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Research Article

Qiuping Yang and Fang Hao*

Deep auto-encoder network for mechanical fault diagnosis of high-voltage circuit breaker operating mechanism

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Abstract: To improve the accuracy of the mechanical fault diagnosis of the operating mechanism and fully exploit the characteristic information in the vibration signal of the high-voltage circuit breaker, a mechanical fault diagnosis method of the operating mechanism of the high-voltage circuit breaker based on the deep selfencoding network is proposed. First, the vibration signal of the switch operating mechanism is extracted, the wavelet packet conversion is performed, and the vibration signal of each frequency band is divided into equal times. The energy of the time-frequency subplane of the vibration signal is then calculated, and the timefrequency energy distribution is used as a switch. Finally, a breaker failure diagnostic model based on the deep self-coding network is established. Pretraining and tuning and a 126 kV high-voltage switch are used to simulate different types of faults and validate the method. Experimental results show that this method can acquire sample failure data and perform failure diagnosis, and the diagnosis accuracy rate reaches 97.5%. The deep selfcoding network can fully pierce deep information on the switch vibration signal.

Keywords: high voltage circuit breaker, operating mechanism, fault diagnosis, wavelet packet transformation, time—frequency energy distribution, deep auto-encoder network

1 Introduction

The high-voltage circuit breaker is the key equipment of the power system. When the system is running properly, the circuit breaker controls the part of power equipment and line to enter or exit, switches the system operation mode, and realizes load distribution and equipment adjustment. When a fault occurs in the system, the circuit breaker quickly cuts off the faulty part to ensure the normal operation of the nonfaulty part of the system and avoid further expansion of accidents and economic losses. The high-voltage circuit breaker is mainly composed of the operating mechanism and the control unit, which is in the normal operation condition most of the time. But once the power system accident happens, it receives instructions and must be reliably in a very short period of time to complete the corresponding action. If it cannot remove the system failure part timely because of the breaker failure, a short circuit current will cause the circuit and equipment heating, even deformation and charred in the case of minor accidents. In the case of serious accidents, the system will crash, resulting in large-scale and long-term power outages, as shown in Figure 1 [1]. According to the statistical data, the number and time of unplanned power failures caused by highvoltage circuit breaker faults account for more than 60% of the total power failure [2], and the electric quantity and economic loss caused by the majority of the accidents are measured in millions. A circuit breaker in the power system is numerous with complicated structures and the running environment is different. The performance itself and the external environmental factors resulting in circuit breaker failure types are numerous. But according to the three surveys of circuit breaker failure reasons conducted by the international conference on power grid within the scope of the world, it is found that failure of the operatting mechanism of the circuit breaker, in turn, is 33, 43, and 61% [3]. The proportion increases significantly. China's fault factors of circuit breakers investigation statistics show

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<u>High Voltage Circuit Breaker Fault Diagnosis</u>

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High Voltage Circuit Breaker Fault Diagnosis:

Proceedings of the TEPEN International Workshop on Fault Diagnostic and Prognostic Bingyan Chen, Xiaoxia Liang, Tian Ran Lin, Fulei Chu, Andrew D. Ball, 2024-09-02 This book gathers the latest advances innovations and applications in the field of efficiency and performance engineering as presented by leading international researchers and engineers at the TEPEN International Workshop on Fault Diagnostics and Prognostics TEPEN IWFDP held in Qingdao China on May 8 11 2024 Topics include machine and structural health monitoring non destructive testing and fault detection diagnostic and prognostic for both operational and manufacturing processes maintenance optimization and asset management smart metamaterials and metastructures artificial intelligence and machine learning The contributions which were selected through a rigorous international peer review process share exciting ideas that will spur novel research directions and foster new multidisciplinary collaborations

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interested readers **International Conference on Neural Computing for Advanced Applications** Haijun Zhang, Yinggen Ke, Zhou Wu, Tianyong Hao, Zhao Zhang, Weizhi Meng, Yuanyuan Mu, 2023-08-29 The two volume set CCIS 1869 and 1870 constitutes the refereed proceedings of the 4th International Conference on Neural Computing for Advanced Applications NCAA 2023 held in Hefei China in July 2023 The 83 full papers and 1 short paper presented in these proceedings were carefully reviewed and selected from 211 submissions. The papers have been organized in the following topical sections Neural network NN theory NN based control systems neuro system integration and engineering applications Machine learning and deep learning for data mining and data driven applications Computational intelligence nature inspired optimizers and their engineering applications Deep learning driven pattern recognition computer vision and its industrial applications Natural language processing knowledge graphs recommender systems and their applications Neural computing based fault diagnosis and forecasting prognostic management and cyber physical system security Sequence learning for spreading dynamics forecasting and intelligent techniques against epidemic spreading 2 Applications of Data Mining Machine Learning and Neural Computing in Language Studies Computational intelligent Fault Diagnosis and Fault Tolerant Control and Their Engineering Applications and Other Neural computing related topics **Neural Computing for** Advanced Applications Haijun Zhang, Yuehui Chen, Xianghua Chu, Zhao Zhang, Tianyong Hao, Zhou Wu, Yimin Yang, 2022-10-20 The two volume Proceedings set CCIS 1637 and 1638 constitutes the refereed proceedings of the Third International Conference on Neural Computing for Advanced Applications NCAA 2022 held in Jinan China during July 8 10 2022 The 77 papers included in these proceedings were carefully reviewed and selected from 205 submissions These papers were categorized into 10 technical tracks i e neural network theory and cognitive sciences machine learning data mining data security privacy protection and data driven applications computational intelligence nature inspired optimizers and their engineering applications cloud edge fog computing the Internet of Things Vehicles IoT IoV and their system optimization control systems network synchronization system integration and industrial artificial intelligence fuzzy logic neuro fuzzy systems decision making and their applications in management sciences computer vision image processing and their industrial applications natural language processing machine translation knowledge graphs and their applications Neural computing based fault diagnosis fault forecasting prognostic management and system modeling and Spreading dynamics forecasting and other intelligent techniques against coronavirus disease COVID 19 IoT as a Service Yi-Bing Lin, Der-Jiunn Deng, Ilsun You, Chun-Cheng Lin, 2018-10-17 This book constitutes the thoroughly refereed proceedings of the 3rd International Conference on IoT as a service IoTaaS 2017 held in Taichung Taiwan in September 2017 The 46 full papers were carefully selected from 65 submissions The papers deal with the Everything as a Service deployment paradigm which enables the easy adoption of IoT based services and applications by end users and forces providers of smart objects and middleware platforms to architect their solutions accordingly The three special sessions organized were Wearable

Technology and Applications WTAA Building Smart Machine Applications BSMA and Security and Privacy in Internet of Things Services and People SP IoTSP The WTAA special session aimed to address the challenges of maintaining high efficiency of WTAA in terms of high recognition rate energy consumption computational costs and so forth The BSMA special session aimed to explore how to construct smart machines architecture for the industryunder the background of IoT and big data The SP IoTSP special session aimed to investigate recent research and future directions for IoTSP security and privacy

Robotics and Rehabilitation Intelligence Jianhua Qian, Honghai Liu, Jiangtao Cao, Dalin Zhou, 2020-12-18 This 2 volume set constitutes the refereed proceedings of 1st International Conference on Robotics and Rehabilitation Intelligence ICRRI 2020 held in Fushun China in September 2020 The 56 full and 4 short papers were carefully reviewed and selected from 188 submissions The papers are divided into the following topical sections In the first volume Rehabilitation robotics and safety machine vision application electric drive and power system fault diagnosis robust stability and stabilization intelligent method application intelligent control and perception smart remanufacturing and industrial intelligence and intelligent control of integrated energy system In the second volume smart healthcare and intelligent information processing human robot interaction multi robot systems and control robot design and control robotic vision and machine intelligence optimization method in monitoring advanced process control in petrochemical process and rehabilitation intelligence The Proceedings of the 19th Annual Conference of China Electrotechnical Society Qingxin Yang, Zhaohong Bie, Xu Yang, 2025-01-06 This book compiles exceptional papers presented at the 19th Annual Conference of the China Electrotechnical Society CES held in Xi an China from September 20 to 22 2024 It encompasses a wide range of topics including electrical technology power systems electromagnetic emission technology and electrical equipment The book highlights innovative solutions that integrate concepts from various disciplines making it a valuable resource for researchers engineers practitioners research students and interested readers **Mechanical Engineering And Control Systems -Proceedings Of The 2016 International Conference On Mechanical Engineering And Control System (Mecs2016)** Jinjia Wei, 2016-12-29 The 2nd Annual 2016 International Conference on Mechanical Engineering and Control System MECS2016 was successfully held in Wuhan China in 2016 The MECS2016 is one of the leading international conferences for presenting novel and fundamental advances in the fields of Mechanical Engineering and Control System attended by more than 80 participants from China South Korea Taiwan Japan Malaysia and Saudi Arabia The MECS2016 program includes 4 keynote speeches 98 oral and poster presentations covering a wide spectrum of topics from mechanics engineering control engineering and technology to automation and mechatronics However after reviewed and careful consideration only 70 articles are included in this proceedings Proceedings of the 1st Electrical Artificial Intelligence Conference, Volume 2 Ronghai Qu, Zhengxiang Song, Zhiming Ding, Gang Mu, Rui Xiong, Li Han, 2025-04-11 This book is the second volume of proceedings of the 1st Electrical Artificial Intelligence Conference EAIC 2024 Artificial intelligence and low carbon economy

are two vibrant research fields in the world today To achieve the goal of carbon neutrality not only signifies a significant transformation in the economic growth mode and a profound adjustment of energy systems but also has equally significant implications for the global economic and social transformation In the wave of the rapid development of digital economy artificial intelligence has become an important driving force for promoting high quality economic and social development In the path to the Dual Carbon goals which are the Peak Carbon Dioxide Emissions goal and the Carbon Neutrality goal artificial intelligence will play an important role especially in energy conservation and carbon reduction in the electrical field which is worthy of in depth exploration and research In order to promote the deep integration of the electrical engineering and artificial intelligence successfully achieve the dual carbon goals and promote green low carbon and high quality development the China Electrotechnical Society and relevant units jointly held the 1st Electrical Artificial Intelligence Conference in Nanjing China during the December 6 8 2024 The conference invited well known experts with significant influence in the fields of electrical engineering and artificial intelligence to jointly explore the application of artificial intelligence in the optimization design fault diagnosis intelligent control and optimized operation of electrical equipment promote the integration of artificial intelligence innovations and various application scenarios and actively lead the trend of technological innovation This book is not only a valuable summary of the new developments in the field but also a useful quideline for the researchers engineers and graduate students Data Science Zhiwen Yu, Qilong Han, Hongzhi Wang, Bin Guo, Xiaokang Zhou, Xianhua Song, Zeguang Lu, 2023-09-14 This two volume set CCIS 1879 and 1880 constitutes the refereed proceedings of the 9th International Conference of Pioneering Computer Scientists Engineers and Educators ICPCSEE 2023 held in Harbin China during September 22 24 2023 The 52 full papers and 14 short papers presented in these two volumes were carefully reviewed and selected from 244 submissions. The papers are organized in the following topical sections Part I Applications of Data Science Big Data Management and Applications Big Data Mining and Knowledge Management Data Visualization Data driven Security Infrastructure for Data Science Machine Learning for Data Science and Multimedia Data Management and Analysis Part II Data driven Healthcare Data driven Smart City Planet Social Media and Recommendation Systems and Education using big data intelligent computing or data mining etc Geometrical Enhancements Based on Data-Driven Design Decisions Sourabh Mandol, Mohit Hemanth Kumar, Akarsh Verma, V. K. Singh, 2025-06-16 The text presents various design and modelling solutions for effective decision making that are grounded on the basics of data analytics It further discusses important topics such as sustainable design and data driven design synthesis product analytics and its role in sustainable development and descriptive models for the geometrical evaluation of product features This book Familiarize the readers with the numerous decision protocols that can be utilized for deducing geometrical qualities using data driven design analysis Offers a more comprehensive approach to multidisciplinary engineering applications using data driven modelling and analysis Discusses multi objective optimization for product design and development through data

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Laibin City Guangxi Province China on December 11 12 2020 It examines a wide range of topics including distributed processing for sensor data in CPS networks approximate reasoning and pattern recognition for CPS networks data platforms for efficient integration with CPS networks machine learning algorithms for CPS networks and data security and privacy in CPS networks Outlining promising future research directions the book offers a valuable resource for students researchers and professionals alike while also providing a useful reference guide for newcomers to the field **New Energy Power** Generation Automation and Intelligent Technology Pengfei Gu, Yang Xu, Weihua Chen, Zhonggiu Wang, Yongbin Sun, Zheming Liu, 2024-09-04 This book is the 1st volume of proceedings of the 1st Smart Nuclear Power Technology Forum and the 8th China Nuclear Power Plant Digital Technology and Application Seminar held in Shenzhen China in June 2024 This seminar aims to explore the software and hardware of digital and instrument control I C systems in nuclear power plants such as inspection testing certification and research of sensors actuators and control systems and the application of electrical and intelligent operation and maintenance technologies It aims to provide a platform for experts scholars and nuclear power practitioners to exchange technology and share experience At the same time it also provides a platform for the combination of universities and enterprises in the aspects of production education and research and promotes the safe development of nuclear power plants In addition readers will encounter new ideas to achieve more efficient and safer instruments and control systems Genetic and Evolutionary Computing Shu-Chuan Chu, Jerry Chun-Wei Lin, Jianpo Li, Jeng-Shyang Pan, 2022-01-04 This book contains selected papers presented at ICGEC 2021 the 14th International Conference on Genetic and Evolutionary Computing held from October 21 23 2021 in Jilin City China The conference was technically co sponsored by Springer Northeast Electric Power University Fujian University of Technology Shandong University of Science and Technology and Western Norway University of Applied Sciences It is intended as an international forum for the researchers and professionals in all areas of genetic and evolutionary computing And the readers may learn the up to date techniques of the mentioned topics including swarm intelligence artificial intelligence information hiding and data mining techniques which can help them to bring new ideas or apply the designed approaches from the collected papers to their professional jobs

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