Report from CCPPETMR for the Period 01/10/19 to 31/03/20

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1.   Background

For medical imaging, the UK is a globally leading country. It has the highest number of Positron Emission Tomography and Magnetic Resonance (PET-MR) medical imaging machines per capita in the world, evenly spread throughout the country. The CCP PET-MR project established in 2015 aims at bringing together the best of the UK's PET-MR imaging expertise to capitalise on the investment in this area. New research shows that the use of MRI intermediate results can improve PET imaging quality and vice versa, and latest scanners can acquire MR and PET data simultaneously. Our CCP is dedicated to exploiting exciting new capabilities that the synergy of MR and PET imaging can deliver. The main deliverable of the project is an open source PET-MR reconstruction software framework we named SIRF (Synergistic Image Reconstruction Framework). SIRF is simple enough in use for educational and research purposes, thus reducing the "barrier for entry" for new contributors to PET-MR imaging research and development, and at the same time powerful enough to process real scanner data.

2.   Highlights for the Current Reporting Period

In the reported period, we continued our software development and networking efforts, adding content to our website www.ccppetmr.ac.uk, maintaining mailing lists (we now have 101 members on the CCP-PETMR announcement list, 34 on the developers and 72 on the users' lists).

On 20 Nov 2019, we published Release 2.1.0 of our Open source software suite SIRF (Synergistic Image Reconstruction Framework). The new release adds Hybrid Kernel Expectation Maximisation (a PET reconstruction algorithm that allows incorporation of MR information) and DICOM-writing and GPU gadgets to SIRF, extends MR capabilities to 3D sequences, and improves the compatibility between SIRF and the CIL library of CCPi.

Our paper "SIRF: Synergistic Image Reconstruction Framework" was published in the 50th anniversary issue of *Computer Physics Communication* (doi: 10.1016/j.cpc.2019.107087). We also published a paper on the PET reconstruction capabilities for the GE Signa PET/MR in *Methods* (doi: 10.1016/j.ymeth.2020.01.005).

On 27-29 Jan 2020, we held our 5th Hackathon, hosted by STFC and attended by 12 researchers from STFC, UCL, Leeds University, Southampton University, MLU (Germany) and PTB (Germany). This Hackathon focused on Motion Correction Image Reconstruction. We had to postpone our 6th Hackathon because of the COVID-19 pandemic.

We had 6 international exchanges of PhD students and postdocs in this period (2 from Australia, 3 from Germany and 1 to Germany), not only all fruitful in training and software development, but also expected to lead to publications.

Finally, we were successful in the extension (and substantial increase) of support from EPSRC for further 5 years, our CCP being renamed CCP on Synergistic Reconstruction in Biomedical Imaging (SyneRBI) to reflect widening of the scope of investigation and development.

3.   Workshops and New Opportunities

On 31 October 2019, we held our yearly STIR Users' and Developers' Meeting at the IEEE Medical Imaging Conference 2019, this year in Manchester. We had 5 contributed talks and about 50 attendees.

On 3-6 November 2019, together with CCPi, we held a 2-day Synergistic Reconstruction Symposium, followed by a 2-day software hands-on training session introducing our Synergistic Image Reconstruction Framework and the CIL library, covering reconstructions of PET, MR and X-ray CT. The Symposium was attended by about 100 international experts, and the training by 40 people. Both events received excellent feedback from the participants. Presentation material, recordings and software is available via our website, providing a major resource for the community.

In February 2020, we contributed to a Siemens User's Meeting presenting our network and software to a large international audience (about 150 attendees). Immediately after this event, together with the UCL/UCLH Institute of Nuclear Medicine we organised a symposium on 'Current technical challenges in clinical research using PET/MR', with about 90 attendees, mostly from the UK but with about 20 international experts.

4.   Issues and Problems

Our main stumbling block remains the installation of SIRF and its pre-requisites under various Operating Systems. In particular, we have not yet succeeded in the Windows installation of Gadgetron. In order to run our SIRF MR scripts under Windows we employ our Virtual Machine running pre-installed Gadgetron as a Gadgetron server. In our SIRF training sessions, we also use Microsoft Azure cloud computing service and Jupyter notebooks.