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: Prof Petros Karadimas (Email: p.karadimas@napier.ac.uk)
- 2ND SUPERVISOR: Dr Bruce Ryan

Subject Group: Cyber Security and Systems Engineering

Research Areas: Communications Engineering, Electrical Engineering, Electronic Engineering, Engineering Mathematics, Mathematical Modelling, Stochastic Processes

Project Title: Optimum antenna arrays for 6G wireless communications

Project description:

Antennas are the corner stone of wireless communications as they are responsible for transmitting and receiving the electromagnetic wave that carries the information message. Although a very classical topic with more than 100 years of history since the first wireless transmission, the design of optimum antennas remains a timely issue. Base stations employ antenna arrays to accommodate parallel data streams and increase data rate in multiple input-multiple output (MIMO) communication systems. Particularly, the antenna array should occupy a limited volume at the base station premises while ensuring optimum performance to meet the requirements of future 6G communications. Starting from a very thorough literature review, the PhD candidate will have to understand the radiation mechanisms of antennas and become familiar with the Maxwellian basis of antenna analysis and design. Accordingly, the PhD candidate will study existing antenna arrays and evaluate them according to certain key performance metrics (KPMs) such as the channel

capacity (CC) and energy efficiency (EE). The aforementioned step of studying and evaluating existing state-of-the art antenna arrays will enable the PhD candidate to gain significant experience to progress to the next level. That level and ultimate goal of this project is the PhD candidate to devise new optimum antenna arrays (at least three) that will show better performance, that is, higher CC and EE, compared to existing ones.

References

1. W. L. Stutzman and G. A. Thiele, “Antenna theory and design,” John Wiley & Sons, 2012.

2. A. S. Y. Poon, R. W. Brodersen and D. N. C. Tse, “Degrees of freedom in multiple-antenna channels: a signal space approach,” IEEE Transactions on Information Theory, vol. 51, no. 2, pp. 523-536, Feb. 2005.

3. J.-H. Lee and C.-C. Cheng, “Spatial Correlation of multiple antenna arrays in wireless communication systems,” Prog. Electromagn. Res., vol. 132, pp. 347-368, Oct. 2012.

4. Y. Huang, P. Karadimas and A. Pour Sohrab, “Spatial Channel Degrees of Freedom for Optimum Antenna Arrays,” IEEE Transactions on Wireless Communications, vol. 22, no. 8, pp. 5129-5144, Aug. 2023.

Candidate characteristics

Education:

Minimum 2:1 degree in Electrical/Electronic/Communications Engineering, Mathematics

Subject knowledge:

Electromagnetic Theory and Fields, Microwave and mm-Wave Transmission Systems/Devices, Communication Principles, Engineering Mathematics, Algorithms, Optimization Theory

Essential attributes:

- Knowledge of Electromagnetic Theory and Fields, Microwave and mm-Wave Transmission Systems/Devices, Communication Principles, Engineering Mathematics, Algorithms, Optimization Theory.
- Competent in Electromagnetic Wave Propagation, Antennas, Antenna Arrays, Programming
- Strong motivation with evidence of independent research skills relevant to the project
- Good written and oral communication skills
- Good time management

Desirable attributes:

- Experience with programming environments such as Matlab