

Research on Fault Diagnosis and Recovery Based on Artificial Intelligence in Power System

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Abstract: The complexity of the power system renders it vulnerable to various types of failures, making its vital role in modern society a key issue. To ensure its safe and stable operation, quickly diagnosing and restoring it is essential. Widely employed in a variety of power systems, fault diagnosis techniques based on artificial intelligence technology have been in use in recent times.

Keywords: Power system; Artificial Intelligence; fault diagnosis.

1. Introduction

Artificial intelligence-based fault diagnosis for power systems could further bolster the utilization of information fusion technology in fault diagnosis research. Fusing information, a modern data processing technique, enables mutual complementation and enhancement of information through the thorough handling of an extensive quantity of data. By augmenting the precision and dependability of power system fault identification, thus necessitating research on the utilization of it.

2. A Basic Overview of Artificial Intelligence

Artificial intelligence is a branch of computer science and mathematics. It studies how to make computers imitate or realize human intelligent behavior. The research object of artificial intelligence is to make computers have intelligent behaviors similar to humans, and its purpose is to establish a system that can reason, judge, learn and make decisions in a human intelligent way. Artificial intelligence was first produced in the 1950s. Because it can simulate the human thinking process, it greatly broadens the scope of computer applications. Artificial intelligence is represented by expert systems, neural networks and expert systems. Its research fields include expert systems, pattern recognition, decision support, language recognition, etc.

3. The Development Trend

Beginning with the examination of power system fault mechanism, the advancement of fault diagnosis technology utilizing artificial intelligence in power systems should be pursued. Transforming existing equipment and components into mathematical models for the purpose of solving practical problems, an intelligent diagnosis system tailored to the characteristics of power systems is established. An investigation of an intelligent diagnosis algorithm, capable of resolving the intricate and multi-state fault diagnosis conundrum, is the focus of this paper. An intelligent diagnosis algorithm must be devised to address the diversity, complexity, and uncertainty that often characterize faults in the power system. Construct a fault diagnosis system of great intelligence, suitable for practical use. The intelligent fault diagnosis system should have portability and scalability, and be able to handle different scales, different structures and

different types of power systems. At the same time, the system should be guaranteed to have high reliability and stability. Combining the intelligent fault diagnosis system's development with the present circumstance, the project's application needs, operability, and feasibility must be thoroughly examined. Exploring the potential of designing distinct levels of intelligent fault diagnosis systems and algorithms based on the features of power system faults is a research avenue for the advancement of power system fault diagnosis techniques in the future. As modern intelli grows, so too does the need. there are many deficiencies in the research of intelligent fault diagnosis technology in power system. Therefore, the research on the application of intelligent diagnosis technology in practical engineering should be strengthened, especially for some problems in practical engineering application[1].

4. Common Faults of Current Power System Faults

4.1. Short-circuit fault

Inescapable short-circuit faults are a consequence of the power system's operation; these are caused by an imbalance of current, voltage, and electrical quantity, thus diminishing the system's stability. When a power system short-circuit happens, it can not only disrupt the usual functioning of the system and even lead to major mishaps, but also necessitate rapid fault diagnosis and recovery. A grave consequence ensued. In the event of harm to the circuit breaker and isolating switch, the low-voltage circuit breaker may be rendered ineffective. When the protection and detection system fails to function properly, the high-voltage circuit breaker will not be able to cause a disruption. Another situation is a short circuit caused by damage to some components in the power grid or unqualified quality. In the event of a failure, the cable may be damaged. After the cable is damaged, the high-voltage circuit breaker may fail to operate. Due to the complexity and diversity of the power system and the difference in the quality of related equipment, it may have different characteristics when a short-circuit fault occurs. Moreover, in some cases, even if there are a large number of short-circuit faults in the power grid, the power system may not necessarily fail. In some cases, it may be caused by the damage of some equipment installed on the line or the occurrence of equipment damage. In some cases, it may be caused by the protection device itself or by the electrical

coupling between the protection device and the circuit breaker. A short-circuit fault can arise when the system is impacted by external or internal shocks; thus, faults caused by different causes may have distinct features and manifestations. Analyzing the various phenomena and situations that may arise from a short-circuit fault in the power system is a highly challenging task. In this instance, Artificial intelligence technology can be utilized to effectively detect any issues that may be present in the power system. It will involve artificial intelligence technology, computer science, signal processing and other disciplines. It is necessary to make full use of artificial intelligence technology to carry out short-circuit fault diagnosis and recovery in power systems. It is necessary to deeply explore and study the various disciplines involved and solve its practical application problems.

4.2. Disconnection fault

Disconnection faults are common faults in power systems, such as cable disconnection, mechanical parts disconnection, and short-circuit of cable joints. Disconnection faults usually occur immediately after system failures, causing serious economic losses and the collapse of the power grid. After the disconnection fault, the research of rapid detection and diagnosis methods mainly focuses on the detection of disconnection, the restoration of power supply and the shortening of the action time of the protection device. After the failure, the online detection method is to compare the unstable system with the normal state. Should the instability be detected, the power supply can be swiftly restored. This will result in a great deal of data being generated for the purpose of artificial intelligence diagnosis and recovery. Consequently, The extraction of beneficial data from a vast quantity of information and its utilization in diagnosis and recovery is of paramount importance. The intricate nature of power systems has led to the widespread application of artificial neural networks in diagnosis and recovery. These networks are composed of neurons with analogous roles. Powerful processing capabilities are exhibited by the network when confronted with uncertain data, allowing for real-time learning, prediction, classification and reasoning of intricate information. Widely utilized in artificial intelligence, Artificial Neural Networks is one of the most prevalent fields.

4.3. Failures caused by natural disasters

Natural disasters of power system include earthquakes, tornadoes, rainstorms and floods. The power grid is greatly damaged and the safe functioning of the system is greatly impaired by these natural catastrophes. When natural disasters occur, the power system will be seriously affected, and even lead to system collapse and power outages. Therefore, the fault diagnosis and recovery caused by natural disasters has become an important part of power system protection and control. The traditional method is to diagnose and recover the fault after the fault occurs. However, it is difficult to predict the cause of the fault or the fault point can not be determined for a long time after the fault. This method is difficult to deal with the power system fault caused by natural disasters in a short time. Therefore, real-time monitoring and diagnosis after disasters has become a very important task. Fault diagnosis and recovery based on artificial intelligence technology is a new method, which can quickly detect and effectively deal with power system faults caused by natural disasters in a short time[2].

5. Practical Application of Artificial Intelligence in Power System Fault Diagnosis

5.1. Expert system

The field of Artificial Intelligence is greatly impacted by Expert Systems. It uses the knowledge, experience and logical reasoning ability of experts to simulate the thinking process of experts and imitate the ability of experts to solve practical problems. It has many advantages, has extensive knowledge and experience, knowledge is uncertain, can reason, solve problems quickly, and has a more comprehensive and profound understanding of problems. However, because it is based on rules, it is unable to describe and explain the data comprehensively and accurately. At the same time, the system appears in a form of reasoning, so it also has strong uncertainty. Because the expert system is a tool for acquiring knowledge, reasoning and drawing conclusions from a large number of practical problems, its diagnosis results have a large degree of uncertainty. In practical applications, due to the influence of factors such as the environment, knowledge acquisition methods, knowledge base structure and expression methods, the diagnosis results may be quite different from the actual situation. And because the expert system cannot solve complex system problems, it is not suitable for various types, scales and forms of faults in the power system. Expert systems have a wide range of application prospects in power systems.

5.2. Neural Networks

In recent years, neural network technology has been extensively utilized in power system fault diagnosis due to its capacity to achieve nonlinear mapping and address intricate practical issues. By utilizing a vast amount of real data, Artificial Neural Network technology has the capacity to solve numerous issues that traditional methods are unable to. This technology can gain knowledge through experience. By utilizing data sample training to create an ideal model, Artificial Neural Network technology in power system fault diagnosis is primarily utilized for fault detection within the distribution network. The utilization of an artificial neural network for load forecasting, and its utilization in other contexts. Time-consuming, the training of neural networks can easily be reduced to a local minimum, the structure of the network is hard to determine, and guaranteeing its stability is a challenge. Further research is still necessary to apply artificial neural networks to the diagnosis of power system faults.

5.3. Genetic Algorithm (GA)

Darwin's evolutionary theory serves as the foundation for the Genetic Algorithm (GA), a method of optimization. Individuals are sorted based on their fitness within the population, and search algorithms such as selection, crossover, and mutation are employed. The optimization problem is solved by utilizing individuals from the new population created during the evolution process. Generating a superior population through a succession of reproduction operations, with the aim of continuing to reproduce to optimize the issue, is a fundamental concept. In comparison to other optimization techniques, it is a more effective approach. Rapidity, robustness, global convergence, and adaptability are the advantages of genetic algorithms in the power system fault

diagnosis and recovery problem; they can quickly find the optimal solution. To evade the sway of unpredictable elements in customary techniques, thus. Despite its potential, genetic algorithms have encountered certain issues, such as the calculation of crossover and mutation likelihood, and the effect of population size on the algorithm's effectiveness. In recent times, these issues have been addressed. Scholars have delved deeply into optimization techniques based on genetic algorithms, concentrating mainly on two facets. The first being the utilization of advanced genetic algorithms to simulate and address power system fault diagnosis and restoration issues. Establishing corresponding mathematical models is the second step.

5.4. The Theory of Fuzzy Sets

Fuzzy set theory is an emerging theory in the field of artificial intelligence. In this theory, a fuzzy logic system is adopted. It is a group composed of computers, experts and users, and the final conclusion is drawn through reasoning. The theory believes that there are some ambiguities in nature and human society, such as weather and weather forecasts. In order to further develop the fuzzy set theory, many scholars have conducted a lot of research and practice on its basis. According to the fuzzy set theory, a power system fault diagnosis model can be established, and the model can be used to diagnose power system faults. The essence of power system fault diagnosis is fault diagnosis and state estimation, and fuzzy set theory provides a new method for fault diagnosis. When using fuzzy set theory to establish a fault diagnosis model, we must first determine some basic parameters, such as the probability of equipment failure, the topological structure of the power grid, and so on. Then estimate the fault state of the power grid based on these parameters. Because there is a certain degree of inconsistency between various possible grid state values, it is necessary to use fuzzy analysis method to determine the grid state value. Compared with the traditional data processing method, this method does not need to determine the parameters or their values. In the traditional method, Processing all potential grid state values within the system, the system operation state probability and grid topology structure probability are then

determined. When the probability of power grid operation state and topology structure are near the genuine value, the technique has a higher degree of precision. When the likelihood of the grid's operational state and the likelihood of the grid's topology are near the genuine worth, this is the case. Adapting the traditional fault diagnosis algorithm to system fault changes can be a challenge, resulting in false positives or false negatives; however, when the network topology alters, this is not an issue. The utilization of fuzzy set theory for fault diagnosis can result in the system having either false positives or false negatives.

6. Summary

In its early stages, the exploration of AI in power systems both domestically and internationally has opened up a new avenue of development for power systems, following relay protection, computer, communication, and automation technologies. This paper examines the various uses of artificial intelligence in power system fault diagnosis, analyzing both its advantages and disadvantages, with the aim of enhancing reliability. This analysis was conducted based on the development status. Varying and unsteady.

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