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Application of Particle Swarm Optimization to Thermal Sensor Placement for Smart Grid

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Abstract : Dynamic Thermal Rating (DTR) provides crucial information by estimating the ampacity of transmission lines to improve power dispatching efficiency. To perform the DTR, it is necessary to install on-line thermal sensors to monitor conductor temperature and weather variables. A simple and intuitive strategy is to allocate a thermal sensor to every span of transmission lines, but the cost of sensors might be too high to bear. To deal with the cost issue, a thermal sensor placement problem must be solved. This research proposes and implements a hybrid algorithm which combines proper orthogonal decomposition (POD) with particle swarm optimization (PSO) methods. The proposed hybrid algorithm solves a multi-objective optimization problem that concludes the minimum number of sensors and the minimum error on conductor temperature, and the optimal sensor placement is determined simultaneously. The data of 345 kV transmission lines and the hourly weather data from the Taiwan Power Company and Central Weather Bureau (CWB), respectively, are used by the proposed method. The simulated results indicate that the number of sensors could be reduced using the optimal placement method proposed by the study and an acceptable error on conductor temperature could be achieved. This study provides power companies with a reliable reference for efficiently monitoring and managing their power grids.

Keywords : dynamic thermal rating, proper orthogonal decomposition, particle swarm optimization, sensor placement, smart grid
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