LONDON'S GLOBAL UNIVERSITY

Job Description

Research Fellow:

Machine learning for Multi-scale, Correlative, Biomedical Imaging

Grade: 7

Department: UCL Mechanical Engineering

Location: UCL Bloomsbury Campus

Reports to

Prof. Peter Lee, Dr Claire Walsh, Prof. Danny Alexander

About the Project

The successful candidate will apply Machine Learning techniques to correlate a new and disruptive biomedical imaging modality – Hierarchical Phase-Contrast Tomography (HiP-CT), to existing clinical imaging modalities including CT, MRI and histology, providing ground truth for super-resolution MRI techniques. HiP-CT is an *ex vivo* X-ray imaging technique developed at the European Synchrotron Radiation Facility in Grenoble, capable of multi-resolution imaging of intact human organs. With HiP-CT we are able to image whole human organs with 25um voxels then zoom down to near single cell resolution anywhere within the organ without physically cutting the sample (bit.ly/HiP-CT-videos, mecheng.ucl.ac.uk/HiP-CT, bit.ly/HiP-CT-paper).
The Research Fellow will lead the development of new ML based image processing pipelines to correlate HiP-CT images to clinically used modalities e.g. MRI, CT and histology. The post-holder will devise deep-learning based workflows, extracting biomedical data from HiP-CT images and correlating these with imaging biomarkers from lower resolution clinical imaging modalities to obtain super-resolution.

HiP-CT was developed in 2020 by an international interdisciplinary collaboration between clinicians, scientists and mathematicians, across the UK, Germany and France, in response to the COVID-19 pandemic. You will be part of a multi-national (currently over 30 groups across 10 nations) mapping our organs in health and disease producing the worlds highest resolution Human-Organ-Atlas (https://human-organ-atlas.esrf.eu). This 3D multiscale map of the human body was featured in a recent National Geographic article (https://www.nationalgeographic.com/science/article/worlds-brightest-x-rays-reveal-covid-19-damage-to-the-body) (bit.ly/HiP-CT-paper) and videos can be seen at bit.ly/HiP-CT-videos.

About the Collaborators

The project involves working closely with collaborators from UCL and around the world. Image processing pipeline collaborators include: Profs. Danny Alexander UCL computer Science, *Simon Walker-Samuel* UCL Centre for Advanced Biomedical Imaging (CABI) and Dr *Joseph Jacob (UCL Centre for medical Image Computing CIMIC)* . CIMIC was established in 2005 to bring together technical researchers on all aspects of imaging science and promote translation to application in the clinic and clinical research. Professor Alexander has key expertise in computational modelling and machine learning for biomedical data analysis. He leads the Microstructure Imaging Group (http://mig.cs.ucl.ac.uk) and the progression of neurodegenerative disease (POND) group (http://pond.cs.ucl.ac.uk) and is Director of CMIC. *Prof. Simon Walker-Samuel*, is a leading expert on Biomedical imaging analysis including ML based segmentation of large vascular networks and image based flow modelling. Prof. Walker-Samuel leads the Cancer Imaging group in CABI. (simonwalkersamuel.com). International collaborators supporting the group on data labelling, sharing and visualising include Viren Jain and Jerermy Maitin-Shepard (Google) and Nicholas Sofroniew (CZI-napari team). Leading clinical academics collaborate closely to interpret and provide clinical insight including *Danny Jonigk* and *Maximillian Ackermann* from the

Hannover and Mainz lung groups, (AG-Lunge-Teammitglieder Group), (www.intussusception.org).

Context

Biological systems are inherently multiscale and hierarchical with complex feedback loops between the levels of tissue organisation. Our understanding of human physiology and pathology is governed by our capacity to observe these systems across spatial scales.

Funded by the Chan Zuckerberg Initiative, you will be part of an fast growing International Collaboration to develop Hierarchical Phase-Contrast Tomography (HiP-CT), a new imaging modality using the world's first 4th generation X-ray source EBS located at the European Synchrotron Radiation Facility (Grenoble). The technique is capable of imaging whole, intact human organs at 25µm, zooming down to single cells at 1µm, without physically sectioning the tissue. The larger project will both develop HiP-CT and apply it to help understand the injury imparted by Covid-19 and other pathologies on our organs. You will be part of a multidisciplinary international team of X-ray physicists, computer scientists, medics and computational modellers aiming to develop each stage of HiP-CT, including sample preparation, scan acquisition/reconstruction, image processing pipelines including correlative imaging and image based dynamic modelling. Prof Peter Lee is the UCL lead of the project, and he 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 UCL but requires occasional travel to ESRF and other centres. The Research Fellow will develop new deep-learning based image processing pipelines to correlate HiP-CT images to clinically used modalities e.g. MRI, CT and histology. The post-holder will implement deep-learning based workflows, to extract meaningful biomedical data from HiP-CT images and correlate these imaging biomarkers acquired with the clinical imaging modalities. Responsibilities include working in close collaboration with clinicians, biologists, physicists, bioinformaticians, and computer scientists in an international and interdisciplinary environment, and will involve the provision of training and assistance to PhD and masters students.

The post-holder will have experience of, or a strong interest in, development in the imaging sciences to answer biomedical and clinical research questions, as well as a strong background in implementing deep-learning based workflows for large imaging datasets.

Duties and responsibilities

- To develop and apply deep-learning based workflows for extraction of biomedically relevant data from HiP-CT Images.
- To develop deep-learning based image registration pipelines to correlate HiP-CT data to other modalities e.g. clinical MRI, CT and histology.
- To liaise and collaborate with biologists, clinicians and other imagers to label, analyse and interpret the results.
- To participate and help manage the preparation high quality ground truth datasets.
- To participate in beamtimes at ESRF.
- To maintain an awareness of research literature that is pertinent to the project.
- To contribute to the drafting and submitting of papers to appropriate peer-reviewed journals.
- To disseminate research findings at appropriate 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 contribute to the preparation and drafting of research bids, grant applications and proposals under the supervision of the Principal Investigators.
- 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. mathematics, computational biology, engineering, biophysics, computer science)	Essential	Application
• Experience in deep learning with open source libraries	Essential	Application, Interview
• Experience in large image data handling	Essential	Application, Interview
• Experience in image registration	Desirable	Application, Interview
• Understanding of human physiology and biological imaging	Desirable	Application, Interview
• Experience in x-ray imaging, or similar modality	Desirable	Application, Interview
Skills and abilities		
• Ability to understand and interpret experimental data from 3D imaging, ideally biomedical	Essential	Application, Interview
• Ability to perform, understand and interpret statistical analysis techniques	Essential	Application, Interview
• Ability to present complex information effectively to a range of audiences	Essential	Application, Interview
• Effective written and verbal communication skills, which can be adapted to a range of audiences	Essential	Application, Interview
• Ability to handle and prepare biological samples	Desirable	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