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

PHD STUDENT PROJECT

Application instructions:
Detailed instructions are available at :
https://www.napier.ac.uk/research-and-innovation/doctoral-college/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: Dr Chan Hwang See (Email: c.see@napier.ac.uk)
- 2ND SUPERVISOR: Dr. Naser Ojaroudi Parchin and Dr. Dongyang Sun

Subject Group: Cyber Security and System Engineering

Research Areas: Computer Science: Internet of Things, Engineering: Communications Engineering, Electrical Engineering, Electronic Engineering, Systems Engineering

Project Title: Design and Development of Green Miniaturised Balanced Antennas and Antenna Arrays for Future Sustainable Electronics Devices

Project description:

The advances in wireless networks and electronics have led to the emergence of Wireless Sensor Networks (WSNs), which are considered to be one of the most important technologies that can revolutionize healthcare systems. This technology has impacted the medical devices field, replacing thousands of wires connected to traditional sensors as found in hospitals and providing enhanced mobility. However, miniaturization is one of the key requirements for both wearable and implantable devices.

Antenna is the key element in the wireless communication devices to transmit and receive radio signals. It acts as an omnipresent critical component in any wireless devices, i.e. smart phones, tablets, implantable wireless biomedical devices, radio frequency identification systems, radars, etc. Compact antenna reply on an EM

wave resonance, and therefore typically have a size of more than one-tenth of the EM wavelength. The limitation on antenna size miniaturization has made it very challenging to achieve compact antennas and antenna arrays, particularly at very-high frequency (VHF, 30-300 MHz) and ultra-high frequency (UHF, 0.3- 3GHz) with large wavelength, thus putting several constraints on implantable medical devices and Internet of Medical Things (IoMT) transceivers.

The aim of the proposed PhD research is to develop miniaturised antennas by using optimized structures/material combinations for biomedical wireless sensing and communication applications. By incorporating metamaterial structures, cellulose nanomaterials, conductive polymer and carbon nanotubes, the electromagnetic constitutive parameters of the host substrate can be enhanced and thus the size of the antenna reduced and the performances improved, i.e. impedance bandwidth, radiation characteristics, etc. The work proposed herein is novel and can be distinguished by its innovation to ultilise new flexible, renewable, biodegradable, recyclable materials as the device materials, with these, well-tailored magnetic and electric properties offer great potential in realizing compact antennas with adequate bandwidth and efficiency. The outcomes of this research will provide necessary leap within biomedical and wireless communication research to satisfy the ever-growing demands for miniaturised and “green” transceivers.

This project is a collaboration between two engineering research areas, i.e. Advanced Materials and Microwave Engineering within School of Computing, Engineering and the Built Environment (SCEBE). It is suitable for applicants with interests and good background in applied electromagnetics, materials science, and particularly in antenna/antenna arrays, metamaterial and nanocellulose.

References:

1. H. Nakano, T. Abe and J. Yamauchi, "Recent Progress in Circularly Polarized Meta-antennas," 2024 IEEE International Workshop on Antenna Technology (iWAT), Sendai, Japan, 2024, pp. 1-4, doi: 10.1109/iWAT57102.2024.

2. H. Nakano, T. Abe and J. Yamauchi, "Recent Progress in Circularly Polarized Meta-antennas," 2024 IEEE International Workshop on Antenna Technology (iWAT), Sendai, Japan, 2024, pp. 1-4, doi: 10.1109/iWAT57102.2024.

3. M.Alibakhshikenari, Bal. S. Virdee, S. Salekzamankhani, S. Aissa, C.H. See, N. Soin, S.J. Fishlock, A.A. Althuwayb ,R.A.Abd-Alhameed, I. Huynen, J.A. McLaughlin, F. Falcone, and Ernesto Limiti, “High-Isolation Antenna Array Using SIW and Realized with a Graphene Layer for Sub-Terahertz Wireless Applications,” Scientific Reports, vol.11, Article no. 10218, May 2021, https://doi.org/10.1038/s41598-021-87712-y

4. D.Wang, B.L.H. Saw, A. J. Onyianta, B. Wang, C. Wilson, D. O’Rourke, C.H. See, C-M. Popescu, M.Dorris, I.Shyha, Z.Lu, “Preparation of Elastomeric Nanocomposites Using Nanocellulose and Recycled Alum Sludge for Flexible Dielectric Materials”, Journal of Advanced Dielectrics, (Accepted, November 2022)

Candidate characteristics

Education:

A first degree (at least a 2:1) In Electrical & Electronic Engineering and Materials Science

Subject knowledge:

Knowledge of Electromagnetism, antenna, Physics, Advanced Materials, Metamaterial radio propagations and microwave theory

Essential attributes:

- Experience of fundamental antenna design and modelling
- Competent in Electromagnetics Theory and Fields
- Programming skills
- Knowledge of Microwave/millimetre wave transmission systems and devices, Physics, Metamaterials, radio propagations and wireless communication theory/principles
- Good written and oral communication skills
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Desirable attributes:

- This project is suitable for applicants with interests and good background 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