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Improved optimization search tool for self-regulating smart distribution system with wind energy integration

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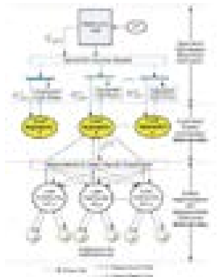
As an integral part of a smart grid, the smart distribution system is an important concept that employs advanced communication, control and information technologies to manage and optimize the resources of a feeder in order to improve energy efficiency and customer power consumption patterns, increase penetration and storage of Renewable Energy (RE) thereby decreasing GHG emissions and enable markets, consumer motivation and participation. For electrical distribution systems and demand-side management, demand response (DR) control is an emerging concept to manage customer power consumption patterns in response to system operation conditions and to minimize (or provide) system ancillary services while maintaining customer-side comfortable usage requirements. Reliable bidirectional smart grid communications and customer's grid-friendly participation provide new opportunities that enable DR to be employed to optimize grid operation utilizing the energy storage capability of modern homes via control of heat pumps and in the near future, plug-in electric vehicles (PEVs). Considering the complex interactions between an electrical distribution network and grid resources, in a quasi-steady-state simulation environment, optimal operation and management requires robust global optimization techniques that also incorporate distribution load flow simulations to optimally integrate RE generation, loads and corresponding DR control strategy. System power loss reduction was selected as an objective for the optimal distribution load flow optimization and the optimization process simulates load calculations and demand-side DR resource control. Residential heat pumps with thermal energy storage were chosen as typical DR resources to help regulate system power balance. An advanced recently improved metamodel-based global optimization (MBGO) search tool, named Approximated Promising Region Identifier (APRI) algorithm, was applied to determine minimum system power losses and optimal DR resources operation to offset wind fluctuations. This MBGO tool solves complex global design optimization problems with black-box objective/constraint functions and is ideally suited to this complex, computationally intensive application. The optimal control solution was compared with the un-optimized results to show the benefit of the proposed advanced optimizer. The inability to achieve an optimized solution and the poor computational efficiency of conventional optimization approaches in identifying the correct global optimum are also illustrated. The novel optimization method prospects the whole design space by generating sample points, reporting evaluating information using a surrogate model and then focusing the search in the most promising region by deploying more agents. Using the integration of these adaptive tools and methods, the optimization results are considerably promising in terms of computational efficiency and performance enhancement of the turbomachinery blade airfoil shape in both design and off-design conditions.



Biography

Dr. Adel Younis, PhD, P.Eng., a faculty member and professional engineer and researcher in the province of British Columbia, Canada and former research associate at both University of Victoria (UVic) and Simon Fraser University (SFU) in Canada. Dr. Younis has worked as a professional and lead project engineer in oil and gas; renewable energy, hydroelectric; and mechanical sectors around the world. He has been teaching mechanical and materials engineering courses at UVic, SFU and currently at Australian College of Kuwait (ACK). Dr. Younis' areas of interest are engineering design, optimization of complex mechanical systems, and renewable energy. He has published many research papers pertaining to mechanical, optimization and renewable energy. He has more than 18 years of work, research and teaching experience in mechanical, materials and structural engineering areas.

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