CCP PET-MR Exchange Report

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Summary

This exchange was co-funded by CCP PET-MR and CSIRO.

In this exchange, I aimed to achieve four primary goals: to make progress on (1) the development of an automated pipeline for PET reconstruction from raw data extracted from the scanner through to reconstructed equivalent to manufacturer DICOM output; to (2) apply the recently integrated HKEM technique in STIR/SIRF to a larger dataset in order to determine its effectiveness in a 18F-Florbetaben study; to (3) learn from UCL's experience in kinetic modelling of dynamic PET for use at CSIRO; and finally, to (4) develop the work to be presented at MIC on PCA motion regression to be expanded into a journal publication. Given the broad scope of work to be achieved, most of the visit was spent developing plans and preliminary implementations of the intended products, and work will be continued by myself in Australia.

Work towards the first goal consisted of expanding work towards STIR's handling of physical geometry, which remains the primary challenge to having vendor-consistent reconstructions within SIRF. Refactoring of the existing code has been planned and begun, and a plan to incorporate bed position and arbitrary calibration transforms within `ProjDataInfo` has been developed and agreed upon with UCL. Work to this end will be continued through January 2020. This work was carried out predominantly in collaboration with Kris Thielemans and Richard Brown.

The second goal is, to some extent, dependent upon the work in the first goal: one hinderance to application of HKEM in clinical research using SIRF is the alignment between anatomical, including MR images and PET reconstructions. In addition to the work towards the first goal, a number of improvements to the HKEM implementation is STIR were developed during the visit, and can be found in STIR pull requests 421, 422, 424, 435 and 436 and issue 429. This work included a visit to the National Physical Laboratory to Daniel Deidda, where Harry Marquis and I presented to the group. This work was carried out predominantly in collaboration with Daniel Deidda and Harry Marquis.

I had several meetings with Kjell Erlandsson and Benjamin Thomas in which we discussed my previous approaches in dynamic PET analysis and resulting issues, in relation to the third goal of the visit. Through these discussions, Kjell and Ben have proposed a number of remedial approaches that I intend to use through January 2020, including the single-target correction (STC) partial volume correction (PVC) approach available in PETPVC.

Work was begun on the fourth goal also, expanding the validation on using regression of a PET PCA tracking against MR-derived motion estimates for head motion beyond the validation presented at MIC 2020. The extended validation will use a larger dataset available at CSIRO, acquired as part of the Prospective Imaging Study of Ageing project. This work was carried out in collaboration with Kris Thielemans and Richard Brown.

In addition to each of the above four technical goals, another primary outcome of the visit was my attendance at the 2019 Manchester Medical Imaging Conference (MIC) and the Synergistic Reconstruction Symposium (SRS) and associated training school. At MIC, I presented one of the outcomes from my 2018 exchange visit: a technique for estimating continuous head motion from sparse MR-derived motion estimates using regression against a PET-derived PCA tracking signals. I also presented a condensed version of this as a poster and 2-minute talk at the SRS. Finally, I aided in instruction at the SRS training school.

Secondary outcomes included networking visits to St Thomas' Hospital, KU Leuven and PTB Berlin. In addition, progress was made on the MR Geometry capabilities in SIRF, specifically the ability to populate the `GeomInfo` class from ISMRMRD data. This work was led by Richard Brown.

In total, the trip was extremely valuable and constructive. I was able to greatly accelerate my learning and skills. In addition, I was able to contribute to others' work in ways I would otherwise not have been able to. Finally, I was able to meet a set of new colleagues whom I am able to collaborate and exchange ideas with in the future.