RWTH AACHEN UNIVERSITY

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

Master Thesis:

A Data-Driven Technique for Dynamic States Estimation Using Gaussian Processes

Brief Background:
States estimation routine is one of the first routine to run at the control center of transmission or distribution systems, which then provides state of the grid for use in other operational applications such as contingency analysis, congestion management and optimal power dispatch. The once passive distribution grid is becoming more dynamic in nature which arises the need for estimating the states of the grid dynamically to be able to monitor the dynamics of the system. In literature, the dynamic states estimation is performed using Kalman Filtering (KF) techniques, which make use of the known equations for states transition and measurements model. However, sometimes these equation-based models may not be available due to several reasons, such as restrictions due to intellectual property or unknown underlying dynamics of the devices. As a first step to overcome this challenge, this thesis work will model the measurement and state transition model as Gaussian processes (GP), and employ these models into Kalman filter formulations for grid dynamic states estimation using Gaussian processes (GP-DSE). The selection of a suitable KF technique will depend upon the choice of state variables and assumed available measurement. The GP models will be trained using the available measurements and knowledge on states.

The student will make use of existing theoretical framework [1], [2], [3] to implement the GP-DSE for states estimation for power system states monitoring and analyze its performance under different operating conditions.

Your Tasks:

- Literature review on data-driven techniques for states estimation.
- Familiarization with Gaussian process modeling and Kalman filtering techniques.
- Implementation of GP-DSE using linear and/or non-linear KF. Implementation preferably using python or Matlab programming language.
- Select an appropriate test case to test the implemented algorithm(s) and justify the selection
- Statistical analysis of the implemented states estimation algorithm(s) and comparison of implemented estimation algorithm(s) accuracy against classical equation-based DSE under various operating conditions.
- Analysis on computational challenge of the implemented algorithm(s) and outline the challenges of using this method for real-time application.

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

Your Profile:

- Master student in computer science or electrical engineering
- Background on power system monitoring, concepts on statistics and machine learning are beneficial
- Good programming skill in Python, Matlab is mandatory
- Interest in inter-disciplinary research topics
- Critical thinking and enjoys working independently

Thesis Take Away:

- Inter-disciplinary thesis where you will enhance your knowledge on Kalman filters, machine learning, and power system states monitoring
- Practical application and hands-on experience of a popular machine learning technique called Gaussian processes
- Possibility to co-author a scientific article, if interested.

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] C.E. Rasmussen, C.K.I. Williams, "Gaussian Processes for Machine Learning", MIT Press: Cambridge, MA, USA, 2006

[2] J. Ko, D. Fox, "GP-BayesFilters: Bayesian filtering using Gaussian process prediction and observation models", 2008 IEEE/RSJ International Conference on Intelligent Robots and Systems

[3] J. Ko, D. Fox, "Learning GP-BayesFilters via Gaussian process latent variable models", Autonomous Robots, vol. 30, pp. 3–23, 2011

Contact:

Priyanka Arkalgud Ganeshamurthy
Tel. +49 241 80 49746
priyanka.ag@eonerc.rwth-aachen.de

Abraham Ezema
Tel. +49 241 80 49749
abraham.ezema@eonerc.rwth-aachen.de

ACS | Institute for Automation of Complex Power Systems
ERC | E.ON Energy Research Center
RWTH Aachen University
Mathieustr. 10, 52074 Aachen, Germany