



## **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://blogs.napier.ac.uk/scebe-research/available-phd-student-projects/>

*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: Chan Hwang See (Email: [C.See@napier.ac.uk](mailto:C.See@napier.ac.uk))
- 2<sup>ND</sup> SUPERVISOR: Naser Ojaroudi Parchin

**Subject Group:** Cyber-security and system engineering

**Research Areas:** Electronic Engineering

**Project Title:** Microwave Long Range Wireless Power Transfer System

**Project description:**

Wireless sensor network (WSN) is a cutting-edge technology with applications in every corner, ranging from space exploration, process/production, environment monitoring to healthcare inspection and disease diagnosis, and essentially forms the core of the Internet of Things (IoT) technology. Energy-harvesting devices allow the wireless sensor networks to be deployed to areas where the power cannot be accessed or with limited access. Thus, they enables a completely battery-less operation and reduces the operation cost of WSNs, which is mainly due to battery replacement, thus making it very important for a sustainable “near-perpetual” WSN operability.

Current approaches for deploying large-scale sensor networks involve miles of cabling that provide source power and collect data, or battery-operated wireless sensors, which pose a serious environmental risk with the disposal of billions of batteries every year. While these methods are necessary in some situations where real-time data or harsh environments prohibit manual monitoring of critical environment parameters, the cost, installation difficulty, and maintenance rarely justify their use over manual inspections and monitoring. Due to the above reasons, the concept of energy harvesting was introduced to alleviate this problem.

The project's aim is to develop an autonomous wireless sensor network system with energy transfer and harvesting capability. This work will focus on the development of RF energy harvesting systems for battery-less wireless sensor network. This research work will require to design, develop and implement a generic low-cost smart sensing environment and communication protocol for monitoring the nation's ageing infrastructure and harsh environment. Due to the complexity of the monitoring system requires the following published literatures to be explored: sensor systems, energy harvesting/transfer/storage technologies, antennas, wireless communications, autonomous systems, information management, programming and design tools, trust security and privacy, systems theory, human factors and social issues. It is also important that the system allows communication between different infrastructure owners. Hence there is a need to take a holistic approach rather than an infrastructure specific approach to tackle this problem.

This project is suitable for applicants with interests and good background in electromagnetics, battery/power management theory, cyber security and microwave engineering particularly in electromagnetic wave propagation, antennas, rectennas and antenna arrays for communication systems. Indicatively, applicants should have good performance in the following subjects: Electromagnetic Theory and Fields, Microwave and mm-Wave Transmission Systems and Devices, Sensors, Communication Principles/Theory, power/battery management and storage, Engineering Mathematics.

#### **References:**

- [1] X. Lu, P. Wang, D. Niyato, D. I. Kim and Z. Han, "Wireless Charging Technologies: Fundamentals, Standards, and Network Applications," in IEEE Communications Surveys & Tutorials, vol. 18, no. 2, pp. 1413-1452, Secondquarter 2016.
- [2] A. Foote and O. C. Onar, "A review of high-power wireless power transfer," 2017 IEEE Transportation Electrification Conference and Expo (ITEC), 2017, pp. 234-240, doi: 10.1109/ITEC.2017.7993277.
- [3] Huda SMA, Arafat MY, Moh S. Wireless Power Transfer in Wirelessly Powered Sensor Networks: A Review of Recent Progress. Sensors (Basel). 2022 Apr 12;22(8):2952. doi: 10.3390/s22082952. PMID: 35458935; PMCID: PMC9028858.

### **Candidate characteristics**

#### **Education:**

A first-class honours degree, or a distinction at master level, or equivalent achievements in Electrical & Electronic Engineering

**Subject knowledge:**

- Electromagnetism, antenna, battery, supercapacitor, renewable energies, cyber security, radio propagations and microwave theory

**Essential attributes:**

- Knowledge of renewable energies, wireless sensor network, Microwave/millimetre wave transmission systems and devices, cyber security, power analysis and wireless communication theory/principles
- Experience of fundamental antenna design and modelling
- Competent in Electromagnetics Theory and Fields
- Good written and oral communication Skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management
- self-starter

**Desirable attributes:**

- This project is suitable for applicants with interests and good back ground in renewable energies, radio propagations, electromagnetic and electromagnetics design and particularly in electromagnetic wave propagation, antenna and antenna arrays for communication