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Application of quasi-oppositional driving training-based optimization for a feasible optimal power flow solution of renewable power systems with a unified power flow controller

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The current study's objective is to reveal the best possible solution for an optimal power flow (OPF) problem. The driving training-based optimization (DTBO) technique has been applied in this work to achieve the goal where quasi-oppositional based learning (QOBL) has been integrated with DTBO and referred to as quasi-oppositional driving training-based optimization (QODTBO). The experiments have been carried out on IEEE 57 & 118 bus systems. Four different test scenarios have been considered here. The first one is the traditional IEEE 57 bus network; the IEEE 57 bus with renewable energy sources (RESs) (i.e., solar and wind units) is chosen in the second one, and the third one considers the IEEE 57 bus with RESs and unified power flow controller (UPFC) and finally the IEEE 118 bus network with RESs and UPFC. In each test scenario, there are four objective functions, among which one is single objective and three of them are multi-objective. Obtaining minimum total cost comes under the single-objective function. Simultaneous reduction in the overall cost and emission, concurrent reduction in overall cost and voltage deviation (VD), and simultaneous reduction in overall cost and voltage stability index come under multi-objective cases. The acquired test outcomes by QODTBO have been contrasted with the outcomes found by the use of DTBO, backtracking search optimization algorithm (BSA), and sine cosine algorithm (SCA). The effect of inherent uncertainties within RESs is gauged in the current study by the choice of appropriate probability density functions (PDF). Based on the experimental outcomes using different optimization techniques over thirty trials, a statistical report has been prepared that ascertains that QODTBO is the most robust optimization scheme among the optimization tools taken into consideration in this study. To represent the statistical analysis, pictorially box plots and error-bar plots are provided. One-way analysis of variance (ANOVA) tests have also been conducted on test outcomes to enhance the degree of reliability of the inferences made based on statistical results. From this work, it is also