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Distribution Systems State Estimation Using Sparsified Voltage Profile

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This paper exploits an electrical characteristic of distribution networks to cast the state estimation problem into a sparse vector recovery problem. In distribution networks, voltage differences between two buses of each line segment are much smaller than the infeed bus voltage. Therefore, the voltage profile signal can be sparsified with a difference transformation and recovered from only a few micro-phasor measurement units (μPMUs) using compressive sensing (CS) and ℓ1 regularization. The effectiveness of the proposed algorithm is verified through the simulation results of a standard unbalanced distribution network, the IEEE 123-bus system, under different operation conditions. The method accurately estimates system states even with multiple bad current measurements. It also detects, identifies, and corrects bad voltage measurements. In addition, a problem of binary integer linear programming is solved to obtain and optimally place the minimum number of μPMUs necessary to provide a unique solution for the proposed state estimation formulation.

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