

Report from CCP_PETMR for the Period 25/11/16 to 06/06/17

Evgueni Ovtchinnikov and Kris Thielemans - <http://www.ccppetmr.ac.uk/>

This text is based on the report submitted to the CCP Steering Panel.

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 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 will be an open source PET-MR reconstruction software framework we named SIRF (Synergistic Image Reconstruction Framework). SIRF will be 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.

Core support funded by EPSRC

The 1.16 FTEs of the core support at STFC currently focusses on developing the SIRF code base that provides an easy-to-use script-language (Python and Matlab) environment built around existing open source imaging software. This includes 0.2 FTE for maintaining network, website, community support, running workshops and training courses and benchmarking, and 0.9 FTE for software engineering effort that contributes to SIRF development, testing, deployment and documentation.

In the current reporting period, efforts have been primarily provided by Evgueni Ovtchinnikov and Ron Fowler. Approximately 0.5 FTE effort has been re-profiled to 17/18 and 18/19 FYs to accommodate a new recruit – Dr Eduardo Pasca who has started working on the project from April 2017.

Our work during the reported period progressed according to the job plan: software development and engineering efforts aiming for the first SIRF release, adding content for the website (<http://www.ccppetmr.ac.uk/>), maintaining mailing lists (we now have 88 members on the CCP-PETMR announcement list – 6 new members joined since Nov. 2016, 18 on the developers and 60 on the users lists); organising working group and executive meetings, organising a series of well-attended Developers Days' to present and discuss progress in our software framework development.

Highlights for the Current Reporting Period

Grant applications

Our CCP Flagship proposal “A framework for efficient synergistic spatiotemporal reconstruction of PET-MR dynamic data” was awarded EPSRC grant EP/P022200/1. This project, starting from 25 June 2017 for 32 months, will fund a full-time postdoc at UCL and part-time effort at STFC (28% Senior Software Engineer and 6% Software Engineer for software management).

Progress in software development

Our open source software suite SIRF had its **first public release on 17 June 2017** (Release 0.9). This release is based on PET reconstruction package STIR (Software for Tomographic Image Reconstruction) and MR reconstruction package Gadgetron. SIRF distribution includes source code, installation instructions and scripts, test scripts, demo scripts and several layers of documentation. An Oracle Virtual Machine (VM) is also provided that has all the necessary software (except, for licensing reasons, Matlab) pre-installed for a quick start in any operating system that supports VMs. These are available on public CCP website.

The development of SIRF opens up significant opportunity for the user community to adopt or test the codes in a real PET-MR system. It is the first time ever the community will have access to a software system that facilitates end-to-end PET-MR imaging method testing, from pre-processing to reconstruction to post-processing, all under one software framework. We expect that this new development will significantly ease the efforts and time required to test and validate PET-MR methods and algorithms before releasing the software publicly.

Integrated help and user guides, as well as links to the OneDrive and Drupal archives are in continual development.

Summary of successful networking events in this six month period:

- Several software framework meetings have been coordinated: these developers' workshops have continued to be popular and been held at various user locations: Manchester [16 Jan 2017 \(att 16\)](#), Leeds [9 Mar 2017 \(att 23\)](#); UCL [11 May 2017 \(att 11\)](#).
- We have instigated two-weekly developer t-cons to discuss more urgent issues.
- In May 2017, on the 9th and 10th, Dr Tsoumpas presented two seminars to attendees from PET centres in Japan (Akita, Chiba, Fukushima, Tohoku) which highlighted the new developments of our CCP network. At the University of Tohoku in Sendai, Japan, for a class of 12 students, Dr Tsoumpas also gave a 2 day course on PET reconstruction including practical exercises using the CCP PETMR VM and STIR, and discussing the role of the synergy between PET and MR for more accurate modelling of the acquisition process.
- A poster introducing the first public release of our SIRF software was presented at PSMR 2017, the 6th Conference on PET-MRI and SPECT-MRI in May 2017, Lisbon, Portugal.
- We contributed to the PET-MRI School for students and early stage researchers at PSMR (25 attendants) with a hands-on PETMR software training session using SIRF. We funded UK attendants to the school.
- Advertised main events (also some seminars):
 - 3rd UCL/UCLH PET MRI Course, 11-13 May 2017
 - King's College London Course on Simultaneous PET-MR: Science and Practice June 28, 2017
- Embedding of STFC developers in the network: EO 1 day per week at UCL, EP 1 day in UCL.

Online media presence

- Physics advances by CCP PET_MR members help shape clinical PET: <http://medicalphysicsweb.org/cws/article/research/67475>

Funded Exchange Scheme

- Ottavia Bertolli (UCL) to Service hospitalier Frédéric Joliot, Orsay, France, "PET-MR data acquisition and management"
- Yu-jung Tsai (UCL) to KU Leuven, "Performance comparison between two anatomical priors with the use of a spatially variant penalty strength"

Reports are available on the website <http://www.ccpetmr.ac.uk/exchange.html>.

Workshops and New Opportunities

We continue with our regular meetings: Working Group meetings every 6 months, bi-monthly Executive Group meetings, Software Framework meetings every 6 weeks and bi-weekly brainstorming tele-conferences.

There will be consultation with the community regarding the content of SIRF Release 1.0 (and a roadmap towards Release 2.0) at an extra Software Developers' Meeting prior to the CCPETMR Working Group meeting on 15 June 2017.

Planned future networking and software opportunities:

1. Software release v1.0 including capability of processing measured data from Siemens and GE PET-MR scanners (Q4 2017)
2. Use of our software STIR in interactive training (1 day short course) at the IEEE Medical Imaging Conference in Atlanta, Georgia, USA, <http://www.nss-mic.org/2017>.
3. Workshop on synergistic reconstruction (joint with CCPi) – proposal stage
4. Establishment of databases for phantom data, with links formed with the Dementia Platform UK.

The next CCPETMR Working Group meetings are planned to be held on 15 June and 17 November 2017.

Issues and Problems

Our main stumbling block at present is the installation of SIRF and its pre-requisites under Windows. In particular, we have not yet succeeded in the Windows installation of Gadg-etron. Consequently, the only way to run our SIRF MR scripts under Windows at present is via our Virtual Machine running Gadgetron, which is pre-installed on it.

Another issue requiring attention is the fact that our PET scripts run considerably (2-3 times) slower under Windows than under Linux. In a wider perspective, ways to optimize the performance of our software will need to be investigated.