Department	School of Engineering and the Built Environment
Supervisors	DoS: Dr. Chan H. See, SS: Dr. Naser Parchin, Dr. Zhiyuan Tan
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 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 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 electromagnetics design and particularly in electromagnetic wave propagation, antennas 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, Engineering Mathematics.

Academic qualifications

A first degree (at least a 2.1) ideally in Electrical & Electronic Engineering with a good fundamental knowledge of Electromagnetism, antenna, renewable energies, cyber security, radio propagations and microwave theory.

English language requirement

IELTS score must be at least 6.5 (with not less than 6.0 in each of the four components). Other, equivalent qualifications will be accepted. Full details of the University's policy are available online.

Essential attributes:

- Experience of fundamental antenna design and modelling
- Competent in Electromagnetics Theory and Fields

- Knowledge of renewable energies, wireless sensor network, Microwave/millimetre wave transmission systems and devices, cyber security, power analysis and wireless communication theory/principles

- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management

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 communications systems and energy harvesting systems.

Indicative Bibliography	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. 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. 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.
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