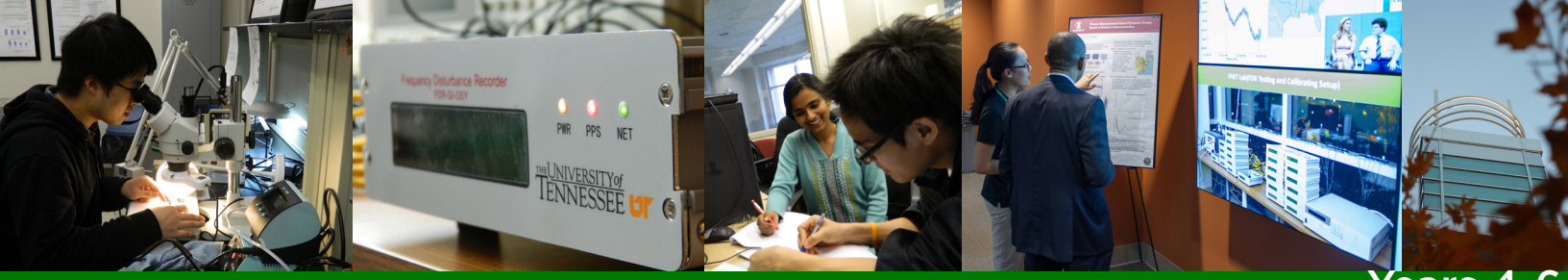

Years 4-6

CURENT

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RESEARCH

Dynamic State Estimation and Cyber Security Issues

Overview

Static and dynamic security assessment for large scale interconnected power grids cannot be accomplished without an accurate real-time model of the system. CURENT is investigating robust and numerically efficient methods to track system models and states. Synchrophasors are used to develop a robust linear estimator whose outputs are then used by dynamic state estimators for individual or groups of generating units. Given the strong dependencies of these methods on cyber systems, CURENT is also looking at cyber security issues by developing customized applications of cyber security and attack avoidance technologies.

Technology Pathway

A two-stage dynamic state estimator is under development. The first stage involves a robust tracking estimator based strictly on phasor measurements. The second stage will implement a robust dynamic state estimator for individual or groups of machines in a subsystem or zone. The impact of parameter errors on the first stage estimator will be avoided by implementing a stand-alone parameter error identification method. The uncertainties in parameters as well as latency issues in dynamic estimators will be accounted for via the use of robust estimation techniques. The project will also investigate observability issues to ensure that the dynamic estimator employs proper set of measurements for full state observability.

Cyber-attacks in power grids will be studied using a communication network model and game-theoretic solutions for both signature based and non-signature based detection of anomalous behavior in the smart grid cyber infrastructure will be proposed. Cyber vulnerabilities of PMUs (phasor measurement units) and data communication will be evaluated by simulating attacks using techniques such as malware.

Impact

- Prediction-based delay mitigation in dynamic estimators will maintain closed-loop stability in the presence of significant estimation latency and time-stamp inaccuracy. Improved estimates of dynamic states will allow more accurate control of turbine speed and frequency. It will also facilitate development of efficient dynamic security assessment tools given the availability of accurate
- Linear tracking state estimator will improve monitoring of voltage stability margins. Network parameter error identification will improve accuracy and reliability of utility system data bases.
- The proposed cyber security solutions will result in a robust cyber-threat detection technique and optimal counter-measure allocation scheme.
- The impact of attacks on PMUs and data communication networks will be demonstrated on LTB and HTB.

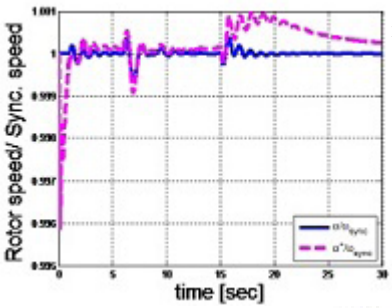

Figure 1 Dynamic state estimator with only Pe measurement

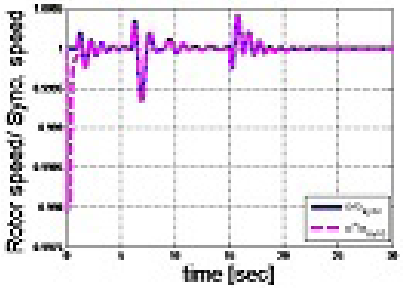

Figure 2 Dynamic state estimator with both Pe and Qe measurements

Figure 3 Communication network of the NPCC test system (Ethernet Model)

POINT OF CONTACT

Ali Abur
617.373.3051 (ph.)
617.373.4431 (fax)
a.abur@neu.edu
Northeastern

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