Technology Innovation Project *Project Brief*

TIP 321: Real-Time Estimation of Generator Dynamic States and Damping Torque Using PMU Data

Context

A growing challenge inherent in grid integration of diverse sources of generation, is characterizing individual generators' contributions to higher-level, system-wide objectives such as grid stability. In the context of electromechanical stability and damping of oscillations, analysis tools have, for a long time, addressed this problem by defining the "damping torque" associated with each generator.

But damping torque has traditionally been purely a conceptual tool, with limited success in seeking to implement its actual measurement.

However, with the availability of high speed phasor measurement unit (PMU) data, there is increasing interest in the applying this data to understand power system oscillatory stability. Despite a significant investment in the Wide Area Measurement System infrastructure and the availability of a wealth of PMU data, a method for online estimation of the driving forces behind the oscillation problem has not yet been successfully devised. System operators are frequently faced with challenges of "false alarm" and "missed detection" A direct measure to assess and predict oscillatory stability in real time along with the potential sources will be beneficial for the transmission operators.

Description

The project will conduct a three-year, $1.6 million program to develop and prototype a new algorithm to quantify contributions of individual generators to the system-wide objective of stable operation

A key aspect of the project is the development of a phasor-based technique that uses a recursive Kalman filtering algorithm to estimate the generators' damping torque contribution using PMU data.

Unlike other projects that target a single specific learning technology, our aim is to develop a useful software platform and in so doing to characterize the strengths and weaknesses of a variety of potentially useful approaches that have been successful in small scale or proof-of-concept settings. Simultaneously, we will benchmark our approaches against hand crafted rule-based methods developed by domain experts.

Why It Matters

As BPA begins to look into advanced applications to improve damping in the system, this innovation will lay a foundation for current and future applications to leverage PMU data.

This technology will provide valuable information about the global system stability and the contribution of the different generators to the stability through non-invasive damping torque estimation.

BPA's oscillation monitoring system and the planned wide-area oscillating damping control system will directly benefit from the project:

Goals and Objectives

The objectives of the project are:
Generator Dynamic State Estimation—Develop algorithms to estimate the dynamic states of generators using PMU measurements.

Non-Invasive Damping Torque Estimation—Develop a non-invasive phasor-based technique for estimating the damping torque contribution from generating units.

Prototype Development and Demonstration—Develop a prototype with human machine interface (HMI) and advanced visualization, and demonstrate the results in BPA's Synchrophasor Lab.

Deliverables

The deliverables from the project will include set of software tools for mining the PMU data stream as well as the models obtained from learning on our data set. The project team will deliver a written project report along with existing software algorithms and experimental infrastructure. These digital artifacts will comprise a complete specification of our technology (source code, learned models, and experimental documentation). This specification could then be used by BPA as a prototype to guide the development of a full system for mission qualification and other uses beyond Technology Readiness Level 7.

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Project Start Date: October 1, 2014

Project End Date: September 20, 2017

Reports & References (Optional)

Links (Optional)

Funding

Total Project Cost:	$1,634,394
BPA Share:	$817,896
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For More Information Contact:

BPA Project Manager:

Gordon Matthews , ghmatthews@bpa.gov

GE Global Research Principle Investigator:

Dr. Nilanjan Chaudhuri, chaudhuri@ge.com

Participating Organizations

GE Global Research, Niskayuna, NY
GE Energy Consulting
University of Wisconsin–Madison (UW)