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Sdudy on Fault Analysis Method of Optical Transmission Network Based on Deep Learning

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Abstract: *In order to ensure the efficient and stable operation of optical transmission network, timely and efficient fault diagnosis is very necessary. This paper studies the fault analysis method of optical transmission network based on deep learning, and summarizes the fault analysis method and research status of optical transmission network based on deep learning from two aspects of deep learning and fault diagnosis, for your reference.*

Keywords: *Optical transmission network, Fault diagnosis, Deep learning, Artificial Intelligence*

1. Introduction

With the rapid and iterative development of communications technology, many military activities need to be supported by ultra-high network transmission rates. As a core component of network infrastructure, optical networks have a high transmission rate advantage, so the practical effect can not be underestimated. Safe, reliable, uninterrupted over-the-horizon and large-capacity information communication mainly rely on existing and immediate optical transmission networks. The fast and accurate fault location technology can lay the foundation for the normal service of optical transmission network. Based on this, it is of great practical significance to promote the optical transmission network to develop in a better direction.

Fault location is one of the most basic problems in optical communication networks. In opaque optical networks, both fault detection and fault location are relatively simple. In the transparent wide network, due to the fact that no corresponding fault detection protocol or detection mechanism is set at the intermediate nodes, when the fault detection protocol or related mechanism is captured, various faults in the optical network can be accurately located or identified. In essence, this kind of localization and identification needs to be based on node hardware cost or protocol.

With the continuous expansion of network scale and deepening of heterogeneous degree, the detection and location of single link faults by maintenance personnel based on system operation monitoring cannot meet the practical requirements of network fault location. It is reflected as follows: First, there are many types of network faults, and there is a very obvious correlation between each fault point. In this case, the analysis results calculated by operation and maintenance personnel are not only inefficient but also unreliable in the face of fault source analysis. Second, the poor interoperability between sub-network operation and maintenance systems leads to the difficulty in accurately defining the fault influence scope and locating the network fault. Third, the whole operation and maintenance system lacks comprehensive analysis means and intelligent fault prediction mechanism for a large number of monitoring logs and alarm data. Therefore, centering on the problem of intelligent fault location, deep learning is used as the technical means to construct the fault diagnosis model and study the location method of optical transmission network, so as to deal with the fault data body with various types of network faults.

2. Research status of deep learning

If the marker of the third industrial revolution is information technology, the future industrial revolution will revolve around artificial intelligence, or AI. In the International Go World Tournament held in 2016, Google took on former world champion Lee Sedol. In the whole process of the match, Google won the match 4:1 with the help of AI and deep learning technology. Since then, deep learning and AI have gradually attracted extensive attention from all walks of life and attracted many researchers to conduct in-depth exploration. According to the analysis of the research perspective adopted by academic researchers, it is known that the research on the content of artificial intelligence starts from the

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development of robots at the earliest, then goes through a number of technologies such as face recognition, and finally studies in the field of game theory or philosophy. Along with the continuously go deep into academic research, in under the action of the various theoretical perspectives, AI technology obtained the widespread use, and closely connected with people's life and production achieved, in this context, all kinds of new products emerge in endlessly, for example, intelligent speakers or intelligent voice assistant, etc., and for the development of human society has brought great changes, from which can see, Artificial intelligence is very powerful; As for the division of fields related to artificial intelligence, if we start from the model principle, it can be divided into many different sub-fields. According to the analysis below, artificial intelligence and machine learning, that is, familiar technologies such as "ML", Transfer Learning (TL), Representation Learning (RL) and Deep Learning (DL) are carefully divided and classified.

As one of the important ways of feature learning, deep learning mainly uses nonlinear models to transform some original data and express them in a higher level or abstract way. At the same time, some functions with higher complexity can be simplified by using this transformation, so as to realize effective learning [1]. In essence, the strength of deep learning cannot be separated from the support provided by neural network model; In retrospect, the earliest appearance of neural network was in 1943, which was proposed by the famous researcher Mcculloch et al. [2] after their research. Later, Minsky et al. [3] proposed in their research that the neural network model built around the perceptron showed very weak computing ability in the calculation link, so the bottleneck faced by the neural network was difficult to break through for a while. Then, in 1982, the famous researcher Rumelhart et al. [4] After the research, it is stated that in order to improve the performance of the neural network model, it can be realized by the back propagation algorithm. Since then, the neural network model has attracted the attention of many researchers again. Some researchers, however, the study found that although can take back propagation way will gradually update the model parameters, however, when the neural network layer increased, the process will disappear phenomenon caused by gradient, and training problems, and in the face of this kind of problem, does not have a feasibility to effectively solve the way; After 2006, the famous researcher Hinton [5] proposed a method to solve this problem after continuous efforts, that is, to effectively train the network model with unsupervised greedy training method layer by layer, so as to achieve a proper solution to the problem. The proposal of this view has made a great contribution to the subsequent development of deep learning. After that, deep learning has gradually realized a qualitative leap. Up to now, deep learning has been gradually applied in many fields by virtue of its excellent performance. After research, some researchers propose that the application of deep learning algorithms in computer language processing or visual processing can improve the overall processing speed and efficiency. The continuous emergence of these research results also lays a solid foundation for the cross-domain application and development of deep learning [6-8].

3. Research status of fault diagnosis methods in optical transmission networks

At present, the general method of fault analysis in optical transmission network management is that operation and maintenance personnel carry out fault diagnosis by virtue of manual professional judgment and fault auxiliary analysis function of network management. Among them, the manual professional judgment comes from the thorough understanding of the system and the experience of analyzing and accumulating a large number of network faults. The fault analysis function of network management is to synthesize the historical information and online information of network management, and get the result from the general statistical algorithm. The fault assist analysis process in network management includes the query or collection of fault or alarm, performance monitoring information, multi-dimensional analysis of run logs, and fault recurrence combined with simulation function [9,10].

At present, the most frequently used fault location method mainly uses network elements as the core to detect or locate the fault location. Chen [11] said after research that network elements can be used to build corresponding fuzzy directed graphs for locating faults in optical networks. Kompella et al. [12] proposed a new fault location method after research, and the core of this method is risk modeling. To enhance efficiency and detection rate, famous researchers such as Wu [13] after the study put forward a kind of monitor as the core of the detection scheme, this scheme is mainly installed on each link in the corresponding monitor, failure to do so, can in a short period of time from the monitor to locate fault point are, however, it is important to note that In this way, the number of links must be the same as the installed data of the monitor. In this way, the maximum effect of the monitor can be achieved.

Nowadays, optical network structure in complicated direction development gradually, in this context, in order to improve the accuracy of the optical network to detect and locate the fault point, the network

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protocol or rules of the network as the core of mode gradually banned the original network element as the core position of localization algorithm, and this way is very much has made remarkable achievements, It has strong applicability in complex optical network structures [14-16]. Zheng Qiuhua [17], a famous researcher, took the network alarm information as the core and conducted an in-depth study based on the fault location algorithm. At the same time, in the research link, it puts forward a hypothetical conclusion for the first L faults, and verifies this conclusion repeatedly with the help of testing technology. However, in practice, the application of the optimal fault hypothesis algorithm will be affected by many factors, the most typical of which is the optical communication network structure. In this kind of network structure with high complexity, this method is difficult to propose accurate fault hypothesis. after the study that the improved and optimized genetic algorithm could be used to optimize the fault diagnosis methods of wavelet neural network or BP neural network. Mas et al. stated after research that the TFLA algorithm can be used to locate the fault points of transparent optical network. Majidi et al introduced a new method of fault location using sparse representation vector and fuzzy clustering. Before introducing machine learning technology into the field of optical communication, this method is mainly based on the target parameters as the core, through the relevant data model calculation, and then obtain the corresponding estimate value. Including statistical moment method, error vector amplitude method, delay line interference method; For example, Stokes parameter method and Golay sequence method etc.

Artificial intelligence technology is a research hotspot in the field of science and technology. With the evolution of war form and the development of equipment, artificial intelligence technology needs to be gradually applied to the field of equipment system research. The generation of combat capability needs not only excellent equipment, but also efficient and timely equipment support. In the face of some problems existing in the evaluation of equipment support capability, an intelligent evaluation model of equipment support capability is designed based on the expert system based on the confidence rule base, so as to realize the intelligent evaluation of equipment support capability, and provide beneficial reference and method reference for improving the efficiency of evaluation of military support capability and reducing the support cost.

4. Research status of deep learning-based fault analysis methods

In order to achieve more efficient fault diagnosis, deep learning can be used in the optical communication network management system, and the overall performance of the management system will be improved by using this method [18]. In a sense, deep learning is mainly based on long-term field data as the core, communication fault diagnosis process as the basis, the two are fused to form the expert knowledge base, and the knowledge base is established. Then artificial intelligence technology is used to simulate the thinking process of human experts in solving the problem, and an inference engine is built to solve the fault diagnosis problem.

In this system, the whole process of fault diagnosis is essentially a process of stepwise classification of fault sample data, and the fault category can be clarified by classification. By analyzing the fault category, an effective solution can be found. There are two core tasks: one is to obtain fault sample sets with attribute characteristics; The second is to choose the appropriate fault sample classification algorithm. In the classification algorithm, machine learning method is used to learn the implicit correlation between fault symptoms and faults from the existing fault data, which is the fundamental way to cope with the increasing types of optical transmission network faults and the increasingly complex correlation. For example, Tanimura (2016) et al. [19] proposed an Optical Signal Noise Ratio (OSNR) monitoring model with deep neural network (DNN) as the core after research. This model mainly focuses on asynchronous sampling data. Combined with QPSK system to estimate the accurate OSNR. Wang (2017) et al. [20] took the DNN model as the core in their study. After analyzing this model, they found that the accuracy of this model could reach 100%, and it could monitor the modulation format adopted by the transmitted signal. Mata (2018) et al. took the long-term short-term memory network, namely "LSTM", as the core to effectively monitor the specific situation of nonlinear noise transmission power. Shahkarami proposed a variety of different machine learning algorithms based on Binary support vector machine (binary-SVM), Random Forest (RF) and so on, and used these algorithms to effectively locate the fault points of optical networks. At the same time, the actual performance of different algorithms is compared and analyzed. Rafique established a set of perfect cognitive fault detection system for intelligent network guarantee, and clarified the role and value of this system. After research, Wang proposed a fault prediction method with support vector machine (SVM) as the core and double exponential smoothing (DES) as the foundation, which laid a good foundation for the intelligent development of optical network faults.

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5. Conclusion

Fault diagnosis of optical transmission network requires analysis and extraction from a large number of data to finally determine the fault location. Deep learning has become an important analysis method, which can be applied to the boring analysis and processing of a large number of data.

In this paper, according to the overall order, the fault diagnosis methods of deep learning and optical transmission network are firstly described, and the current research status of deep learning-based fault analysis methods is finally summarized. In the future, deep learning-based fault analysis methods will become an important means of optical transmission network fault diagnosis.

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