RWTH AACHEN UNIVERSITY

E.ON Energy Research Center
ACS | Institute for Automation of Complex Power Systems

Master Thesis:

A Dynamic Phasor based Dynamic State Estimation for Converter Driven Grids

Brief Background:
Today's distribution grid is characterized by connection of converter-based resources and new load types, resulting in a harmonics-infused, low-inertia power system with faster changing grid dynamics. This changing landscape of the power system necessitates the monitoring of grid states and frequency dynamically for supporting various critical grid operations. In literature, applying Kalman Filtering (KF) techniques is the most common approach for performing dynamic states estimation, which make use of the known equations for states transition and measurements model [1]. However, the classic KF formulations employ static phasor formulations, which may not be a suitable assumption for a typical distribution network with harmonics. Employing dynamic phasor (DP) formulations enables the extension of fixed network frequency models to include the impact of harmonics. Therefore, in this work a dynamic-phasor formulation based dynamic states estimation (DP-DSE) using Kalman filter technique will be implemented.
The estimated load-bus voltage phasor can be further processed by a complex PLL to extract the load-bus frequency.

The student will make use of an existing framework on Matlab and extend the work to implement dynamic-phasor based linear and/or non-linear KF for power system states estimation. Linear or non-linear implementation of KF will depend upon the choice of state vectors and measurement types that are assumed to be available. Further, the implemented method will be tested against other classical linear and/or non-linear KF implementation for different operating conditions and grid scenarios [2].

Your Tasks:

- Literature review on dynamic states estimation and dynamic phasor approach.
- Selection of appropriate state vector and assumption on available measurement type
- Implementation of linear and/or non-linear DP-DSE in Matlab
- Test the implemented approach on selected test bench networks for different operating conditions
- Statistical analysis and comparison of the implemented method's accuracy against other methods for states and frequency estimation.

The scope of the work can be extended based on the progress.

Your Profile:

- Master student in electrical engineering
- Background on power system monitoring, state-space modelling, uncertainty propagation theory is beneficial
- Good skills in Matlab Simulink and scripting, Python is mandatory
- Critical thinking and enjoys working independently

Supervision will be done in English.
If this position sparks your motivation and you are interested to apply, please send an email with your CV and current grades to the contact below.

References:

[1] J. Zhao and A. G. Exposito and M. Netto and L. Mili and A. Abur and V. Terzija and I. Kamwa and B. Pal and A. K. Singh and Z. Huang and A. P. S. Meliopoulos, "Power System Dynamic State Estimation: Motivations, Definitions, Methodologies, and Future Work", IEEE Transactions on Power Systems, vol. 34, no. 4, pp. 3188 – 3198, 2019

[2] C. Muscas, P. A. Pegoraro, S. Sulis, M. Pau, F. Ponci and A. Monti, "New Kalman Filter Approach Exploiting Frequency Knowledge for Accurate PMU-Based Power System State Estimation", IEEE Transactions on Instrumentation and Measurement, vol. 69, no. 9, pp. 6713 – 6722, 2020

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