Internship Offer: GridSight

Extended State Estimation for Power Systems

Duration: 5 to 6 months
Desired start: Between March 2026 and July 2026
Internship level: Master's / Final-year Engineering student
Location: Laboratory of Signals and Systems (L2S), French research laboratory located in Paris-Saclay University - RTE Chair "The Digital Transformation of Electricity Networks"
Contact: Patrick Panciatici and Sorin Olaru.

1 RTE Chair at CentraleSupélec

The RTE Chair is a partnership between RTE and CentraleSupélec, coordinated by Prof. Sorin Olaru. For several years, RTE has been studying the potentialities offered by digital technologies in the management of the electrical system.

Building on its close scientific and educational relationships with CentraleSupelec, RTE has sought to strengthen this collaboration and establish this new partnership in the long term in order to accelerate its innovation processes and benefit from the scientific expertise of leading research teams with which to interact in the field of engineering sciences.

RTE is the operator of the French high- and extra-high-voltage transmission network. RTE provides a public service mission by guaranteeing the proper functioning and security of the power system in France. It operates, maintains, and develops the transmission grid to meet the needs of its customers, while ensuring economic efficiency, environmental responsibility, and supply security.

Its central role in the French and European power system makes RTE a unique pioneer in anticipating energy futures.

2 Context

Large-scale power systems are undergoing radical change. The transition to a low-carbon or even zero-carbon economy is driving electricity generation from non-carbon sources and increasing electrification in energy-intensive sectors. This shift raises critical questions about the integration of renewable energy into the grid, which power system stakeholders must address.

As complexity grows, ensuring reliable operation becomes more challenging. Modern power systems, now intricate cyber-physical networks, require advanced engineering solutions. Renewable energy sources—primarily solar and wind—are inherently variable and rely on stochastic primary power flows. They typically connect to the AC grid via power electronic converters at various power and voltage levels, introducing highly controllable elements capable of rapid response.

To manage this complexity, automatic control is essential, leveraging feedback strategies to mitigate disturbances and enhance performance while avoiding costly, over-sized infrastructure. However, as more active devices emerge at the system's edge, centralized control becomes impractical and fragile. In this context, distributed control is a necessity.

A structured approach based on hierarchical control and protection strategies is required to ensure stability and efficiency in large power systems undergoing transition, taking into account the inherent separation of time scales in system dynamics.

3 Internship Objectives

This internship focuses on Extended State Estimation for Power Systems.

State estimation for the power system estimates voltage node phasors and flow phasors (current, active power, and reactive power) on the branches. These estimates are corrected even if the system is not in a steady state. However, to perform a dynamic simulation, we must estimate the state variables within each connected component (generating units, loads, and converters) and their associated controllers. Typically, this is done by assuming the system is in a steady state while using the boundary conditions provided by the power system state estimator. However, this method cannot guarantee that the system is in a steady state. This is never the case because loads and uncontrolled generation units change stochastically.

For decades, dynamic state estimators have been proposed in the literature, but they are complex and cannot be used in practice due to unpredictable structural changes in the network (disconnection of lines or components, busbar switching, ...).

We propose to investigate in this project what we call **Extended State Estimation**, which decomposes the problem into a sequence of two state estimations. This is a new idea that needs to be explored and clarified. More precisely, the idea is to combine a standard grid state estimator with local Kalman filters in order to more efficiently estimate the derivatives of state variables. The project involves creating a test case, simulating it, and evaluating its accuracy and robustness. One interesting issue that must be solved is that the grid state estimation runs at most every 10 seconds, while the dynamic model of the component must run at a time step of less than 0.1 seconds.

4 Internship Plan

The main steps are as follows:

1. Understand and formulate the problem, including an analysis of the state of the art.

2. Develop a minimal toy example in Matlab with two generating units, two loads, two nodes, and two parallel lines. Create an interesting test case involving load variations and power line switching, and perform simulations.

3. Develop a standard grid state estimation for this test case and analyze its performance.

4. Develop local Kalman filters (EKF) and test them in a simulation with perfect knowledge of the inputs.

5. Propose coupling approaches between grid state estimation and local Kalman filters. Perform an analysis of drawbacks and potential issues.

This internship is intended to lay the groundwork for more in-depth doctoral study on the same topic. Students interested in pursuing a Ph.D. after the internship will be given priority consideration.

Thanks to the RTE Chair at CentraleSupélec, this work will be carried out in close collaboration with RTE.

Profile and Skills

The selected student must have strong analytical skills, be capable of working autonomously, and have a logical approach to problem-solving. Knowledge of automatic control, electrical engineering, and mathematical programming is desirable. The student will perform software development and data preparation tasks. Proficiency in MATLAB and an interest in programming are preferred.