Enhanced DVR Control System Based on the Harris Hawks Optimization Algorithm

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Abstract

The dynamic voltage restorer's (DVR) transient, steady-state, and dynamic responses are essential requirements for protecting sensitive loads against upstream voltage disturbances via the DVR's ride-through capabilities. DVRs also look after transient oscillation at the instant of entering, and /or exiting by the DVR. This paper presents an enhanced, optimized, and less complex DVR control system structure, which is capable of improving the transient, steady-state, and dynamic responses as well as eliminating inherent transient oscillations. The control system comprises a closed-loop feedback control signal and feedforward upstream disturbance detection signal. Incorporating the feedforward term helps, dramatically, in improving the system response and eliminating the transient oscillations in the load voltage. The error signals are adapted using a PI controller to make the load voltage faithfully track its predefined reference waveform. The controller is implemented in the dq synchronous rotating reference frame. The parameters of the PI controller are selected using modern population-based optimization called the Harris Hawks Optimization (HHO) technique. The results obtained using the HHO technique are compared with two other optimization algorithms, namely Particle Swarm Optimization (PSO) and Whale Optimization Algorithm (WOA). The results show that the HHO gives the best system response. The system is simulated using MATLAB/Simulink and the validation via Typhoon HIL402 real-time emulator. Both HIL402 validation and simulation results show that the proposed control scheme recovers normal operation against voltage disturbance within approximately 1.2 milliseconds without overshoot with steady-state error near zero and significantly dampens the inherent voltage oscillation that occurs at the instant of DVR entrance and/or exit.

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