Fault Location Method of Multi Power Distribution Network based on Deep Learning

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Abstract

Smart grid can meet the various needs of modern people for production and life and improve the intelligent level of production and life. The normal operation of smart grid is the basis of maintaining production and life, so the fault monitoring of smart grid becomes more and more important. With the rapid development of renewable energy power generation, microgrid has attracted the attention of the industry because it has the advantages of stabilizing the power fluctuation caused by the access of a large number of distributed generators and improving the power supply reliability of equipment. The author uses deep neural network to identify power grid fault signals and constructs transmission line short-circuit fault identification model. Experiments show that this method can achieve good results and has broad development prospects.

Keywords

Deep Learning, Fault Identification, Reliability.

1. Introduction

With the rapid development of artificial intelligence, the use of deep learning network to identify and classify multi factor and multi feature tasks has been applied in many fields. In recent years, with the continuous improvement of the transmission level of China's power grid and the continuous improvement of intelligent requirements, how to use monitoring signals to quickly identify the operation state of power grid is the focus of current research. Generally speaking, large-scale power grid accidents are often caused by small transient faults [1]. When the power grid fails, Massive fault alarm data collected by the monitoring system (including correct alarm information, error alarm information, repeated alarm information and irrelevant information) shall be sent to the dispatching center from the local automatic device. Power grid fault diagnosis can quickly analyze the fault correlation characteristics from the fault data, accurately judge the fault cause, assist the dispatching and operation personnel to analyze and deal with the accident timely and accurately, and also provide support for the maintenance and operation personnel It is of great significance for the safe and reliable operation and rapid self-healing recovery of power grid. Once the monitoring system can not accurately identify the transient faults and take correct disposal measures, it may lead to small-scale fluctuation or even large-scale collapse of the power grid. Domestic experts and scholars have improved and perfected the distributed traveling wave fault location method, and put forward a variety of traveling wave analysis methods, which can better realize fault location [2]. In order to further realize the identification of traveling wave data types, the research on lightning shielding and counterattack identification has made some progress, covering most high-voltage AC / DC lines, and the judgment of lightning types has made relatively mature development [3]. Transmission line faults caused by mountain fire, foreign matters, wind deviation and other disasters occur from time to time, which makes the identification of non lightning faults particularly important. Therefore, this paper proposes a deep learning method to solve the identification of lightning faults and non lightning faults.

ISSN: 2414-1895 DOI: 10.6919/ICJE.202201_8(1).0100

Intelligent grid fault detection based on artificial intelligence has made great achievements [4]. For example, reference [5] proposed a new method of convolutional neural network and task decomposition framework based on Choi Williams time-frequency distribution. In order to improve the recognition ability of power line fault detection, reference [6] proposed a modeling method for power line fault recognition, which is based on sparse self coding neural network. Through the pre training analysis and modeling of fault signal characteristics, the deep neural network is used as the fault detection classifier. Simulation results show that the fault recognition rate of this method is more than 99%. Reference [7] proposed an effective algorithm for transmission line asymmetric fault detection, fault type classification and fault zone location based on artificial neural network. The scheme adopts the pre fault and post fault signals of three-phase current and the grounding current signal at the transmitting end of the transmission line [8]. This method is directly applicable to the original voltage and current data, so it does not need any feature extraction algorithm. These methods prove the effectiveness of fault detection methods based on artificial intelligence, but there are also some problems to be solved. The computing time and resources consumed by neural network are not considered, and the time limit of fault detection in smart grid is not considered.

2. Depth Neural Network based on Multidimensional Features

2.1 Deep Neural Network

Deep residual network is to make up for the shortcomings of deep learning network. Its obvious feature is to use a cross layer linked identity mapping to transform complex functions into simple residual problems. When the input of the neural network is x, the expected output is h (x). If we simply learn such a model, it will bring a huge amount of calculation. Joining the network can obtain high accuracy. The next work is to transform the task learning into identity mapping, so as to avoid the decline of accuracy in the subsequent layer level.

2.2 Fault Information of AC / DC Transmission System

Different from the traditional AC power grid, when the transmission line of AC / DC transmission system fails, due to the nonlinear time-varying characteristics of converter and the complexity of DC control system, there is a strong coupling relationship between the electrical quantities of AC and DC systems on both sides of converter station [9]. In case of AC line fault, the electrical quantity on the DC side will change, which will change the fault characteristics of the DC side, and then affect the DC protection performance. When the fault is serious, it will even cause the commutation failure of DC system inverter [10]. The regulation process of DC control system will have a secondary impact on AC system, which is easy to cause AC protection misoperation. Therefore, in AC / DC transmission system, the real fault can not be diagnosed timely and accurately only based on the protection action information. At present, it is necessary to obtain accurate and complete diagnosis information efficiently in the process of fault diagnosis of AC / DC transmission system.

2.3 Model

In the process of establishing neural network, the data time series is calculated through 5 layers of convolution layer and pooling layer, and the results are output at the full link layer. The model architecture is based on the Alexnet network structure, fine tune the parameters, and finally get the appropriate classification model [11]. At present, most of the methods for power grid fault are trained with big data, which often ignores the timing and periodicity of power grid fault. At the same time, the fault influencing factors faced by power grids with different transmission levels are also different. Blindly concentrating all power grid data for training may lead to the disorder of network diagnosis standards. In addition, the instability of power system is mostly caused by oscillation in the power grid. On the premise of excluding intentional damage, it is mostly caused by natural faults [12]. Selecting appropriate characteristic factors as input can obtain better analysis results. Generally speaking, in case of oscillation and other faults in the power grid, the generator set will be affected instantaneously. Therefore, this paper selects the generator electromagnetic power, bus voltage and generator rotor angular speed as the fault characteristics, and summarizes the characteristic data according to the time sequence, so as to ensure that the power grid corresponds to the generator as much as possible when the conditions are met.

2.4 Network Structure Configuration

There are many factors affecting the performance of CNN in power grid fault diagnosis, which can be considered from three aspects: network layer structure, convolution core size and number of convolution cores. 1) The number of convolution pooling layers of network layer structure often affects the depth of fault feature extraction and the effect of dimensionality reduction. With the increase of the number of convolution pooling layers, the stronger the ability of data feature extraction, the more likely it is to mine key features. However, the network layer structure is constrained by error back propagation training. Too many layers will lead to the complexity of the network structure, and even the disappearance of gradient, which limits the efficiency of parameter optimization. Therefore, it is very important for CNN to select the appropriate number of convolution pooling layers. 2) The number of convolution cores usually affects the efficiency of fault feature extraction. In the transmission system fault scenario, the more the number of convolution cores, the stronger the ability of the convolution layer to extract fault features. However, if the number of convolution kernels is too large, the number and scale of training parameters will be significantly expanded, and even the over fitting phenomenon of data extraction will occur, which will seriously affect the extraction efficiency; When the number is too small, the extraction effect can not meet the diagnostic requirements. 3) Convolution kernel size explores the influence of convolution kernel size from a biological point of view, and it is found that there is a strong correlation between convolution kernel and receptive field. A larger convolution kernel indicates that the convolution layer can receive more fault information, which is advantageous.

2.5 Network Optimization Training

In order to improve the efficiency of network diagnosis and reduce the error of each link of fault diagnosis, network optimization training is a very important part of the CNN model. Local connection is the idea that runs through the convolution and pooling process of the model. Although it can achieve the purpose of rapid dimensionality reduction, it is also the direct cause of error propagation. In order to minimize the error caused by the diagnostic model and fully reflect the ability of convolution, pooling, rapid dimensionality reduction and deep mining, it is necessary to reverse optimize the training parameters. At present, the commonly used optimization algorithms include random gradient descent method (SGD), root mean square transfer method (rmsprop) and Adam algorithm. The proposed method combines the advantages of Adam algorithm, such as small memory occupation and easy to deal with complex and massive fault data, which is helpful to extract fault features quickly and efficiently.

3. Conclusion

In order to improve the accuracy of power grid fault diagnosis, a deep neural network based on multi-dimensional data characteristics is proposed in this paper, which solves the problems that the insulation sheath of disconnector can not be installed directly due to the insecurity and limited geographical conditions of live installation of insulated glove operation method, expands the project and Application scope of uninterrupted operation in distribution network, and can effectively reduce the fault rate of disconnector, Improve the safe operation and stability of distribution network.

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