accelerated. It has surpassed human naturally acquired intelligence in some fields, and has become a trend in more fields, which will eventually change the direction of the development of human society. In this context, the security and stability of smart grid control system will become

the focus of smart grid security research.

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