Report from CCP_PETMR for the Period 1/10/17 - 31/03/18

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http://www.ccppetmr.ac.uk/

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 is intended to 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.

The 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. All this software is available for free download on our public website www.ccppetmr.ac.uk and via github.com/CCPPETMR.

Highlights for the Current Reporting Period

Our work during the reported period progressed roughly according to plan, with some delays on the software development but expanded networking.

After the previous public release of our open source software suite SIRF (Release 0.9.2) in September 2017, SIRF Release 1.0.0 took place on 3 April 2018. These releases are based on the PET reconstruction package STIR (Software for Tomographic Image Reconstruction) and the MR reconstruction package Gadgetron. Release 1.0.0 provides initial support for data of the Siemens mMR PET/MR scanner. It was a major upgrade compared to the previous releases, in particular adding capability for PET data. SIRF is now capable of reconstructing data of one of the two available commercial systems in an easy to use framework, albeit it not yet with full quantification for PET due to lack of scatter estimation (planned for the next release). We have also expanded our distribution mechanisms from self-compilation (with a CMake "SuperBuild") and a Virtual Machine with pre-installed software, to add support for Docker, a widely used container mechanism.

As mentioned in our previous report, we have obtained official agreement from GE Healthcare to provide open source software for reconstruction of their PET data directly from the raw scanner data, i.e. disclosing the previously confidential file format. We have received considerable help and code from GE. We are making good progress on incorporating this into STIR and SIRF. This work is currently pushed by a PhD student and a postdoc at UCL and Leeds (due to the nature of the agreement). Work by postdocs and students at Hull, UCL and Leeds to add Time-Of-Flight capabilities for PET to STIR is

now almost completed and a journal paper has been submitted. This code will also be applicable to GE PET/CT systems, increasing the impact of our work considerably.

Our network has continued to grow during this period. A major new initiative was the start of a group for discussions on "phantoms" (i.e. test objects) specifically for validation and evaluation of synergistic reconstruction of PET/MR. This group has met twice via teleconferencing, due to the wide international interest. We have also made connections with related initiatives on harmonisation in PET/MR, such as the Dementia Platform UK and a joint- initiative of the (US) Society of Nuclear Medicine and Molecular Imaging (SNMMI) and International Society for Magnetic Resonance in Medicine (ISMRM). We have also started a discussion on simulation software in PET/MR and how it could interact with SIRF. This initiative started with a presentation of 5 different international groups on their current and planned efforts. We see CCP PETMR and SIRF as an integrator for these efforts.

We now have 90 members on the CCP-PETMR announcement list, 21 on the developers, 63 on the users lists and 54 on our new list on phantom discussions. We continue our series of well-attended Developers Days' to present and discuss progress in our software framework development. We have these at different locations to attract other researchers, although we always have a large fraction of remote attendees (also from Europe or elsewhere).

The development of SIRF opens up significant opportunity for the user community to adopt or test the codes in a real PET-MR system. For 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.

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 (average attendance ~20) and bi-weekly brainstorming tele-conferences (average attendance ~5).

A poster introducing SIRF Release 0.9.2 was presented at IEEE Nuclear Science Symposium and Medical Imaging Conference 21-28 October 2017.

We continue consultation with the community regarding the content of SIRF Release 1.x releases to complete the processing of data from both commercial PET/MR scanners and an online roadmap towards Release 2.0 in 2018.

Training/Outreach

Our main outreach activities during the reported period continued to be our regular (every 6 weeks) Software Framework meetings, where we discussed our development progress with our potential users from PET-MR research community (KCL, Leeds, Manchester and other Universities' researchers) and representatives of major imaging scanner manufacturers, including Siemens and GE. We note that a majority of the universities and companies attending our developers' meetings are funded independently, i.e. outside of the core CCP support, indicating a strong community commitment. Furthermore, we have already attracted independently funded university researchers who are now actively contributing to the testing and documentation of the codes, despite the early stage of the project.

CCP PET-MR has funding to support the exchange of researchers (staff and students) between institutions. In this reporting period we funded multiple visits between UCL and University of Leeds to work on supporting PET data from the GE Signa PET/MR.

We used STIR for hands-on training in a 1 day Short Course on Image Reconstruction for PET and SPECT at the IEEE Medical Imaging Conference, Atlanta (USA) in October 2017. The course had about 50 participants. The hands-on sessions received excellent feedback and we have been requested to repeat this next year. In addition, we are gearing up towards using SIRF at a 1 day Training School on PET-MR image reconstruction that we organise at the PET SPECT and MR (PSMR) conference in May 2018.

Issues and Problems

We are experiencing some delays in the software development due to two main reasons: targeting of both Python and MATLAB, and development for multiple operating systems (OS) and environments. Both of these are requirements decided by our Working Group. Our intention is for researchers to be able to deploy SIRF easily on their own hardware and OS. As SIRF depends on many other open source packages, managing this is a challenge, even when using state-of-the-art tools for cross-platform development. Some of our development time is going towards bug fixing of the tools and packages we depend on, but we do contribute those bug fixes upstream.