UNDERGRADUATE SUMMER RESEARCH PROGRAM PROPOSAL

Project title: Grid-Forming Control for Inverter-based Resources: A Current-Source Converter based Approach

Faculty advisor: Hang Gao

Project description:

Background: As renewable energy-based electricity generation penetrates the grid, inverter-based resources (IBRs) are gradually replacing traditional synchronous machine-based electricity generation. The trend results in the loss of inertia in the grid, which impacts the grid's stability especially during transients and under fault events. Existing inverters are mostly regulated by grid-following (GFL) controls, which assume the grid with constant voltage and frequency. Unfortunately, GFL controls are not suitable for a weak grid with very low inertia. Hence, inverters with grid-forming (GFM) capability become necessary to provide support on the grid's voltage and frequency and maintain its stability. Existing research on GFM controls focuses on voltage-source inverters (VSIs). Unfortunately, VSIs with GFM controls usually suffer from huge current stress during transients and faults. Though extra current limiting control schemes can be added, they make the overall control structure complex and have a direct impact on the stability of the inverter and synchronization to the grid. On the other hand, current-source inverters (CSIs) inherently feature the current limiting capability because of the DC choke. However, the research on CSIs with GFM controls is scarce, which leaves a huge knowledge gap to be filled.

Activity: To fill the knowledge gap, a small-signal analysis for CSI with GFM control will be conducted to incorporate CSI's both AC and DC dynamic behavior. Based on the derived mathematical model, the stability analysis for CSI with GFM control will further be done, especially its transient stability analysis. Then, a droop control based GFM control for CSI will be evaluated during various transients and under different fault events. The results will be compared with a VSI with the same control technique and system parameters.

Deliverables:

1. A comprehensive mathematical model for CSIs with GFM controls
2. Simulated results for CSI and VSI with GFM controls
3. Experimental testing results on a real-time interface platform.
4. Project poster for UGSRP24 and a conference paper.

Time requirements:

1. Totally 180 hours.
2. Mon-Frid, 9am-5pm, May 16 – Aug 5; 30 hours per week for the month of June.

Constraints:

No specified constraints on the project.

Required skills and knowledge:

Fundamental knowledge of power electronics; skills on MATLAB/Simulink preferred.