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Editorial: Advanced Optimization and Control for Smart Grids With High Penetration of Renewable Energy Systems

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Editorial on the Research Topic

Advanced Optimization and Control for Smart Grids with High Penetration of Renewable Energy Systems

INTRODUCTION

This Research Topic aims to collect and encourage research related to the exploitation and implementation of various advanced optimization and control techniques, which aims to solve a series of strong inherent randomness and uncertainty problems in current power grids with large-scale renewable energy integration. Fortunately and Surprisingly, this research topic has received widespread interests and submissions from the researchers and engineers globally, which published 48 articles in total until its close date. These works are all in line with the original purpose and potential topics of this Research Topic, which significantly promotes up-to-date research and share promising ideas in the related fields. Basically, the topics in the energy research areas include optimal operation and optimal control.

OPTIMAL OPERATION

Hence, as for the work related to optimal operation, here are the basic summarization: Tan et al. propose an objective function considering integrated power losses, voltage profile and pollution emission, and swarm moth flame optimization algorithm (SMFO) is used to optimize the location and sizing of distributed generators. Tao et al. develop basic soft-switching technology based on hard switching, and an improved soft-switching technology is proposed to improve the conversion efficiency by reducing the switching loss, which can effectively optimize the dynamic and steady-state performance of MPPT and average tracking time. Tang et al. present a cost-sensitive extremely randomized trees (CS-ERT) algorithm to solve the problem of imbalanced classification in wind turbine generator fault detection, in which the cost-sensitive learning method is introduced into an extremely randomized trees (ERT) algorithm. Sun et al. design a novel bio-inspired grouped beetle antennae search (GBAS) algorithm is devised to effectively identify unknown parameters of different

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PV models, which owns high optimization precision and stability. Chen et al. propose a deep learning approach for the power prediction of multiple wind turbines, in which a deep neural network combines spatiotemporal correlation to simultaneously predict the power of multiple wind turbines. Li et al. develop a novel parameter extraction strategy by data prediction-based meta-heuristic algorithm (DPMhA). Thus, PV cell parameters can be obtained with high accuracy and convergence rate. Chen et al. develop a BESS power configuration scheme (PCS) considering the renewable energy penetration (REP) constraint to configure the proper power of battery energy storage systems (BESSs) in system frequency regulation. He et al. establish a novel optimal array reconfiguration (OAR) of a PV power plant for secondary frequency control of automatic generation control (AGC), in which the battery energy storage system is used to balance the power deviation between the AGC signals and the PV power outputs. Kou et al. propose a random forest (RF) and current fault texture feature–based method for current sensor fault diagnosis in three-phase PWM VSR systems, and fault texture features are adopted to train the random forest current sensor fault detection and diagnosis (CSFDD) classifier. Wang et al.develop a novel genetic neural network (GNN)-based parameter estimation strategy for solar cells, based on measured *I-V* data, GNN accomplishes the training of the neural network via genetic algorithm. Gao et al. summarize a series of challenges brought by the highly coupled cyber-physical system, such as the primary and secondary collaborated planning models and solution algorithms. Tang et al. devise a new framework through combining the Spearman rank correlation feature extraction and cost-sensitive LightGBM algorithm for WT gearbox's fault detection, in which the feature selection is employed by using the expert experience and Spearman rank correlation coefficient. Peng et al. establish a multi-objective optimization model for the optimal locating and sizing of BESSs, which aims at minimizing the total investment cost of BESSs, the power loss cost of DN and the power fluctuation of the grid connection point. Chen et al. investigate a complete renewable heating system (RHS) framework and sizing the components to decarbonise building heating, which uses the particle swarm optimization algorithm for optimal sizing of each component in the RHS to find a solution to minimize CO_2 emissions. Liu et al. propose and constructs a Gaussian mixture model-binary parameter hidden Markov model (GMM-BPHMM) which takes into account the randomness of new energy power supply, clusters the load status based on active power and steady-state current to reduce the possibility of volatile clustering results from the new energy grid under a high penetration rate. Li et al. undertake a survey to design feasible schemes to ensure the sufficient utilization of renewable energy and the construction of integrated power grid systems to meet shortages of electricity supply especially in the isolated small islands in the Philippines through cooperation with China, meanwhile, Li et al. design feasible schemes to boost the international promotion of China's unmanned aerial vehicle (UAV) transmission line inspection standardization and further development of international UAV inspection technology. Zhu et al. review four FLC methods for comparative analysis. Furthermore, the design details and experimental result will also be given to help choose and measure these methods, which presents a clear image of the technology of FLC based MPPT to readers. Chen et al. propose a solution framework is to achieve the optimal robustness and economical operation of the system, which provides a new way for the application of the intelligent algorithm in the robust optimal dispatching. Xi et al. present feature extraction method for evaluating the complexity of the Electromagnetic Environment (EME) of the photovoltaic power station by using logarithmic morphological gradient spectrum (LMGS) based on the mathematical morphological theory. Zhang et al. propose a convex approximation algorithm to improve the feasibility of solving the model, and the steady-state model is developed with considering the loss characteristics and multiport coordinated control strategy. Zhang et al. takes distribution transformer as the research object and proposes a medium-and long-term load forecasting method for group objects based on Image Representation Learning (IRL). Shan et al. propose a single-ended protection principle based on the analysis method of transient power change for the "mesh structure" ring-shaped flexible direct current (DC) grid. Guan et al. propose a method for identifying the electricity consumption pattern of the customer based on the BB-Stacking model fusion framework, which yields the preliminary forecast results of customer load based on the actual load accounting results of the customers. Gao et al. propose a bidding model for PV-integrated BESS Power Plants in a pool-based day-ahead (DA) electricity market, in which the uncertainty of PV generation output is considered. Shao et al. propose a novel aggregation algorithm that considers the power loss of offshore submarine cable, which is different from the traditional wind farm modeling method that adopts amplifying transformer as aggregation medium. Yu et al. devise a novel data-driven phase identification algorithm based on advanced measurement infrastructure (AMI) in development of smart gird.

OPTIMAL CONTROL

Research aiming at optimal control can be outlined as: Wang et al. introduces the concepts, developments and perspectives of life cycle cost (LCC) management of equipment assets in high-penetrated renewable energy power grid, and probes into cost collection and estimation scheme in the process of equipment asset management. Xu et al. propose a three-layer and multi-time scale control mode of integrated automation system, PET cluster and PET controller based on the idea of hierarchical and partitioned control. Zhang et al. selects the bus as the hybrid simulation interface bus in the AC system near the DC system, which can effectively improve the simulation accuracy of the AC/DC system interaction. Li et al. propose a data-driven optimal control method for an air supply system in proton exchange membrane fuel cells (PEMFCs) with the aim of improving the PEMFC net output power and operational efficiency. Besides, to improve the proton exchange membrane fuel cell (PEMFC) working efficiency, a deep-reinforcement-learning based PID controller is proposed by Li et al. for realizing optimal

PEMFC stack temperature. Furthermore, Li et al. develop a data-driven PEMFC output voltage control method, moreover, an improved deep deterministic policy gradient algorithm is proposed for this method. Li et al. also propose a data-driven output voltage control strategy based on regulation of the duty cycle of the DC-DC converter to improve the stability of proton exchange membrane fuel cell (PEMFC) output voltage. Wang et al. apply the output power of different poles for the abnormal grounding point fault location based on the analysis of the output power of de-icing devices. Zhu et al. propose coordination rotor speed control (RSC), pitch angle control (PAC) and inertial control (IC) to control wind turbines, together with demand side response (DSR) participating in frequency regulation to balance active power in the power system. Yao et al. study and propose an optimization algorithm of automatic inspection of Unmanned Aerial Vehicles (UAVs) to improve the efficiency and cost of the inspection and maintenance work of renewable energy power grids. Sun et al. derive the sequence impedance model of the sending-end converter (SEC) of voltage source converter-based HVDC (VSC-HVDC) with the PQ-control outer loop and PLL with the explicit analytic expression. Teng et al. devise a robust control method based on H_{∞} loop shaping method to suppress the effect of uncertain integration on voltage stability of DC distribution system. Zhang et al. propose an inductor current sensorless control strategy based on modified virtual synchronous generator (VSG) method for single-phase inverter-interfaced microgrid application. Li et al. analyzes in detail the traditional control method, parallel control strategy and serial control strategy of the wind storage system, and combines the advantages of the two to propose an optimal control strategy. Zhang et al. adopt the direct modulation based on the virtual resistor and the reference value of dc-bus voltage, and instantaneous-value model of three-phase half-bridge MMC is derived by introducing differential-mode and common-mode component representation. Chen et al. develop a nonlinear control based on feedback linearization control (FLC) to track the ORS. In the FLC, the WT is linearized firstly, then the rotor speed controller is designed via linear control technique. Feng et al. devise a set of on-site DC test system of transmission line arresters to complete DC reference voltage test. Li et al. design the control mode switching strategy of M-CT-MMC to improve the power transmission capability of the non-fault pole and make it absorb surplus power independently. Yuan et al. study the exponential stability of load frequency control (LFC) for time-delay power system with electric vehicles (EV) aggregator based on Lyapunov theory and linear matrix inequality. Su et al. considers the optimization and H{infty} performance problem for LFC of power systems with time-varying delays. Tang et al. adopt FLC to achieve smooth and fast-tracking performance, and a rule-based strategy (RBS) is applied for power demand allocation.

AUTHOR CONTRIBUTIONS

BY: Structure, Writing-Reviewing and Editing. DS: Writing-Original draft preparation, Investigation. XH: Writing-Reviewing and Editing. XZ: Supervision. SC: Supervision, Investigation. CD: Resources. YR: Writing-Reviewing and Editing, Investigation.

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