Cardiff University
School of Psychology

Studentship Title:	EPSRC Doctoral Training Partnership PhD Studentship
Research Area/ Project Title:	Magnetic Resonance Imaging of Moving Patients at Ultra-high Field: Real-time Motion Corrected Parallel-transmit Pulse Design
Location:	Cardiff University Brain Research Imaging Centre (CUBRIC)
Expected Start Date:	1 October 2018
Duration:	3.5 years
Deadline for Application:	16 March 2018

Description of Research Opportunity:

Ultra-high field (UHF, 7T and above) magnetic resonance imaging (MRI) scanners present a unique opportunity to study the brain at much higher resolution than previously possible. Many brain MRI acquisitions last upwards of several minutes. Any small deviation in subject position during this time, due to involuntary movement or breathing, can change the imaged volume, leading to destructive artefacts in the images, and necessitating a rescan of the patient (Figure: Effect of 1.5cm motion towards right-posterior and with correction). Motion is specifically problematic with uncooperative patients such as in paediatric imaging, or for patients with Parkinson's or dementia. Sedation, which is common practice in such cases, is invasive, and has been reported to cause adverse side effects and even admittance to emergency care. Therefore, it is desirable to compensate for motion through updating the imaging protocol in real-time to maintain the same imaging volume.

Higher field strengths are accompanied by intrinsic artificial contrast variations. These unwanted variations can be compensated for by using specifically designed imaging protocols (excitation RF pulses), in addition to sophisticated hardware (i.e., pTx: parallel-transmit arrays). However, because of the computational complexity of designing such pulses, no method has been developed yet that can compensate for patient motion in real-time.

At Cardiff University Brain Research Imaging Centre, we are developing a method that can design pulses for UHF MRI in less than a second. In this project, you will advance this method for structural MRI and implement real-time motion correction. The project will involve:

- Year 0-1: learn about MRI physics, signal/data processing, and coding; implement motion correction to the method.
- Year 1-2: learn about MRI protocol programming, recruiting and interacting with patients; implement the method for structural MRI. Demonstrate the method with in-vivo experiments. Optimize method to improve in-vivo performance.

- Year 2-3.5: compare structural MRI with motion correction to cases without correction and without motion at 7T; compare motion corrected MRI at 7T versus high-field (3T), all with in-vivo experiments.

The developed method will continuously redesign pulses during a scan to correct the effects of patient motion as it happens. Thus, it will address one of the main obstacles in UHF MRI and reduce the need to rescan patients due to motion. The method will also decrease the application of sedatives, make the up-and-coming HF- and UHF-MRI more available to a wider population, and unlock the full-potential of UHF-MRI for children and aging populations.

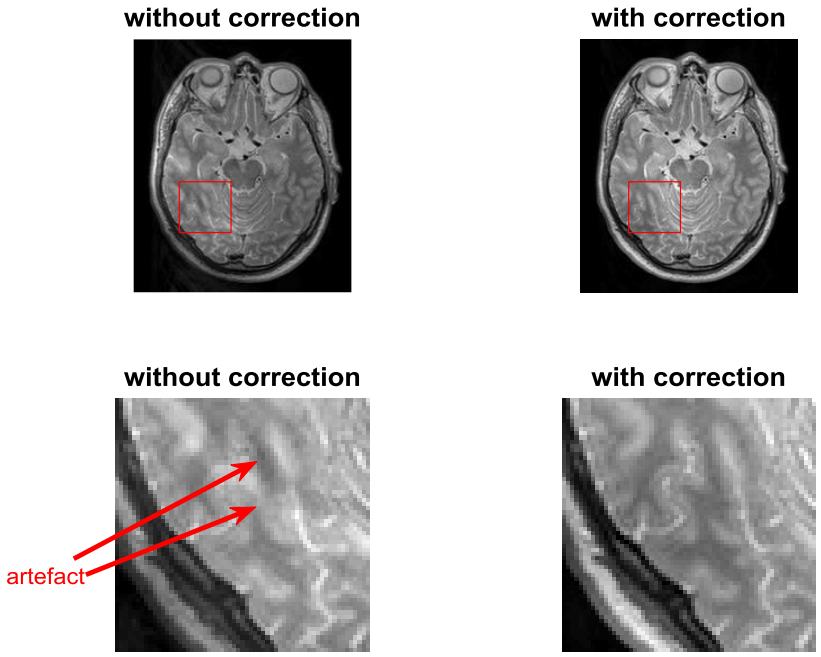

Figure: Effect of patient motion on image quality demonstrated via simulations. Left: Artefacts when the patient moves towards the right-posterior direction by 1.5cm. Right: Artefacts are suppressed when patient motion is accounted for during pulse design. Note that, all effects are due to motion during excitation and effects of patient motion on encoding are already corrected in all images.

Supervisors:
Dr. Emre Kopanoglu
Prof. Richard Wise
Prof. Kevin Murphy

Research Training:

The student will be supervised by a group of faculty members from the schools of Psychology and Physics.

The student will be fully supported during the project to develop specific and transferrable skills across multi-disciplinary domains, including, programming fluency (e.g. Matlab, C++, Python), MRI sequence development (Siemens IDEA); MRI scanner (7T and 3T), parallel-transmit and motion tracking hardware; robust knowledge on MRI physics and signal processing; experience on conducting research with patients; MRI data acquisition and

analysis. S/he will also be supported and guided to attend from over 350 workshops offered through the Doctoral Academy to further develop research and professional skills. Furthermore, the Schools of Psychology and Physics have an active portfolio of training for PhD students that include teaching opportunities, seminars and networking events.

The project lies at the interface of multiple disciplines and the student will collaborate with clinicians and academicians from physics, engineering, medicine and psychology. Being a part of a multi-disciplinary team and working on an interdisciplinary project, complemented by the aforementioned skills, will catalyse a successful research career for the student.

CUBRIC has strong collaborative ties with Siemens Healthcare, which will expose the student to academia-industry collaborations.

The student will be the first to design motion corrected pulses at UHF, and will gain extensive experience with special MRI hardware such as parallel-transmit and motion-tracking.

Award:

The studentships will commence in October 2018 and will cover your tuition fees (at UK/EU level) as well as a maintenance grant. In 2017-18 the maintenance grant for full-time students was £14,553 per annum. As well as tuition fees and a maintenance grant, all School of Psychology students receive conference and participant money (approx. £2250 for the duration of the studentship).They also receive a computer and office space, additional funding for their research, and access to courses offered by the University's Doctoral Academy and become members of the University Doctoral Academy.

Eligibility:

The Doctoral Training Partnership welcomes applications from both UK and EU applicants; however, as a consequence of the EU referendum result, final award decisions will depend on the outcomes of the UK/EU negotiations.

Full awards (fees plus maintenance stipend) are open to UK Nationals and EU students who can satisfy UK residency requirements. To be eligible for the full award, EU Nationals must have been in the UK for at least 3 years prior to the start of the course for which they are seeking funding, including for the purposes of full-time education.

A small number of awards may also be made available to EU Nationals who do not meet the above residency requirement, provided that they have been ordinarily resident in the EU for at least 3 years prior to the start of their proposed programme of study. There are also a very limited number of opportunities for international applicants, in competition with applicants across all the DTP Schools to receive a full award, which includes an international fee waiver.

Applicants for a studentship must have obtained, or be about to obtain, a 2.1 degree or higher in a relevant subject or a Master's degree with distinction in the research dissertation in a relevant discipline.

How to apply:

Applicants should submit an application for postgraduate study via the Cardiff University Online Application Service.

Applicants should select Doctor of Philosophy (Psychology), with a start date of October 2018, either full-time or part-time, depending on your preference.

In the "Research proposal and Funding" section of your application, please specify the project title and supervisors of this project and copy the project description in the text box

provided.

Please select “No, I am not self-funding my research” when asked whether you are self-funding your research.

Please add “EPSRC Doctoral Training Partnership PhD in Psychology" when asked "Please provide the name of the funding you are applying for".

Please specify that you are applying for this particular project.

Application deadline: 16 March 2018.

Webpages:

https://www.cardiff.ac.uk/study/postgraduate/research/programmes/project/magnetic-resonance-imaging-of-moving-patients-at-ultra-high-field-real-time-motion-corrected-parallel-transmit-pulse-design

https://www.cardiff.ac.uk/study/postgraduate/funding/view/epsrc-doctoral-training-partnership-phd-in-psychology

General Information:

The School of Psychology is one of the largest and most successful in the UK (http://www.cf.ac.uk/psych/). The School’s excellent standard of research and teaching has been recognised in every Research Assessment Exercise. It has its own brain-imaging centre (http://www.cf.ac.uk/psych/cubric/), enhancing the international-leading research in behavioural neuroscience, cognitive ergonomics, forensic, social and developmental psychology.

Cardiff is the youngest capital city in Europe and the fastest growing in the UK. It plays host to many national and international sporting events at the Millennium Stadium (http://www.millenniumstadium.com/). Culturally, the city is thriving, with the Wales Millennium Centre (http://www.wmc.org.uk/) in Cardiff Bay. Cardiff is in very close proximity to the beautiful Welsh countryside (http://www.breconbeacons.org/), has a two hour rail link to London and a (cheap) one hour air link to Paris and Amsterdam (http://www.cardiffairportonline.com/)

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