ESPRC DOCTORAL TRAINING PARTNERSHIP PHD STUDENTSHIP 2019/2020 ENTRY

| Title |
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| Modelling and experimental study of capsule locomotion in the small intestine for endoscopic diagnosis |
| **Theme** |
| Robotics and Autonomous Systems |
| **Location** |
| University of Exeter, Streatham Campus, Exeter EX4 4QJ |
| **Primary Supervisor** |
| Dr Yang Liu, Department of Engineering, College of Engineering, Mathematics and Physical Sciences |
| **Additional Supervisors** |
| Dr Shyam Prasad, Consultant Gastroenterologist and Lead for Endoscopy at the Royal Devon and Exeter NHS Foundation Trust (RDEFT) |

| Project description |
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| Gastrointestinal (GI) disease is the third most common cause of death, the leading cause of cancer death, and the most common cause of hospital admission. The burden of GI disease in the UK is heavy for patients, the National Health Service (NHS), and the economy. Endoscopy plays a vital role in the diagnosis of GI disorders, and the demand for GI endoscopy has doubled in the past 5 years, with on-going growth of 6.5% per annum predicted by the NHS.<br><br>Since its introduction into clinical practice 15 years ago, capsule endoscopy has become established as the primary modality for examining the surface lining of the small intestine, an anatomical site previously considered to be inaccessible to clinicians. However, its reliance on peristalsis for passage through the intestine leads to significant limitations, in particular due to the unpredictable and variable locomotion velocity. Significant abnormalities may be missed in a minority of cases, due to intermittent high transit speeds that lead to incomplete visualisation of the intestinal surface. Furthermore, each case produces up to 100,000 still images, from which video footage is generated, taking between 30 and 90 minutes for the clinician to examine in its entirety. The procedure is therefore considered both time-consuming and burdensome for clinicians.<br><br>There is, therefore, in GI endoscopic practice a desperate need for new modalities that are safe, painless, accurate, reliable and disposable, and which require minimal training for practitioners. A prototype of the self-propelled capsule robot driven by internal excitation and impact has been developed in Dr Liu's laboratory at Exeter. Now, this project will focus on the study of capsule-intestine interaction, including both static and dynamic, through numerical modelling and experimental investigation in order to optimise this prototype for efficient and reliable endoscopy.<br><br>The selected PhD student will develop a realistic mathematical model to predict the locomotion of the capsule robot in the human small intestine by considering its natural peristalsis and food fluids. Computational fluids dynamics analysis by using ANSYS Fluent will be used to understand the behaviour of the capsule, and finite element analysis by using ANSYS will also be required to |

evaluate the influence of the vibrational behaviour of the capsule on the intestinal wall and the consequent causes on patients. Both numerical analysis and experimental investigation will be carried out.

The PhD candidate will have the opportunity to work with the clinicians in the Royal Devon and Exeter NHS Foundation Trust (RD&E), so frequent travel between the University of Exeter and RD&E will be required.

The candidate with the knowledge of applied mechanics, having the experience of mechanical design and experimentation, and desiring to contribute novel healthcare technology would extremely suitable for this position.