

Research on Application of Artificial Intelligence in Power System

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Keywords: Application, Artificial Intelligence, Power System

Abstract: Artificial intelligence technology (AI) is widely used to solve nonlinear problems and plays an important role in the control, management and operation of power systems. The application characteristics of artificial intelligence technology such as expert system, artificial neural network, fuzzy set theory and heuristic search in power system are expounded. The development trend of artificial intelligence technology in power system is forecasted. It is pointed out that hybrid intelligence is one of the important development directions for artificial intelligence.

1. Introduction

In recent years, with the popularization of artificial intelligence technology in life, artificial intelligence technology is well known. The National Development and Reform Commission incorporated this technology into development planning and strategy, and emphasized the need to apply artificial intelligence technology to various industries. In the "13th Five-Year Plan for Power Development", it is emphasized that artificial intelligence technology must be combined with power systems to build a "smart grid" for the benefit of the people. In response to national policies, some domestic research institutes bear the brunt of trying to combine artificial intelligence technology with power systems. In 2015, Google introduced AI technology into data centers, relying on AI technology Google to explore effective management equipment and balance power supply methods, saving The company's huge energy costs. Followed by Baidu in 2014 to build artificial intelligence buildings to save power resources, and Baidu will focus on the core technology of artificial intelligence, and will be involved in every aspect of the power system. As a leader in the application of artificial intelligence in the power industry, General Electric Company (GE) uses artificial intelligence technology in the customer service, information construction, energy services, production operations, power dispatching and scientific research of power systems. Therefore, AI technology has broad application prospects in power systems.

2. Artificial Intelligence Technology

AI (Artificial Intelligence) is an abbreviation of artificial intelligence technology. AI is a new technology. It is a technology to study the theories and methods used to simulate, extend and extend human intelligence. The development of AI technology includes three important phases: technology-driven, data-driven, and context-driven. AI technology has achieved the greatest momentum in the technology-driven phase. Especially after the Dartmouth meeting, the algorithmic programming language has gradually become familiar, and more and more developers have invested a lot of enthusiasm. The first wave of artificial intelligence development has started.

At present, AI technology has also achieved remarkable achievements. For example, in 1997, IBM "Deep Blue" defeated the chess champion. In 2011, Apple released the mobile phone voice assistant Siri, and in 2016, Alpha Go defeated the world champion Li Shishi. In addition, in terms of AI-based pattern recognition, functions such as face recognition, text recognition, license plate recognition and fingerprint recognition have gradually matured. The achievements in automation engineering mainly include autonomous driving technology, production line production of the banknote printing factory and automatic drawing of the Falcon system. From the perspective of functional structure, the AI industry layout can be divided into three levels: The first is the basic level, where there are mainly video content recognition, context-aware computing, speech

recognition and natural language processing. These operations are used as artificial intelligence. The underlying support of technology. The second is the theoretical level, which is based on machine learning algorithms, which lays a theoretical foundation for the application of AI technology. The third is the application level, mainly based on aspects of artificial intelligence technology applications, such as machine learning applications, computer vision applications, gesture control applications, speech translation applications, and intelligent robot applications.

The advantages of artificial intelligence technology are reflected in our work, life, and learning. In terms of work, it can help us improve production efficiency, help us get rid of heavy and repetitive tasks, and help us get rid of complex data sorting, statistics and applications. . With the development of technology, artificial intelligence technology will also make major breakthroughs and completely change our lives.

3. The Cause of the Application of Artificial Intelligence in Power Systems

A fundamental goal of power system operation control is to provide high quality power to users under economically reasonable conditions. To this end, it is necessary to plan, monitor and control the power system. As the scale of power systems continues to increase, the decision-making tasks faced by energy management system (EMS) operators are increasing, making it difficult for operators to ensure safe, economical, and reliable operation of power systems. On the other hand, the computer software of the existing EMS center is usually numerical analysis software, and lacks intelligent processing functions. This practical situation also makes the decision-making judgment of the operating personnel very important. Especially in the event of an accident, the decision of the operating personnel often affects the safe operation of the entire power system. To this end, it is necessary to use artificial intelligence technology (AI) to assist operators in decision-making and judgment. This is a major cause of the influx of power workers in various countries into the field of artificial intelligence application research in recent years [1]. Another technical cause of the application of artificial intelligence in power systems is computer science and the corresponding level of hardware development, and it also promotes the penetration of artificial intelligence into other industrial fields. At present, the advanced logic languages for intelligent programming are numerous and mature, and the hardware systems for intelligent software are also continuously put into the market. These realities make the application of artificial intelligence technology in power systems have broader prospects.

4. Application Direction of Artificial Intelligence in Power Systems

With the rapid development of China's power grid and the construction of "Sanhua" UHV power grid, there are more and more factors affecting the safe operation of the power grid. The power grid operation mechanism is more and more complicated. In order to ensure the safe operation of the power grid, the power system is artificial. Intelligent technology research is also more important. In order to study the characteristics of the power system that are suitable for solving problems through artificial intelligence tools, the problem is divided into real-time control and management planning in time frame [2].

Real-time control includes discrete and continuous control systems. Real-time control is relatively simple in individual operations, but the interaction between them makes the control of the power system extremely complex. The role of energy management systems in modern power systems is becoming increasingly prominent. The whole system data is transmitted to the EMS through supervisory control and data acquisition (SCADA), and the control signals are transmitted from the EMS to the components. The whole process needs to be synchronized. This requires the EMS to have real-time processing capability for a large amount of information and can be normal. Control decisions are made in a timely and correct manner in the event of an accident. Monitoring and diagnosis are important features of EMS. Artificial intelligence plays an important role in the field of condition monitoring and fault diagnosis. Various diagnostic strategies based on expert systems and neural networks have been developed at home and abroad, and will not be elaborated

in this paper.

5. Early Research on the Application of Artificial Intelligence in Power Systems: Expert Systems

Expert systems are intelligent software that uses expert experience to solve complex problems in a narrow field. In the 1980s and the first half of the 1990s, the application of expert systems in power systems was in full swing, involving power system alarm processing, fault diagnosis, operational planning, control, and system analysis. The knowledge representation method used was based on production rules. There are also a class of predicate logic, framework and semantic network, etc. Most of the late application research adopts Prolog or C++, so the first-order predicate logic and object-oriented knowledge representation method become the mainstream. Because Prolog has an internal automatic reasoning mechanism, embedded database management, and a general first-order predicate knowledge representation method, even now it is a good language and tool for implementing deductive reasoning.

The application of expert systems in power systems in China is not too late in the world. The first case was an expert system developed by Zhang Zhiying, a graduate student of the North China Electric Power College under the guidance of Professor Yang Yihan, in 1985 for the power system daily dispatch plan. The goal was to use the expert experience to determine the start and stop plan of the furnace, which was at the PDP. The machine is implemented in LISP language, and the system layout result can basically be recognized by the dispatcher, but the software localization problem is not solved, so the developed system has not been put into practical use.

Under the guidance of Professor Yang Yihan, the author developed an expert system for the operation of substation operation tickets in 1986 [3]. This system belongs to the production system, based on operational tasks and known operational methods, using expert experience for extended reasoning. . The research on this topic began at the end of 1985 and was put into operation at the Tieling Primary Substation at the end of 1986. This is the first expert system in the domestic power system to be put into operation. Since the problem of the Chinese language of the intelligent language Prolog and LISP was not solved at the time, this system had to be written in BASIC, which made the versatility of the program limited, but it greatly promoted the research work. Professor Yang Yihan led the research group to carry out the operation record of the switch and the high voltage switch diagnostic expert of the thermal power station. From the spring of 1989, Professor Yang Yihan developed a grid operation ticket, fault analysis and processing expert system for the Northeast Power Grid. Since Prolog is used to express the grid topology and expert knowledge, and can realize internal automatic reasoning, the research team decided to use Prolog to develop the system. Grid operation tickets are used in large quantities, but they are small in variety and are particularly suitable for use with Prolog and expert systems. The system developed by the team of the author [4] At the time, the total dispatching application of the Northeast Power Grid was more than 3 years, and the billing usage rate was about 97%, which shortened the time for scheduling the operation of the ticket. The expert system for power grid fault diagnosis and processing is much more complicated. At that time, EMS has less information. The status of the switch and the trip information are directly available. Finally, we propose a diagnostic method based on the switch trip distribution and the protection action. the expert system was realized by GKD Prolog on the VAX machine, and won the second prize of the scientific and technological theoretical achievements of the Ministry of Power Industry. Due to the limitation of computer application level at that time, the system interface is relatively rough, and the information exchange with EMS is not smooth, and the application effect is greatly reduced, but the verification is theoretically feasible. In the late 1980s and early 1990s, many units carried out research on the application of expert systems, such as: Shanghai Jiaotong University's distribution network operating ticket system and reactive power control system, Zhejiang University's emergency control, Huazhong Reactive power control of the University of Science and Technology, Fuzhou University's distribution network economic operation system. From the enterprise, there is the load forecast of Jiangxi Provincial Institute and the reactive power optimization system of Heilongjiang

Province; the dynamic safety operation planning decision support system and alarm compression processing system of the former Nanjing Automation Institute are from the research institute. In addition, China Electric Power Research Institute, Xi'an Jiaotong University and Southeast University are also carrying out work in this area.

6. Mid-Term Research on the Application of Artificial Intelligence in Power Systems: Neural Networks and Evolutionary Computation

The application of neural networks in power systems is mainly after the emergence of BP neural networks. BP neural network can realize arbitrarily complex nonlinear relationship mapping, and fit a large number of training samples, but no specific discriminant function can do this. Therefore, the classification and prediction results of BP model are more than the conventional pattern recognition method. It must be good. It is particularly well suited for applications where there are a large number of conclusive (label) samples and lack of explicit expert rules, such as image and voice recognition, and fault tolerance for error samples, and thus the application of many pattern recognition problems has been successful. Application research in power systems mainly involves load forecasting, dynamic safety estimation of power systems, and fault diagnosis of power equipment and transmission lines. However, because the neural network requires a large number of training samples, the more changes in input and output, the larger the number of training samples required, and the difficulty in obtaining a large number of training samples in solving many fault diagnosis problems. Therefore, BP neural network is in the power system. There are not many successful applications in it.

7. Late Research on the Application of Artificial Intelligence in Power Systems: Correlation Vector Machine

Since artificial neural networks require many samples and long training time, since the beginning of the 21st century, the application of artificial intelligence in power systems has turned to support vector machines and related vector machines that support finite sample learning.

The correlation vector machine (RVM) is a supervised learning algorithm proposed by Micnacl E. Tipping on the basis of sparse Bayesian learning theory in 2001. This method combines Bayesian theory, Markov property and maximum Likelihood estimation and the theory of automatic relevance determination (ARD). The functional form of RVM is similar to the support vector machine (SVM). It is also a linear problem that transforms low-dimensional space nonlinear problems into high-dimensional space based on kernel function mapping, which can effectively solve small samples and high-dimensional, Nonlinear classification problem. The correlation vector machine is mainly used to solve the two-class problem [5]. For multi-classification problems, it is usually necessary to adopt a "one-to-many" or "binary tree" method to convert it into multiple two-class problems, but these methods There are problems such as overlapping and unclassifying classifications, and the need to construct more classifiers.

8. Conclusion

With the continuous development of AI technology, more and more applications of artificial intelligence technology and power system have been combined, and good results have been achieved in the application. At present, electric energy has become an indispensable part of human life. With the rapid development of the power system, it has produced massive power system data. Faced with these massive amounts of data, the complexity of manual management has increased exponentially. In these contexts, artificial intelligence technology stands out with its high degree of automation and intelligence. Therefore, the application of artificial intelligence technology in power systems is very promising. The combination of artificial intelligence technology and power system not only strengthens the scientific research and application of intelligent science in the power grid, but also ensures the continuous, stable, safe and economic operation of the power grid system.

References

- [1] Zhang Xi, Ji Yuan, Huang Yusong. Application of Artificial Intelligence Technology in Power Dispatching Automation System [J]. Information and Computer (Theoretical Edition), 2017(22): 132-133.
- [2] Zhao Qichun. Application Analysis of Artificial Intelligence Technology in Power System Fault Diagnosis [J]. Computer Knowledge and Technology, 2017, 13(02): 183-185.
- [3] Sun Qiuye, Yang Lingwei, Zhang Huaguang. Application and Prospect of Smart Energy-Artificial Intelligence Technology in Power System [J]. Control and Decision, 2018, 33(05):938-949.
- [4] Liang Chun, Qiu Wenning. Application of Artificial Intelligence Technology in Fault Diagnosis of Ship Power System [J]. Ship Science and Technology, 2018, 40(16): 52-54.
- [5] Tao Yubo, Chen Wei, Qin Xiaohui, Meng Zhaojun. Concept, Model and Method of Short-term Wind Power Forecasting [J]. Electric Power Engineering Technology, 2018(05):7-13.