2021 Summer School:
Surgical & Interventional Engineering

28th June 2021 – 2nd July 2021

Organisers:
Dr Christos Bergeles, Associate Professor, Surgical Robotics
Dr Wenfeng Xia, Assistant Professor, Photoacoustics

Summer School Schedule

Date:	Monday 28/06/2021	Tuesday 29/06/2021	Wednesday 30/06/2021	Thursday 01/07/2021	Friday 02/07/2021
Topic:	**Interventional Devices**	**Product Development**	**Biophotonics**	**Surgical AI and Planning**	**Computational Modelling**
11:00 – 12:00	Dr Christos Bergeles	Dr Clare Heaysman	Dr Wenfeng Xia	Dr Rachel Sparks	Dr Thomas Booth
12:00 – 13:00	Dr Hongbin Liu	Dr Valentina Vitiello	Prof Daniel Elson	Prof Tom Vercauteren	Prof Silvia Schievano
13:00 – 14:00	Lunch and Break-out Sessions | Participant Teasers				
14:00 – 15:00	Dr Dana Damian	Prof Prashant Jha	Prof Ton van Leeuwen	Dr Evans Mazomenos	Prof Alistair Young
15:00 – 16:00	Dr George Mylonas		Prof Lianzhong Xiang	Dr Stamatia Giannarou	Dr Martin Bishop
16:00 – 17:00	Prof Prokar Dasgupta		Dr Simeon West	Dr Jonathan Shapey	Dr Adelaide De Vecchi

~~~ All times are UTC+1 (UK Summer Time) ~~~
~~~

Interventional Devices

Monday 28th June 2021

11:00 – 17:00

Dr Christos Bergeles

Title

Concentric tube robot design and control for surgical interventions

Abstract

Concentric tube continuum robots can navigate anatomical pathways to reach deep seated pathology locations. Their flexible structure makes them ideal intraluminal navigation and operation in confined spaces. Critically, however, their flexibility comes at the expense of manipulability, force capability, workspace, intuitiveness and operational safety. This talk will discuss modelling of those robots, also visiting the fields of machine learning for kinematics and inverse kinematics derivation. Patient- and surgery- specific design processes for optimal operational capability of the robots will be presented. The talk will conclude with new control algorithms that consider the inherent non-holonomic constraints of these elongated slender continuum robots, showing how mechanical instabilities and control «local minima» can be avoided.

Bio

Christos Bergeles is Associate Professor at King's College London, United Kingdom, and Deputy Director of the Centre for Doctoral Studies on Surgical & Interventional Engineering. His research focuses on the development of image-guided micro-surgical systems, crossing the boundaries between smart instrumentation and artificial intelligence. The mission of his team, the Robotics and Vision in Medicine Lab, is to develop flexible robotic systems that deliver regenerative therapies with micrometer precision. Key experience includes the development of robust mechatronic systems that adhere to clinical requirements to facilitate their translation. Close collaboration with expert clinicians ensures that the develop ed systems are fit for purpose, and speeds up the process of delivering patient benefits. Christos is the recipient of the ERC Starting Grant (2017 - 2023) and the Fight for Sight award (2014) from the Royal College of Ophthalmologists.

Dr Hongbin Liu

Title

Robotic Haptic Sensing and Interaction for surgery and intervention

Abstract

Haptic capability, both sensing and interaction, is essential for a robot working in unstructured environments, yet robotic haptic technology today is still very primitive compared to even the simplest biological creatures. Haptic interaction is a cornerstone of many medical interventions/practices to ensure safety and efficacy. Our lab designs robots with advanced haptic perception and interaction capabilities to address unmet needs in medicine, enabling safer and more effective diagnosis and treatment. We commit our work to benefit both patients and the medical profession while advancing the frontier of haptic robotics research. In this lecture, I will share our experience of how to create augmented haptic sensing for medical instruments, and how we achieve effective haptic interaction during diagnosis and robotic endoscopy.

Bio

Dr Hongbin Liu is a Reader in the School of Biomedical Engineering and Imaging Sciences, Faculty of Life Sciences & Medicine, King's College London (KCL) where he is directing the Haptic Mechatronics and Medical Robotics (HaMMeR) Laboratory. Dr. Liu obtained his BEng in 2005 from Northwestern Polytechnical University, China, MSc and PhD in 2006 and 2010 respectively, both from the Division of Engineering, KCL. He is a member of the IEEE, and a Technical Committee Member of IEEE EMBS BioRobotics. He has published over 100 peer-reviewed publications at top international robotic journals and conferences and is inventor for 6 patents. His research has been funded by EPSRC, Innovate UK, NHS Trust and EU Commissions. His current research focuses on developing soft robotic systems for assistive minimally invasive surgical interventions, with strong collaborations from IBM and Ericsson.

Dr Dana Damian

Title

Implantable robots: Challenges, Progress and Opportunities

Abstract

In this seminar I will discuss about implantable robots - these are robots that reside inside the body for medium to long-term in order to restore a biological function or structure.
The in vivo technological endeavors made so far have provided a glimpse of the challenges of the therapeutic tissue-device interaction: harsh, dynamic and sometimes difficult-to-access biological environment, but also the limited endurance or efficacy of the underlying technologies.
We will look at some of the technical challenges that arise from turning an apparent adverse tissue-device interaction into an engineered synergetic responsive therapy. We will emphasise on soft implants design and modelling, tissue therapeutic stimulation optimisation and robot resilience for regenerative medicine applied to the gastrointestinal tract.

Bio

Dana D. Damian is a Lecturer in the Department of Automatic Control and Systems Engineering at the University of Sheffield since 2015. She received her diploma in computer science and engineering from the Technical University Timisoara, Romania in 2007. She received her PhD in 2012 from University of Zurich working on soft sensing for prosthetics. In 2011 she was a visiting scholar for one year at Johns Hopkins University and Stanford University, U.S.A. working on haptics for prosthetics. In 2012 she was a visiting scholar at Carnegie Mellon University, U.S.A., working on wearable soft sensors. From 2013 to 2015, she was a postdoctoral research fellow at Boston Children's Hospital, Harvard Medical School, U.S.A., where she worked on robotic implants. Her research interests reside in the area of medical robots and bionic technology, aspiring to create sustainable robots for long-term personalized assistance.

Dr George Mylonas

Title

Necessity is the mother of invention in surgical robotics (also)

Abstract

The seminar presents a potpourri of developed interventional and diagnostic devices, sensing methodologies for soft robotic devices, and perceptual human-robot interfaces. The process of invention and innovation is highlighted as the result of real clinical need and respective solutions are described. Projects to be discussed include: the Cyclops robot, EndoDrone, SIMPLE, LaryngoTORS, Electrical Impedance Tomography for shape sensing in soft robots, human gaze interfaces in the Smart OR.

Bio

George is the lead of the Human-centred Automation, Robotics and Monitoring in Surgery (HARMS) lab at The Hamlyn Centre, Institute of Global Health Innovation at Imperial College. He is leading research in the areas of surgical robotics, minimal access surgical technology, cyber-physical systems, perceptual human-robot and human-computer interfaces, Smart operating theatre. His work has won several awards, most recently the Best Surgical Robotics runner up at ICRA'19, Gerhard Buess Best Technology Award of the European Association of Endoscopic Surgery (EAES) 2018, Advanced Technology Award of the International Society for Medical Innovation and Technology (iSMIT) 2017, Best Innovation Award, B.E.S.T. Innovation Symposium, IRCAD/IhU 2016. He holds several patents in the areas on diagnostic and interventional technologies and perceptual interfaces, and has licensed such technologies to medtech, notably the CYCLOPS surgical robot platform, and a method and system for stereo gaze tracking in robotic surgery. George serves in key positions and roles, notably the Technology Committee of the European Association of Endoscopic Surgery (EAES). He is serving in the Board of journals such as Frontiers in Robotics and AI, Applied Sciences-Applied Biosciences and Bioengineering, Journal of Minimally Invasive Therapy & Allied Technologies, and as associate editor, programme and organising committee of numerous conferences, including ICRA, IROS, MICCAI, CRAS, HSMR.

Product Development

Tuesday 29th June 2021

11:00 – 17:00

Dr Clare Heaysman

Title

Regulations and Quality Management in Product Development

Abstract

The high standards of quality and safety for medical products are set out in regulation; protecting the health of patients and users by ensuring all products meet established safety and performance requirements. This seminar will introduce regulatory requirements and processes for quality management used in the development of clinically usable medical devices and discuss best practises to consider in ‘bench-to-bedside’ translational research projects.

Bio

Dr Clare Heaysman is the Medical Engineering Quality Systems Manager in the Wellcome/EPSRC Centre for Medical Engineering. Clare started working with academic groups on applying the design practices adopted by regulated industries in translational research projects in 2014. She also has 10 years’ experience working in industry on the design and development of drug-device combination products for interventional oncology, generating intellectual property and working on the technical transfer from academic and industrial partners.

Dr Valentina Vitiello

Title

The translational research pathway: from research prototype to clinical product

Abstract

This talk will focus on the different steps of the translational research pathway and what are the main requirements, challenges and regulatory considerations for the successful clinical adoption of novel medical technology. Common pitfalls will be addressed for each step, providing a framework that considers all aspects of medical device development within an academic environment.

Bio

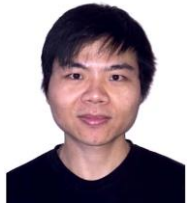
Valentina is Specialist Technical Operations Manager at King's College London, where she manages the GIFT-Surg research programme and is responsible for maintaining regulatory processes for an engineering facility for medical device development and testing. She is a Medical Engineer by training and was awarded the PhD in Medical Robotics from Imperial College London in 2012. During her PhD and post-doc, she was involved with all aspects of the development of robotic devices for surgery and gained extensive experience with in vivo deployment of prototypes during pre-clinical live animal trials and clinical human trials, including ethical and regulatory approval matters for medical device certification and clinical translation.

Prof Prashant Jha

Biophotonics

Wednesday 30th June 2021
11:00 – 17:00

Dr Wenfeng Xia



Title

Photoacoustic ImagingforSurgical and Interventional Applications

Abstract

Photoacoustic imaging is a hybrid imaging modality that inherits some of the advantages from both optical and ultrasound imaging, providing spectroscopic tissue contrast at highly scalable spatial resolution, field of view and tissue penetration depths. Photoacoustic imaging has matured over the last two decades with a wide range of demonstrated preclinical and clinical applications. In this lecture, we will discuss the principles of photoacoustic imaging and its applications for guiding surgical and interventional procedures.

Bio

Wenfeng Xia is a Lecturer in the School of Biomedical Engineering & Imaging Sciences at King's College London, UK. He received a BSc in Electrical Engineering from Shanghai Jiao Tong University, China, and a MSc in Medical Physics from University of Heidelberg, Germany, in 2005 and 2007, respectively. In 2013, he obtained his Ph.D from University of Twente, Netherlands. From 2014 to 2018, he was a Research Associate in the Department of Medical Physics and Biomedical Engineering at University College London. His research interests include non-invasive and minimally invasive photoacoustic imaging, and ultrasound-based medical devices tracking for guiding surgical and interventional procedures.

Prof Daniel Elson

Title

Surgical imaging with emerging optical techniques

Abstract

Optical imaging in the operating theatre is now about more than simply imaging the colour of tissue under reflected white light illumination. Techniques such as near infrared fluorescence imaging, multispectral imaging, polarization-resolved imaging and optical coherence tomography are starting to play a role in intrasurgical diagnostics and guidance. Some of these emerging techniques will be introduced as well as some of their implementations into open and endoscopic surgical settings.

Bio

Daniel Elson is a Professor in the Hamlyn Centre for Robotic Surgery, Department of Surgery and Cancer and the Institute of Global Health Innovation. Research interests are based around the development and application of photonics technology with endoscopy for surgical imaging applications, including multispectral imaging, polarization-resolved imaging and fluorescence imaging. Further projects include work on the development of illumination and vision systems for endoscopy combining miniature light sources such as LEDs and laser diodes with computer vision techniques for structured lighting and tissue surface reconstruction as well as the robotic guidance of optical probes. These devices are finding application in minimally invasive surgery and in the development of new flexible robotic assisted surgery systems.

Prof Ton van Leeuwen

Title

Optical coherence tomography: principles and clinical applications

Abstract

Optical coherence tomography (OCT), the optical analogue of US imaging, is an imaging technique in which low coherence interferometry is used to produce depth resolved complex-valued backscatter profiles of (biological) samples up to a few milliliters deep. Because the OCT signal is dependent on the optical properties of the tissue under study, OCT has created a wealth of methods in order to measure numerous parameters of tissue and relate these to physiology and disease. The attenuation of the OCT signal is directly related to scattering coefficient, which can be related to the grade of tumors. The amplitude of the OCT signal is directly related to the back-scattering properties of the tissue. Axial movement of probed tissue can be quantified using the Doppler shift, while lateral movement can be quantified by measuring the decorrelation of the OCT signal. In this presentation, principles of OCT and clinical applications will be addressed.

Bio

Ton van Leeuwen graduated in physics at the University of Amsterdam in 1989. After his PhD and post doc at the Lab. for Exp. Cardiology at the UMC Utrecht and an ICIN fellowship at CWRU (Cleveland), he became staff member of the Laser Center at the AMC. In 2001, Ton was appointed as professor in Clinical Application of Biomedical Optics at the University of Twente, at which he headed the Biomedical Optics group from 2003 - 2008. In 2008 he was appointed as professor in Biomedical Photonics and head of the new BME & Physics department at the Academic Medical Center of the University of Amsterdam, currently named the Amsterdam UMC. In 2009, he was appointed as full professor in Biomedical Physics. Current research focuses on the physics of the interaction of light with tissue, and to use that knowledge for the development, introduction and clinical evaluation of (newly developed) optical imaging techniques for gathering quantitative functional and molecular information of tissue.

Prof Liangzhong Xiang

Title

Next Generation Ultrasound-Guided Interventions

Abstract

We explore new ways to generate ultrasound for theragnostics. Specifically, we use varies radiations (X-ray, laser, and electrical field) to treat diseases, simultaneously it will produce ultrasound waves for image-guided interventions. This talk will cover three primary research areas: 1) X-ray-induced acoustic computed tomography (XACT) for precision radiotherapy; 2) electroacoustic tomography (EAT) for irreversible electroporation (IRE) monitoring; and 3) photoacoustic imaging (PAI) image-guided laser therapy. Prospects and challenges for the clinical implementation of these techniques will be discussed. The successful development of these technologies will expand the current clinical paradigm towards precision medicine.

Bio

Liangzhong (Shawn) Xiang is a tenured associate professor with joint appointments in the Departments of Biomedical Engineering and Radiology, and Faculty Innovation Fellow at University of California, Irvine (UCI). He is also a core faculty member in Beckman Laser Institute and Medical Clinic, and Chao Family Comprehensive Cancer Center at UCI. Dr. Xiang's lab focuses on biomedical imaging and image-guided treatment. Before joining UCI, he was awarded the Lloyd G. and Joyce Austin Presidential Professorship at The University of Oklahoma (OU). Prior to OU, he completed his postdoctoral fellowship training in medical physics at Stanford Medical School where he was awarded the DoD Prostate Cancer Postdoctoral Fellowship.

Dr. Xiang is the recipient of the NIH MERIT Award (R37), and Research Scholar from the American Cancer Society. Dr. Xiang has served as conference chairs for the 2019 AAPM annual meeting and 2018 CIOP. He served as an SPIE Student Chapter advisor, editorial board members of numerous international journals, and grant reviewer for the NIH, Department of Energy (DOE), Russian Science Foundation (RSF), Helmholtz Association of German Research Centre, and ETH Zurich.

Dr Simeon West

Title

Guidance of minimally invasive peripheral vascular access procedures using LED-based photoacoustic imaging

Abstract

In this lecture we will explore the practices and pitfalls of vascular access using conventional imaging, and the potential advantages and disadvantages of LED PAI in this field.

Bio

Dr Sim West is a consultant anaesthetist with a special interest in regional anaesthetic nerve blocks and ultrasound at University College Hospital London. His research interests include novel imaging modalities and medical device tracking, as well as clinical research into novel nerve blocks.

Surgical AI and Planning

Thursday 1st July 2021

11:00 – 17:00

Dr Rachel Sparks

Title

Computer-Assisted Planning & Simulation for Image-guided Neurosurgery

Abstract

Dr. Rachel Sparks will describe how her research into advanced medical image computing and computer-assisted planning can provide image-guidance address challenges in treatment efficacy and safety in neurosurgery. She will describe novel deep learning methods to segment brain structures, how segmented structures can be used for planning keyhole neurosurgery, and advanced modeling and simulation techniques to improve planning and treatment.

Bio

Rachel Sparks joined as a Lecturer in Surgical and Interventional Engineering at the School of Biomedical Engineering & Imaging Sciences, King's College London in 2018. The primary focus of her research is on developing computer-assisted planning and image-guidance techniques to increase accuracy of medical diagnosis and improve safety during surgical interventions. This work involves building patient-specific models to provide quantitative measures of risk and efficacy related to surgical interventions, including the placement of tools, removal or treatment of tissue. Ongoing work is focused on using deep learning to improve diagnosis and prognosis in brain disorders, with a focus on epilepsy.

Prof Tom Vercauteren

Dr Evans Mazomenos

Title

Surgical data science enabling intelligent, performance-aware interventions

Abstract

Surgical data science leverages information from heterogeneous data sources towards improving the quality of interventional healthcare. Objective surgical skill assessment is essential throughout surgeons' careers including in-training evaluation, mentoring, certification, as well as end of career decisions. This talk will present some of the methodologies and current progress in the application of data science for surgical skill assessment and discuss its potential for novel solutions in surgical training and simulation, events and clinical outcomes prediction, decision-making and planning and surgical robotics.

Bio

Evangelos Mazomenos is a Lecturer in Interventional and Surgical Sciences at UCL Medical Physics and Biomedical Engineering and UCL WEISS. Previously he held the position of University Academic Fellow at the University of Leeds and Senior Research Associate at UCL Computer Science and WEISS/CMIC. He his PhD in Electronics and Electrical Engineering from the University of Southampton in 2012, for which he was awarded the Institute of Engineering and Technology Leslie H. Paddle Scholarship in 2009. His main research investigates data science and computer vision for performance evaluation and workflow analysis in image-guided interventions. His work also involves surgical robotics, biomedical informatics, and embedded sensing systems.

Dr Stamatia Giannarou

Title

Surgical Vision for Robot-Assisted Neurosurgery

Abstract

Surgery is undergoing rapid changes driven by recent technological advances and our on-going pursuit towards early intervention and personalised treatment. The future of surgical oncology is the integration of novel intraoperative imaging techniques to enable in vivo-in situ diagnosis and therapy and allow for more accurate tumour margin delineation. The main challenges to such integration are the intraoperative surgical navigation, the scanning of large tissue surfaces with imaging probes, the tissue characterisation and the safety during resection by protecting important anatomical regions and healthy tissue. In this talk, I will present an intraoperative vision system for surgical navigation during robot-assisted neurosurgery to enable efficient robot-assisted tissue scanning with imaging probes. The focus will be on the soft tissue tracking, the reconstruction of 3D morphological structures in the presence of deformation, intraoperative see-through vision and the vision-based tissue deformation recovery for intraoperative force estimation of tool-tissue interaction.

Bio

Stamatia (Matina) Giannarou received the MEng degree in Electrical and Computer Engineering from Democritus University of Thrace, Greece in 2003, the MSc degree in communications and signal processing and the Ph.D. degree in image processing from the department of Electrical and Electronic Engineering, Imperial College London, UK in 2004 and 2008, respectively. Currently she is a Royal Society University Research Fellow and a Lecturer in Surgical Cancer Technology and Imaging at the Hamlyn Centre for Robotic Surgery, Department of Surgery and Cancer, Imperial College London, UK. Her research focuses on enhanced surgical vision for intraoperative navigation in minimally invasive and robot-assisted operations. In 2017, she won “The President’s Award for Outstanding Early Career Researcher” at Imperial College London. She received best paper awards at international conferences and symposia including the “Rank Prize Symposium on Medical Imaging Meets Computer Vision 2013”, the M2CAI-MICCAI 2014, IPCAI 2016, AE-CAI-MICCAI 2020, IPCAI 2020.

Dr Jonathan Shapey

Title

Hyperspectral imaging for neurosurgery: transforming intraoperative visualisation

Abstract

Each year in the UK, approximately 70,500 patients are diagnosed with a brain tumour, 5,000 of whom undergo surgery. Brain tumour surgery involves removing as much of the tumour as safely as possible. If all tumour is removed, patients have significantly better outcomes and live longer. However, even with the best hands and the most modern technology currently available, it is often not possible to reliably identify tumour during surgery. Due to this uncertainty and the need to balance risks, tumour is often left behind. Today, close to 30% of brain tumour patients require repeat surgery owing to tumour left behind during their first surgery. Further surgeries are more difficult, pose additional patient risks and lead to increased healthcare costs with often poor patient outcomes. Recent smart camera systems have the potential to enhance the surgeon's vision to more reliably identify tumour and healthy brain structures. We will discuss hyperspectral imaging (HSI), one of the most promising of such technologies providing rich information that is invisible to the human eye and has the potential to provide crucial, but currently unavailable, information about tumour and other critical brain structures during surgery.

Bio

Jonathan Shapey is a Consultant Neurosurgeon at King's College Hospital and Senior Clinical Lecturer within the Department of Surgical and Interventional Engineering, King's College London. After completing specialist training in neurosurgery in 2016 he subsequently undertook a prestigious Royal College of Surgeons Senior Clinical Fellowship in skull base and endoscopic pituitary surgery. This was followed by a Clinical Research Fellowship at UCL where he completed his doctoral studies in Integrated navigation and visualisation for skull base surgery.Jonathan led the pre-clinical development of an intraoperative hyperspectral imaging system for neurosurgery and is now leading the project's clinical development. Jonathan's other research interest includes the development of data-driven clinical support tools using machine learning and artificial intelligence technology.

Computational Modelling

Friday 2nd July 2021

11:00 – 17:00

Dr Thomas Booth

Title

Clinical and biomedical engineering synergy in brain research

Abstract

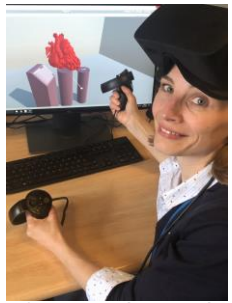
By the end of the seminar you will be able to:

- Describe interventional neuroradiology.
- Discuss interventional neuroradiology collaborative research at KCL/KHP: stroke treatment in 2030s
- Describe diagnostic neuroradiology.
- Understand diagnostic neuroradiology collaborative research at KCL/KHP: AI biomarkers to improve clinical processes in 2020s.

Bio

Thomas C Booth is a Senior Lecturer in Neuroimaging in the School of Biomedical Engineering & Imaging Sciences at King's College London. He is also an Honorary Consultant Diagnostic and Interventional Neuroradiologist at King's College Hospital, London. His PhD from the University of Cambridge included employing machine learning to brain tumour images. His interests include neuro-oncology and neurovascular research. He enjoys collaborating with his Biomedical Engineering colleagues using imaging biomarkers of abnormalities as well as biomarkers of brain tumour treatment response, particularly employing machine learning. On the neurovascular side, he enjoys collaborating with his Biomedical Engineering colleagues on stroke imaging and aneurysm procedural work. He is reminded continuously how important interventional neurovascular procedures are when treating patients in a busy London teaching hospital. Similarly presenting images in clinical meetings highlights the importance of developing good biomarkers. He sits on the National Cancer Research Institute Brain Tumour Committee and the Royal College of Radiologists Academic Committee. He was an awardee of the inaugural Royal College of Radiologists Outstanding Researcher Award.

Prof Silvia Schievano



Title

From Mechanical Engineering to Children's Heart and Head Diseases

Abstract

Children with congenital diseases, compared to adult patients with acquired conditions, typically present with a wide range of anatomies and conditions, that are often unique and complex, and that change as the child grows. The development of devices and tools designed for children lags decades behind those for adults, due to the complexity of the diseases, but also to the far smaller market, which makes it difficult for companies to invest in R&D for such devices. Thus, clinicians have to make do; they engineer solutions, adapting available adult devices and tools, and deal with the extra challenges that come with options not purposely designed for children, resulting in higher risks for patients and suboptimal outcomes. Innovative approaches and methods need to be developed and adopted to design solutions for children and young adults born with physical defects. This seminar will show some examples of computational modelling, patient specific treatment planning and device customisation to tailor treatment in cases of congenital, cardiovascular and craniofacial diseases.

Bio

I am Professor of Biomedical Engineering at UCL Institute of Cardiovascular Science, GOS Institute of Child Health & Great Ormond Street Hospital for Children. After my Master degree in Engineering at Politecnico di Milano, I joined the Cardiorespiratory Unit of Great Ormond Street Hospital for a PhD programme sponsored by the British Heart Foundation. In 2013, I was appointed as a Lecturer at UCL & Great Ormond Street Hospital where I have been leading since on engineering research in congenital diseases. My areas of interest focus on the application of engineering methodologies to support the clinical decision making process and surgical/interventional treatments; modelling of biomedical devices, in particular toward the development of patient specific models to study disease and treatments; development of computational methods to accelerate the biomedical product development process and enhance safety in first-in-human procedures.

Prof Alistair Young

Title

Monitoring Biventricular Disease Progression in tetralogy of Fallot

Abstract

Tetralogy of Fallot is a common congenital heart disease, with an incidence of 1 in 3600 live births. Most cases need early intervention within a few months after birth, with repair of the ventricular septal defect and reconstruction of the right ventricular outflow tract. With recent advancements in cardiovascular surgery, more patients are living into adulthood. However, the pulmonary valve is often disrupted, leading to a chronic regurgitation of blood back into the right ventricle, leading to dilatation, clinical decline (exercise intolerance, arrhythmia, and heart failure), and an increased risk of sudden cardiac death. Many patients require constant monitoring, including evaluation of right and left ventricular (biventricular) function and mass. An important clinical decision is when(and if) the pulmonary valve should be replaced. If left too late, heart function does not recover. If performed too early, additional interventions may be required later, and complications arising from multiple surgeries over time can lead to adverse outcomes. This talk will describe new methods for evaluating biventricular heart function and shape, which may provide additional information useful in the optimization and timing of treatment.

Bio

Professor Alistair Young is Professor of Cardiovascular Data Analytics and AI at King's College, London. He leads the Cardiac Atlas Project which seeks to provide cardiac imaging data and analysis tools to the research community for quantification of heart shape and function changes in cardiovascular disease, including congenital heart diseases such as tetralogy of Fallot (www.cardiacatlas.org).

Dr Martin Bishop

Title

Computational cardiac electrophysiology –
Uncovering mechanistic pathological insight, optimising therapies, and enhancing risk stratification

Abstract

Sudden cardiac death remains a significant cause of death worldwide. Primary clinical challenges in this regard include better understanding the pathological disease processes which cause the heart to beat arrhythmically in different contexts, and more accurately identifying specific patients who may benefit from medical intervention. Moreover, once sought, the medical therapeutic interventions - mainly in the form of implanted cardioverter defibrillators, pharmacological treatments, or permanent catheter ablation therapies - all have significant drawbacks, with great scope for (patient-specific) optimisation. In this seminar, I will describe how computational models are able to conduct detailed ‘in-silico’ experiments, elucidating important mechanistic insight regarding the complex structure-functional interactions which underlie pathological remodelling in a variety of cardiac diseases, and identifying potential ‘biomarkers' which may be used to guide clinical decisions regarding arrhythmia risk stratification. I will further discuss how such models may also be used as patient-specific ‘digital twins’, to better understand the specific causes of arrhythmias in a specific patient, and guiding clinical interventions such as catheter ablation therapy or device implantation

Bio

Following his undergraduate degree in Physics (University of Oxford, UK), Martin Bishop studied for a PhD in Computational Biology (University of Oxford, UK), specialising in Computational Cardiac Modelling. In his first postdoc, Martin developed fine-scaled computational cardiac models directly from high-resolution MRI data, which were used in his later 4-year Sir Henry Wellcome Postdoctoral Fellowship to investigate the role of anatomical heterogeneity in the mechanisms of initiation and maintenance of arrhythmias. Following his Fellowship, Martin took-up an academic position at King’s College London in the Department of Biomedical Engineering, where he is now a Reader in Computational Cardiac Electrophysiology.

Dr Adelaide De Vecchi

Title

Computer modelling to enhance pre-procedural assessment in transcatheter mitral valve replacement with bioprosthetic devices

Abstract

We use computational models alongside clinical imaging to improve preprocedural assessment of patients to maximise the benefits and minimise the risks of an intervention. This is particularly relevant in complex procedures for high-risk categories of patients, such as transcatheter mitral valve replacement (TMVR) with bioprosthetic devices. TMVR offers a promising alternative to open-heart surgery in older, frailer patients, but new unique challenges have emerged in preprocedural planning due to the heterogeneity of the mitral valve apparatus and of the commercial device models. Failure to match device models to the individual patient's pathophysiology can result in left ventricular outflow tract obstruction, valvular thrombosis, and device instability - complications that can lead to fatal heart failure or stroke. Preprocedural planning is currently based on simple geometric predictions from CT angiograms that do not take into account the complexity of the haemodynamic response of the left ventricle to the device. I will present a novel computational workflow to predict key metrics of function post-TMVR, such as ventricular afterload, blood residence time inside the ventricle, and wall shear stress and fluid-dynamic forces acting on the implanted device. This approach has the potential to improve patient selection and could be incorporated in the criteria for preprocedural assessment.

Bio

Adelaide de Vecchi is a Lecturer in computational cardiovascular modelling at King's College London. After completing a PhD degree in aeronautical engineering at Imperial College London, she moved first to the University of Oxford and then to King's to work on computational modelling in bioengineering and personalised medicine applications. She has developed multi-physics cardiac models that can be personalised and updated based on imaging and clinical data. She has applied this workflow to a range of different pathologies, including complex congenital heart diseases, atrial fibrillation and cardiac valve replacement.