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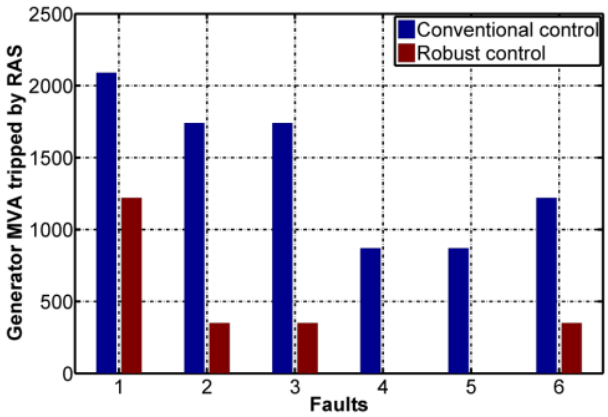
Future Power Grid Control Paradigm

OBJECTIVE

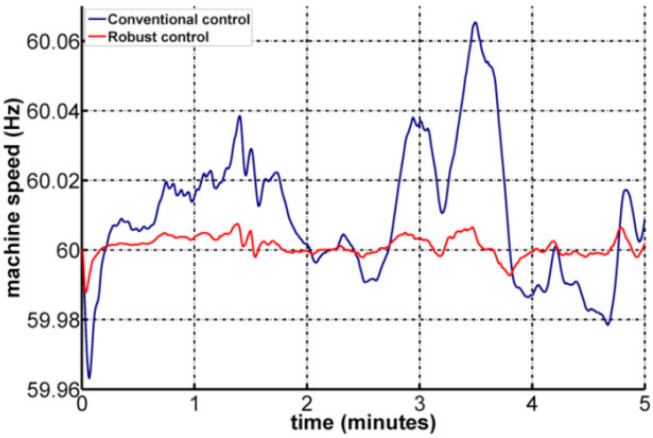
This research developed a hierarchical distributed robust control strategy that

- Allows operators the capability to look ahead and predict the system operations in real time, to take preventive actions as opposed to being reactive
- Enhances overall system reliability through improved transient stability performance over a wide range of operating conditions; more small-signal stability by increasing system damping; and improved voltage stability
- Is vigorous against variability and uncertainty caused by high penetration of renewables.

The Future Power Grid Control Paradigm provides operators with a set of tools to make preventive—rather than reactive—decisions based on look-ahead dynamic controls.



Minimum machine capacity to be tripped by remedial action schemes to ensure system stability



Frequency excursions due to high wind penetration

APPROACH

The project is

- Designing decentralized robust controllers based on decentralized control theory to supplement the conventional droop control action at the primary level—this greatly increases system damping and enlarges stability region
- Incorporating the look ahead capability into proposed robust control so that operators can predict future system operations and take preventive—rather than reactive—actions against contingencies
- Applying look-ahead dynamic simulation to examine system performance under different contingencies with different choices of activated controllers
- Installing proposed robust controllers into the system where possible, and only activating a subset based on given criteria such as stability and frequency indexes.

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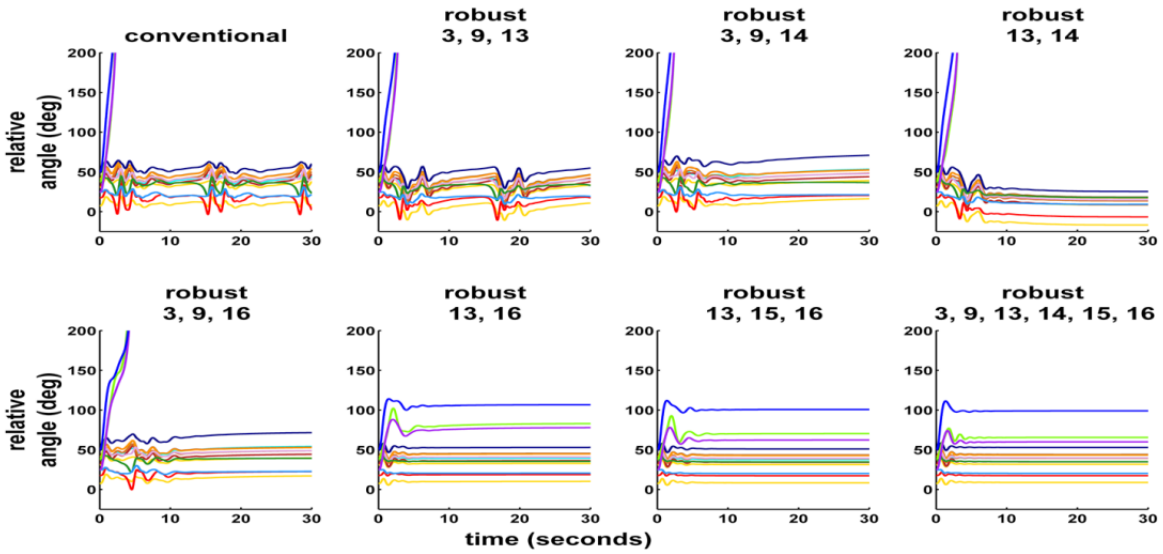

Look-ahead dynamic simulation results

IMPACT

- By deploying the decentralized robust controller, the needed level of remedial action schemes (RAS) action, that is, the amount of generation that needs to be tripped, is greatly mitigated
- Proposed robust controller reduces the frequency excursion due to the variability introduced by the high penetration of wind energy, and keeps it within a tighter bound
- Look-ahead dynamical simulations can help determine the best candidate generators in which to place proposed robust controllers, given the pre-specified contingencies.

ABOUT GRIDOPTICS™

The Grid Operation and Planning Technology Integrated Capabilities Suite (GridOPTICS™) is the core product of Pacific Northwest National Laboratory's Future Power Grid Initiative which concluded in 2015. GridOPTICS™ tools are designed to securely collect and manage data in real time, use data to drive modeling and simulation, and convert large volumes of data to actionable information. GridOPTICS™ concepts and tools show and analyze grid performance at an unprecedented speed, scale, and resolution and support operational and policy decision-making for the grid of the future. A key emphasis is on transitioning GridOPTICS™ tools to open-source status, supported in their future development and use by a "community" including PNNL, other national labs, academia, vendors, and utilities.

For more information, please visit the GridOPTICS™ website or contact:

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