BIOGRAPHICAL SKETCH

Qing Feng is currently a Ph.D. candidate in the Department of Electrical & Computer Engineering at Tennessee Tech University, USA. Her research interests include smart grid, signal analysis, modeling and processing, MIMO Communication, high dimensional statistics, and data mining.

EDUCATION

Doctor of Philosophy
Engineering
Tennessee Tech University, December 2021 *(expected)*
Cookeville, Tennessee

Master of Science
Electronic Circuit and System
Northeast Normal University, 2010
Changchun, China

Bachelor of Engineering
Electronic Information Engineering and Technology
Engineering Normal University, 2004
Changchun, China

FUNDING

Center for Manufacturing Research(CMR)
Center for Energy Systems Research(CESR)
Electrical Engineering Department
National Science Foundation(NSF)
Carnegie Foundation

College of Engineering

TENNESSEE TECH

The Department of

Electrical and Computer Engineering

Announces the Dissertation Defense of

Qing Feng

In Partial

Fulfillment of the Requirements

For the degree of

Doctor of Philosophy in Engineering

October 20, 2021

4:30 p.m.

Tennessee Tech University

Zoom Link: https://tntech.zoom.us/j/82015289225

Meeting ID: 820 1528 9225

FIELD OF STUDY

Smart grid, Large-scale Power systems, Big data

DISSERTATION TOPIC

Early Detection of Power System Anomaly and Its Location Via Application of Random Matrix Theory to PMU Measurements

EXAMINING COMMITTEE

Dr. Ghadir Radman
Professor, Electrical and Computer Engineering

Dr. Charles Van Neste
Associate Professor, Electrical and Computer Engineering

Dr. Douglas Talbert
Associate Professor, Computer Science

Dr. Jeffrey Austen
Associate Professor, Electrical and Computer Engineering

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Research Professor
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ABSTRACT

With the recent developments in communication, computing, and sensing technologies, wide-area measurement system (WAMS) technology and phasor measurement unit (PMU) make online detection and monitoring more convenient. Due to the application of alternative clean energy resources in recent years, the scale of power networks has been dramatically increasing. However, handling a large amount of data with high dimensionality and rich information from advanced power electronics and devices becomes the main challenge to conventional detection methods. As a solution to this challenge, this work focuses on developing the methodologies of fault detection and fault location identification for large-scale power systems employing dynamic PMU measurements based on random matrix theory and big data technology.

The study proposed an early fault detection scheme for large-scale power systems in a non-Gaussian noise environment. Also, spatio-temporal correlations structures of PMU data are explored and determined by the factor model for anomaly detection. In addition, the study investigates the low PMU observability power system. An anomaly detection approach is carried out to increase the dimensionality of PMU measurements based on tensor augmentation. Furthermore, the study gives a data-driven scheme for fault location identification using correlation analysis. Fault location information can be extracted by analyzing the correlation between the influence factors and the system status from PMU data. Finally, a mathematical analysis of multiple line outages detection and localization for transmission systems based on free probability is studied. This methodology explores the polynomials of large random matrices in the background of big data analysis for a large-scale power grid.

The performances of this work are validated by utilizing standard, large, and synthetic systems, including IEEE 57-bus, IEEE 118 -bus, IEEE 300-bus, IEEE 2383-bus systems in different scenarios. The simulation results demonstrated that the presented schemes are more sensitive and robust than other statistic approaches, which are efficient methods applied to online monitoring and fast diagnosis for large-scale power systems.