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Fast Stability Monitoring Algorithms for Large Set of PMU Signals

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Abstract

Synchrophasor measurements are being implemented in power systems all over the world in great numbers, and there is an urgent need for algorithms that can process a large number of these signals towards extracting useful system information. Our research at WSU is focused on developing fast algorithms for stability monitoring of the power grid using a large number of PMU signals. Three classes of algorithms have been developed for monitoring of 1) oscillatory stability, 2) voltage stability, and 3) angle stability, respectively. As an example, Frequency Domain Decomposition (FDD) has been developed for oscillation monitoring using PMUs by the WSU team in recent years. FDD carries out modal analysis of large-scale ambient synchrophasor data. Specifically FDD detects the presence of any poorly damped modes and/or oscillations by estimating the dominant mode frequency, damping ratio, and mode shape simultaneously. FDD has been implemented in several utilities in North America and has proved successful in detecting and analyzing problematic oscillations in the grid. In recent research, we have developed a *turbo* version of FDD called Fast Frequency Domain Decomposition (FFDD) [1] which is *much faster* than any other ambient monitoring algorithm in the literature. The main computational burden in FDD is in two steps: a) the evaluation of the Power Spectrum Density (PSD) matrix, and b) in computing the SVDs of the PSD matrix over the frequency range of interest. This research introduces Fast FDD or FFDD that directly alleviates these two constraints a) and b). Based on a theoretical result, it has been recently proved that the PSD matrix as implemented in FDD algorithm has one nonzero singular value which is equal to the sum of the auto-spectrum terms of the PSD matrix. *FFDD is significantly faster in computational time compared to FDD while providing almost the same estimation results.* For instance, FFDD can analyze one hour of synchrophasor data from over 100 PMUs in about two minutes on a regular server.

[1] H. Khalilinia, L. Zhang, and V. Venkatasubramanian, "Fast frequency domain decomposition for ambient oscillation monitoring", IEEE PES Letters, to appear.

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