COLLEGE OF ENGINEERING AND COMPUTER SCIENCE
FLORIDA ATLANTIC UNIVERSITY

Announces the Ph.D. Dissertation Defense of

Brittny Freeman

for the degree of Doctor of Philosophy (Ph.D.)

"A Framework for Non-Intrusive Ocean Current Turbine Rotor Blade Imbalance Fault Detection"

November 7, 2022, 2:00 pm.
Ph.D. Dissertation Defense
Zoom Link
Passcode: Fall2022

DEPARTMENT:
Electrical Engineering and Computer Science

ADVISOR:
Yufei Tang, Ph.D.

PH.D. SUPERVISORY COMMITTEE:
Yufei Tang, Ph.D., Chair
James VanZwieten, Ph.D.
Valentine Aalo, Ph.D.
Behnaz Ghoraani, Ph.D.

ABSTRACT OF DISSERTATION
Ocean current turbines (OCT) convert the kinetic energy housed within the earth's ocean currents into electricity. However, due to the harsh environmental conditions that these turbines operate in, their system performance naturally degrades over time. This degradation correlates to high operation and maintenance (O&M) costs, which necessitates the need for robust condition monitoring and fault detection (CMFD). Unfortunately, OCT operational data is not publicly available in large and/or diverse enough quantities to develop such frameworks. Therefore, from an industry-wide perspective, the technologies needed to harvest this energy source are still in their infancy. In an effort to alleviate the reliability, cost, and data acquisition concerns associated with marine electricity generation, this dissertation proposes three-pronged objectives: 1) The first objective is centered around developing an OCT rotor blade imbalance fault CMFD framework that leverages advancements in data science, signal processing, and machine learning to ensure that suitable performance metrics can be achieved with a low enough computational cost for real-world usage scenarios. To accomplish this first objective, the framework feeds fault features obtained from the frequency spectrums of OCT generator power signals into a K-Nearest Neighbor machine learning classifier for imbalance fault

detection; 2) The aim of the second objective is to improve the robustness of the framework by making it capable of compensating for the time-varying environmental changes that occur in real-world oceanic operating conditions. This objective is accomplished through the integration of pre-existing environmental knowledge related to current flow speeds and turbulence intensity into the machine learning pipeline of the proposed framework. This prior knowledge is then used to construct a physics-based loss function that alleviates inconsistent target labeling; and 3) The last objective circumvents some of the challenges associated with the lack of operational data in the OCT domain. This circumvention is achieved through the use of transfer learning, whereupon knowledge gained from the wind turbine source domain is transferred over to the OCT target domain. Two different transfer learning methodologies are combined via an ensemble-like fashion to improve model prediction accuracy with reduced amounts of training data. Evaluations of each objective are carried out via the implementation of comparative studies with other state-of-the-art methods in this field in order to validate the merit of our proposed innovations.

BIOGRAPHICAL SKETCH

Patterson, Georgia
B.S., Florida Atlantic University, Boca Raton, FL, 2014
Ph.D., Florida Atlantic University, Boca Raton, FL, 2022

CONCERNING PERIOD OF PREPARATION & QUALIFYING EXAMINATION

Time in Preparation: 2017 - 2022

Qualifying Exam Passed: Spring 2020

Published Papers:

Freeman, Brittny, Yufei Tang, Yu Huang, James VanZwieten, and Shawn Sheng. "Utilizing Wind Turbine Data for Ocean Current Turbine Rotor Blade Imbalance Fault Diagnosis via Transfer Learning." IEEE Journal of Oceanic Engineering (IEEE-JOE), 2022. (Under review)

Freeman, Brittny, Yufei Tang, Yu Huang, and James VanZwieten. "Physics-informed turbulence intensity infusion: A new hybrid approach for marine current turbine rotor blade fault detection." Ocean Engineering 254 (2022): 111299.

Freeman, Brittny, Yufei Tang, Yu Huang, and James VanZwieten. "Rotor blade imbalance fault detection for variable-speed marine current turbines via generator power signal analysis." Ocean Engineering 223 (2021): 108666.

Freeman, Brittny, Yufei Tang, and James VanZwieten. "Marine hydrokinetic turbine blade fault signature analysis using continuous wavelet transform." In 2019 IEEE Power & Energy Society General Meeting (PESGM). IEEE, 2019.