Optimizing PMUs Location for Identification of Single-line-to-Ground Faults with Line Break using GSA-PSO Algorithm

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Abstract:

Transmission and distribution systems are highly vulnerable to single-line-to-ground faults accompanied by line breakage (SLGF-LB). Since the electrical characteristics at the source side of SLGFs are largely similar and the operating conditions of distribution networks vary significantly, distinguishing SLGF-LBs from conventional SLGFs becomes particularly challenging in resonant or ungrounded grounding environments. To address this issue, this work introduces a novel fault detection strategy that integrates Phasor Measurement Unit (PMU) data with hybrid Particle Swarm Optimization (PSO) and Gravitational Search Algorithm (GSA) techniques for optimal and adaptive PMU placement. This hybrid approach enables reliable differentiation between SLGFs and SLGF-LBs by analysing source-side and load-side voltage behaviours. Specifically, the phase angle deviation between the faulted and healthy phases on the load side is employed as the key discriminating criterion. Extensive simulation results confirm the accuracy, resilience, and practical applicability of the method. Overall, the proposed framework enhances fault identification capability and strengthens the operational reliability of distribution networks by precisely characterizing ground faults associated with line breakage.