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EDITED AND REVIEWED BY
ZhaoYang Dong,
Nanyang Technological University,
Singapore

*CORRESPONDENCE
Chunhe Song,
songchunhe@sia.cn

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Editorial: Recent advances of edge computing for smart grid

Peng Zeng[1], Hao Liang[2], Ning Zhang[3] and Chunhe Song[1]*

[1]Shenyang Institute of Automation, Chinese Academy of Sciences (CAS), Shenyang, China, [2]Department of Electrical and Computer Engineering, University of Alberta, Edmonton, AB, Canada, [3]Department of Electrical and Computer Engineering, University of Windsor, Windsor, ON, Canada

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Editorial on the Research Topic
Recent advances of edge computing for smart grid

Smart grid is a power system equipped with ICT system to allow for bidirectional flow of electricity and information (Lo Cascio et al., 2021; Song et al., 2022). With the development of Internet of Things (IoT), a large number of terminal devices have been connected to smart grid and generated massive real-time data. The computing and storage resources of edge devices in smart grid are usually limited, and it is difficult to run complex artificial intelligence algorithms to fully process these data. Meanwhile, transferring all data to the cloud server does not only incur significant latency, but also easily leads to data leakage and security issues. Edge computing is an effective way to solve these problems (Song et al., 2023). Edge computing provides services on the side close to the data source, so as to meet the requirements of smart grid in real-time, intelligence and security (Song et al., 2021). This Research Topic aims to collect original papers on the recent advances of edge computing technology applied to the smart grid and present important results in the fields of system optimization, fault detection, intelligent protection, load analysis and forecasting, security and privacy, etc. In this Research Topic, eight papers have been accepted, and all papers were carefully reviewed by at least two reviewers and one guest editor. Details of these papers are as follows.

Security is a core issue of smart grid, and Li et al., Liu et al., Xu et al. focused on the lightweight security methods for smart grid. In, Liu et al. proposed a cluster-based scheme for the purpose of preventing wormhole attacks. First, a clustering algorithm was proposed to elect clusterheads, then the elected clusterheads were used to implement the wormhole attacks prevention scheme. Simulation results indicated the proposed method can prevent wormhole attacks efficiently. In, Xu et al. designed an edge computing security support engine and a security monitoring system based on the docker container. In this method, a node security judgment method was proposed combined with a container monitoring and objective weighting method, and a method was proposed to evaluate the security of the unmonitored node. The results proved the efficiency of the proposed method for security protection of the edge power system. In Li et al. designed A 5G network security architecture for smart grid, in which they replaced the commonly used plaintext information in the original system with ciphertext based on Software Defined Network (SDN). Meanwhile, they utilized the defects and differences in devices in smart grid to identify signals and prevent attackers from further damaging the leaked sensitive data. The experimental results showed that the SDN based 5G network anti-attack scheme can avoid the centralized exposure of sensitive data and reduce computational overhead, thus improve system security.

Fault detection is the key to ensuring the stable operation of smart grid, and Chu et al., Cao et al. focused on the lightweight fault detection methods for smart grid. In Chu et al. proposed a flexible dual-threshold support vector data description (SVDD) fault detection algorithm to deal with the issue of fault data missing in the power grid. In this method, wavelet packet energy features with Spearman were adopted to extract electric signal features, a relaxed SVDD fault detection algorithm was proposed to increase the sensitivity to the fault samples and lessen the risk of missed detection, and an adaptive update strategy was developed to reduces the computational cost of the model. In Cao et al. proposed a fault diagnosis method based on variational mode decomposition (VMD) and Convolutional Neural Networks (CNN). In this method, the envelope entropy was used to optimize the parameters of VMD, and differential evolution (DE) was used to select suitable parameters for CNN. Experiment results showed that the proposed method can effectively improve the convergence speed the classifier and the accuracy of fault diagnosis.

Three lightweight optimization methods for smart grid were studied in Qin et al., Wang et al., Wang and Li. In Wang et al. proposed a cloud-edge collaboration short-term load forecasting method for smart grid. To reduce the computational load of edge nodes and improve the accuracy of node prediction, a model pre-training pool was built to train multiple pre-training models in the cloud layer, and models were selected, retrained, and updated at edge nodes. Extensive experiments confirmed the effectiveness of the proposed method. In Qin et al. proposed a noise parameter ranking algorithm for predicting the symbol string. The results showed that the proposed method have better decoding performance in the environmental channel of smart grid, thus improved the reliability of smart grid in the process of factory power supply and distribution. In Wang et al. proposed a demand-side guidance method based on time-of-use pricing and coupon to increase the revenue of power retailers and reduce peak-valley difference. In this method, an adjustment load prediction model based on attention-LSTM network was proposed to predict the adjustment load of electricity customers under different coupon coefficients, and a power purchase-sale optimization decision model in multi-level electricity market was established to set a suitable coupon strategy to guide electricity customers to participate in the interaction more precisely. The effectiveness of the proposed method was demonstrated by arithmetic examples.

We would like to thank all the reviewers for their efforts, and all authors who have contributed to this Research Topic.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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