School of Computing, Engineering, and the Built Environment
Edinburgh Napier University

PHD STUDENT PROJECT

Funding and application details

Funding status: Self-funded students only

Application instructions:
Detailed instructions are available at https://www.napier.ac.uk/research-and-innovation/research-degrees/how-to-apply

Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.

Project details

Supervisory Team:
- DIRECTOR OF STUDY: Berk Canberk (Email: B.Canberk@napier.ac.uk)
- 2ND SUPERVISOR: Leandros Maglaras

Subject Group: Cyber-security and system engineering

Research Areas: Computer Science /networks, internet of things

Project Title: Digital Twin-based IoT Framework for Offshore Wind Supply Chain Management

Project description:
Offshore wind energy holds a vital role in generating sustainable energy resources by harnessing vast and consistent amounts of energy. However, the volatile and uncertain nature of wind resources coupled with the remote and harsh environments of offshore wind farms presents a complex set of challenges for supply chain management. To ensure the optimal level of functionality of the wind turbines and provide a seamless energy supply to the power grid, real-time data collection, online feedback mechanisms, production forecasts, demand predictions and predictive maintenance are required. Considering these, the Digital Twins (DTs) emerge as a vital technology for achieving these abilities. Here, DTs refer to

the autonomous virtual entities which can mirror and control the physical entities. For this, real-time bidirectional communication between diverse sets of devices in the supply chain and the DT is required to be established. Based on these, this project aims to design a DT-based IoT framework for Offshore Wind Energy Supply Chain Management. In the scope of this PhD study, the candidate will design a 4-layered DT architecture consisting of physical, connectivity, data modelling and cognitive layers. Novel communication models that support two-way synchronization, real-timeliness, and dynamic control will be researched and designed for digital twin networking. Additionally, the candidate will develop a novel DT model that covers devices and processes within the system and the simultaneous data pipeline for updating this model and performing trigger mechanisms, alert and notification systems. Consequently, the candidate will utilize this DT model for wind forecasting, dynamic production control based on demand analysis, early detection and diagnosis of turbine abnormalities, predictive maintenance and supply chain optimization applications in the cognitive layer. Perspective applicants are encouraged to contact the Supervisor before submitting their applications. Applications should make it clear the project you are applying for and the name of the supervisors.

References:

[1] Mihai, Stefan, Mahnoor Yaqoob, Dang V. Hung, William Davis, Praveer Towakel, Mohsin Raza, Mehmet Karamanoglu et al. "Digital twins: a survey on enabling technologies, challenges, trends and future prospects." IEEE Communications Surveys & Tutorials,2022.

[2] F. Jelti, A. Allouhi, M. S. Büker, R. Saadani, and A. Jamil, "Renewable Power Generation: A Supply Chain Perspective," Sustainability, vol. 13, no. 3, p. 1271, Jan. 2021, doi: 10.3390/su13031271.

[3] M. Fahim, V. Sharma, T. Cao, B. Canberk, T.Q. Duong, 'Machine Learning-based Digital Twin for Predictive Modeling in Wind Turbines', IEEE Access, 2022

Candidate characteristics

Education:
A second class honour degree or equivalent qualification in Electrical and Computer Engineering, or Energy Engineering

Subject knowledge:
- Energy Management,
- Renewable Energy,
- IoT,
- Data Management and Modelling,
- Simulation tools like Ansys, Anylogic, MathWorks Simulink, and programming languages like Python or C++

Essential attributes:
- Software engineering,
- Algorithm design,
- Machine learning,
- IoT and sensor networks,
- Communication networks

Desirable attributes:
- API management, real-time systems