

Project Title: Optimising robotic platforms for terahertz detection of cancer

Supervisor: Prof Emma MacPherson (Physics) and Imran Aslam (University Hospital of Coventry and Warwickshire)

Are you interested in applying physics to situations that could benefit medical diagnosis? Terahertz (10^{12} Hz, THz) pulsed imaging is a new technique with high resolution (about $20\ \mu\text{m}$) and has only emerged recently as a potential new clinical tool for medical imaging. It is a totally non-destructive and non-ionising imaging modality as the average power of the pulse for producing the radiation is as small as 100 nW. The radiation produced is focused onto the sample of interest and then detected coherently. A point measurement is analogous to an ultrasound A-scan.



Reflections off different layers are used to determine the structure at various depths. THz light is very sensitive to hydrogen bonds. By Fourier transforming the time-domain data, useful spectroscopic information can also be revealed. Potential applications range from security imaging to medical diagnosis, but the analysis and instrumentation needs to be tailored for each application investigated. THz light can be generated and detected using photoconductive antennas. The useable frequency range of a THz system depends on the photoconductive devices as well as other factors such as optical alignment.

The aim of this project is to take accurate and repeatable robotically controlled non-contact THz measurements of skin with a view to developing classification algorithms for skin cancer and potentially other skin conditions. For example, it may be possible to use THz imaging to detect early stages of skin cancer, or the lateral extent of tumours that are beneath the skin's surface, and not yet visible. Applicants do not need a medical background, more importantly, they need an interest in robotics, programming, optics and data analysis.

Prof MacPherson joined Warwick University in 2017 and received a Wolfson Merit award to support her research in the UK. For more background information regarding the Ultrafast THz Photonics group and Prof MacPherson's research interests, please see <https://warwick.ac.uk/fac/sci/physics/research/condensedmatt/ultrafastphotonics> and <https://warwick.ac.uk/fac/sci/physics/research/condensedmatt/ultrafastphotonics/emmasthzgroup/>. The PhD project will be linked with the £8M Terabotics Programme grant [Terabotics Programme Grant \(warwick.ac.uk\)](#) and will have links with the University Hospital of Coventry and Warwickshire (UHCW) as well as the University of Leeds and The university of Exeter.

UHCW is a leading robotic surgery centre in United Kingdom offering a range of robotic procedures for wide range of specialities. Ongoing collaborative research with the School of engineering at Warwick University is currently supporting 3 postgraduate research students studying cardiovascular, hormonal, and physical stress of surgeons performing robotic surgeries. The expertise of this collaborative group includes cardiovascular variability in stress machine learning, artificial intelligence, and automation in clinical robotics. The department of colorectal surgery holds grants for research around stress and fatigue amongst surgeons performing robotic surgery and for clinical outcomes for robotic surgery performed for inflammatory bowel diseases. In addition, UHCW holds databases for clinical outcomes of procedures performed through robotic platform. Recently established Institute for Applied & Translational Technologies in Surgery has a dedicated theme for

clinical robotics and research around utility of robotics for complex surgery for which Prof Aslam is a co-lead. UHCW offers various clinical fellowships in robotic surgery for the training of senior trainees in the United Kingdom. Modular training offers exposure to the utility of robotic platform and training about minimally invasive procedures performed in controlled and safe environment. In this project you will have access and exposure to learn about these platforms.

For further information do not hesitate to contact Prof MacPherson directly on e.macpherson@warwick.ac.uk This is a fully funded-PhD studentship at standard UK Research Council rates, available with a flexible start date from October 2024 onwards for a 3.5 year period. The Studentship covers university fees and a living stipend, and is available to UK and potentially international students.

For more information please see <http://go.warwick.ac.uk/PhysicsPG> .