University of California
CIEE

ELECTRIC GRID RESEARCH

Project Summary

Oscillation Detection and Analysis

Context

Electromechanical oscillations occur frequently on power systems. If they are not properly damped, the oscillations can grow out of control leading to grid reliability issues and potentially large-scale blackouts. The multi state power outage on the Western Interconnection system that occurred on August 10, 1996 was caused by such an oscillation. These oscillations frequently limit the power that can be transmitted over major interconnections to substantially less than they could otherwise handle.

Oscillations typically arise when the system is perturbed in some fashion or is otherwise stressed. The understanding of oscillations has been traditionally accomplished by simulating the power system with a computer model. However, with the large size and complexity of the Western Interconnection, it is not possible to perform simulations with required accuracy quickly enough to be of value when a system disturbance occurs. Therefore, it is critical to perform oscillation detection and analysis based on real-time measurement data, rather than on simulation with models. Remedial actions cannot be taken without real time oscillation detection and analysis tools.

Goals and Objectives

The goal of this project is to improve real-time situational awareness of oscillation problems in the Western Interconnection.

Objectives are to:

- Develop an intelligent algorithm for oscillation detection and analysis,
- Evaluate the performance and usefulness of the algorithms using field measurement data,
- Build a prototype graphical user interface (GUI), and
- Develop a real-time prototype tool for monitoring and analyzing power grid oscillations.

Description

This research project will develop and apply advanced signal processing algorithms for oscillation detection and analysis based on phasor measurement unit (PMU) data. It will include testing and validation procedures based on both simulation data and field measurement data. A real-time prototype tool is to be developed for monitoring and analyzing power grid oscillations.

Initially, advanced signal processing techniques are to be applied to extend current algorithms for oscillation detection and analysis used in a previously developed tool, the “mode meter”. Then, the new algorithm will be tested and evaluated for accuracy and speed using both simulation and field measurement data. Finally, a prototype GUI will be integrated with the algorithm into a prototype oscillation detection and analysis tool for testing with real-time streaming PMU data.

Key Results/Conclusions

This project developed, implemented, and evaluated a recursive algorithm for automatically detecting and analyzing power grid oscillations in near real time using ringdown data resulting from disturbances on the grid.

By effectively identifying ringdown data, the modes can be identified accurately within a short time window. Thus, the detection reduces the rate of false and missing alarms. This oscillation study is a major breakthrough in the sense that it significantly lowers false and missing alarms, as well as shortens detection time by applying oscillation detection and analysis algorithms properly.

Why It Matters

Oscillations are occurrences on the power grid with potentially extremely serious impacts such as wide area blackouts with costs estimated in the billions of dollars. With current tools, the primary method of control today is to restrict the flow of power on transmission lines by 1000s of megawatts, which limits the ability of the California and the Western Interconnection to economically exchange power and can lead to shortages.

The method developed in this project is expected to have significant impact on power grid operation, as it will improve reliability and avoid significant economic losses. This study is expected to lay the foundation for achieving the longer term goal of not only detecting oscillations but controlling them.

Project Summary

Oscillation Detection and Analysis (Pg 2)

Participating Organizations

Principal Investigator:

Pacific Northwest National Laboratory

Research Partners:

California Independent System Operator;

Project Start Date: March 19, 2009

Project End Date: Sept 30, 2010

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Reports

Final Report: <u>*Oscillation Detection and Analysis*</u>

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