Friday, November 17, 2023 | 11:30 – 12:30 p.m. CST

Location: Zachry 244

Dynamics and Stability of Large-Scale Power Systems with Inverter-Based Resources

Abstract

Future power systems that are dominated by renewable and inverter-based resources (IBRs) will face significant fluctuations in operating conditions, a lack of transparency in control implementations, and unprecedented complexity in dynamic behavior. The first part of the talk focuses on the modeling and control design of IBRs in large-scale power systems. A novel inverter control scheme that unifies grid-forming and following controllers is presented. The proposed controller incorporates both a phase-locked loop (PLL) for voltage synchronization and power frequency droop for load sharing. It possesses important practical features such as black-start, low voltage ride-through, and autonomous islanding/reconnecting of microgrids. Both small- and large-disturbance performance are demonstrated, and improved robustness is achieved along with favorable interoperability between various inverters and synchronous generators. In the second part of the talk, we will focus on power system voltage stability. The problem is related to finding the singular solution space boundary (SSB) of power flow equations. We propose a method rooted in differential geometry to approximate the SSB of power systems under high variability of renewable generation. Conventional methods mostly rely on either expensive numerical continuation at specified directions or numerical optimization. Instead, the proposed approach constructs the Christoffel symbols of the second kind from the Riemannian metric tensors to characterize the complete local geometry which is then extended to the proximity of the SSB with efficient computations. As a result, this approach is suitable to handle high-dimensional variability in operating points.

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Sijia Geng is an Assistant Professor in the Department of Electrical and Computer Engineering at Johns Hopkins University. Before joining JHU, she was a Postdoctoral Associate at the Laboratory for Information & Decision Systems (LIDS) at MIT. She received her Ph.D. in Electrical and Computer Engineering from the University of Michigan, Ann Arbor, where she also received the M.S. in Mathematics and M.S. in ECE. Her research interests include dynamics, control and stability of inverter-based smart grids and optimization of electrified transportation systems. She is the recipient of a Best Paper Award at the MIT/Harvard Applied Energy Symposium in 2022 and was named a Barbour Scholar and Rising Star in EECS (MIT) in 2021.