LONDON'S GLOBAL UNIVERSITY

Job Description

Research Fellow in HiP-CT quasi-dynamic Cardiac and Other Organ Imaging

Grade: 7

Department: UCL Mechanical Engineering

Location: European Synchrotron Research Facility, Grenoble

Reports to

Profs. Peter D. Lee and Andrew Cook

About the Project

Would you like to generate, visualise and analyse some of the world's newest and highest resolution ex vivo bioimaging data of intact human organs and joints? A new Research Fellow position is available to join the team doing this work, with your post having a focus on developing methods of stepped dynamic imaging to measure blood/air flow and the properties of hard and soft tissue in situ. You will be based at ESRF (the European Synchrotron, Grenoble France) to develop and apply Hierarchical Phase-Contrast Tomography (HiP-CT, see https://mecheng.ucl.ac.uk/HiP-CT), generating 4D scans of intact organs, ex vivo, with near cellular (micron) resolution.

HiP-CT offers the chance to capture dynamic processes within intact organs through quasi-static imaging across the length scales, enabling direct insights into biological mechanisms such as the expansion and contraction of blood vessels and airways, or the effect of osteoarthritis (OA) on both soft and hard tissues in our joints, etc.

In the future, it might be possible to couple spatial transcriptomics to these observations to identify early biomarkers of disease. Additionally, dynamic phenomena, such as the impact of a stroke on blood flow in the brain could be simulated using image-based computational modelling informed by HiP-CT's segmented volumes.

As part of this role, you will also develop methods to use stepped dynamic imaging to measure the properties of tissue in situ. This will provide new insights into how the multi-scale anatomical and structural characteristics of heart muscle and vasculature affect the success of treatment, such as angioplasty or percutaneous valve deployment.

The overall project is led by Peter D Lee, Claire Walsh, and Rebecca Shipley in the UCL Mechanical Engineering Department and Dr. Paul Tafforeau at ESRF (www.esrf.eu), together with an international set of collaborators. Prof. Andrew Cook is a world expert in bio-imaging of pulmonary disease. The overall HiP-CT project involves about twenty Postdocs and PhD students. Mechanical Engineering has a strong track record in healthcare engineering through the Institute of Healthcare Engineering (www.ucl.ac.uk/healthcare-engineering/).

About the Location, ESRF, Grenoble, France

ESRF is the world's first 4th generation high-energy synchrotron, producing the world's brightest X-rays. It is a centre of excellence for fundamental and innovation-driven research in condensed and living matter science. Located in Grenoble, France, the ESRF owes its success to the international cooperation of 22 partner nations. It is a unique place to work, combining interdisciplinary science with a lovely location.

About the Collaborators

The project is an international interdisciplinary collaboration between scientists and mathematicians at UCL, ESRF and clinicians in Germany, the UK and France, together with many other collaborators.

You will be working directly with Profs Peter D Lee, Ryo Torii, Rebecca Shipley, Dr. Claire Walsh and colleagues in Mechanical Engineering on the imaging, rig design and modelling, and with Andrew Cook, Professor of Developmental, Interventional and Surgical Cardiac Anatomy in the UCL Institute of Cardiovascular Science on the medical and biological applications.

In addition to your core project, you will also be part of a Hub helping groups worldwide learn and apply the HiP-CT technique to areas from neurology (with the Harvard/MIT Martinos Centre) to lung disease (with UCLH and Antwerp) to prostate cancer (with Aachen and

Mainz). You will help continue to develop the https://Human-Organ-Atlas.esrf.eu .

Context

Funded by the Chan Zuckerberg Initiative, you will be part of an International Collaboration to continue developing and applying Hierarchical Phase-Contrast Tomography (HiP-CT), a new imaging modality using the world's first 4th generation X-ray source located at the European Synchrotron Radiation Facility (Grenoble). The technique is capable of imaging whole, intact human organs at 15µm, zooming down to single cells at ~1µm, without physically sectioning the tissue. This project will focus on developing and applying HiP-CT for use on quasi-dynamic imaging. Dr Paul Tafforeau is the ESRF lead of the project, and Dr Joseph Brunet (UCL based at ESRF) will be your local supervisor.

Main purpose of the job

This is an exciting opportunity to work in a team developing multi-disciplinary, cutting-edge technologies. The person taking this role will be based at the ESRF with visits to the teams at UCL, Germany and elsewhere. You will focus on developing methods to scan intact human and large animal hearts and other organs, as well as measuring tissue mechanical properties in situ (but ex vivo). Additionally, you will apply image reconstruction algorithms, digital volume correlation, and image correlation to other modalities to help develop models of blood and air flow, and tissue mechanics. The post will require a motivated researcher who is prepared to work with biological samples, develop test rigs, reconstruct and analyse 4D volumes, and segment the images for use in image-based modelling. The development of segmentation algorithms will be provided by counterpart PDRA's based at UCL. The role will require close co-working with researchers from a range of backgrounds and disciplines, in a collaborative team.

HiP-CT is already proving to be a promising technique for understanding changes in angiogenesis in COVID-19 victims (see bit.ly/HiP-CT-paper05), helping demonstrate how angiogenesis can be altered. In cardiac applications, it's helping interpret life-threatening heart abnormalities and could further transform our understanding of dynamic changes in heart and lung microstructure. Your role will be to expand the applications, through experiment, image analysis and modelling.

Duties and responsibilities

- To develop and perform in situ experiments with HiP-CT on large biological samples, with cardiovascular and musculoskeletal applications
- To design rigs for in situ experiments.
- To perform biomechanical characterisation by coupling the experimental and modelling results.
- To develop and apply imaging analysis techniques, especially digital volume correlation, to interpret quasi-dynamic biological system behaviour
- To help develop new sample preparation and HiP-CT techniques for very large samples, including complete cadavers
- To help operate the HiP-CT hub, working with groups worldwide, helping prepare samples, perform HiP-CT scans, reconstruction, and analysis, and training others in these aspects
- To liaise and collaborate with biologists, clinicians, and other imagers to analyse and interpret the results
- To maintain an awareness of research literature that is pertinent to the project
- To disseminate the results in appropriate peer-reviewed journals, meetings, workshops, and conferences
- To prepare progress reports on research for funding bodies as required
- To contribute to engagement activities, including both public and patient engagement, working with the broader research team
- To help supervise MSc and PhD students
- To contribute to the overall activities of the research team and Department as required
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- To contribute to the overall activities of the research team and Department as required

Person Specification

Criteria	Essential or Desirable	Assessment method (Application/Interview)
Qualifications, experience and knowledge		
• PhD in a relevant discipline (e.g. bio-mechanical or other engineering, computational biology, biophysics)	Essential	Application
• Experience in biomechanical characterisation, and understanding of biomechanics	Essential	Application, Interview
• Experience in performing in situ, ideally including the design of in situ flow or mechanical rigs	Essential	Application, Interview
• Experience in x-ray imaging, ideally synchrotron tomography experiments with biological systems	Essential	Application, Interview
• Experience in large data handling	Desirable	Application, Interview
Skills and abilities		
• Ability to understand and interpret experimental data from 3D imaging, ideally biomedical	Essential	Application, Interview
• Ability to understand and modify coding scripts (Matlab/Python)	Essential	Application, Interview
• Ability to perform, understand and interpret statistical analysis techniques	Essential	Application, Interview
• Effective written and verbal communication skills, which can be adapted to a range of audiences, including the public and media	Essential	Application, Interview
• Ability to handle and prepare biological samples	Essential	Application, Interview
Personal attributes		
• Willingness to work collaboratively, within a team	Essential	Interview
• Commitment to high-quality, interdisciplinary research	Essential	Application, Interview
• Commitment to UCL's policy of equal opportunity and the ability to work harmoniously with colleagues and students of all cultures and backgrounds	Essential	Interview