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# Motion-Corrected PET Reconstruction with SIRF

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In order to be able to fully exploit the many advantages of simultaneous PET/MR, novel synergistic reconstruction methods are being developed by several groups. Access to flexible yet powerful reconstruction software is required, which requires components that are not currently available from manufacturers. For this reason, the Synergistic Image Reconstruction Framework (SIRF) has been developed. This open source software platform for integrated PET-MR image reconstruction allows researchers to easily prototype new algorithms.

SIRF has been designed so that it is both easy to use and powerful at the same time. The ease of use comes from being able to interact with SIRF from both Matlab and Python. The efficiency of SIRF comes from the underlying code being in C++. Most of the functionality relies on existing open source packages, including Gadgetron and STIR. These engines are wrapped and presented to the user in Matlab and Python via a C-interface.

Two new functionalities of SIRF are highlighted in this paper: registration (for motion correction) and anatomical priors. To demonstrate these features, a reconstruction workflow for dynamic PET data incorporating motion correction was implemented in SIRF. The method used frame-by-frame realignment, repositioning the attenuation image where necessary. Motion was derived from non-attenuation corrected PET images.

An example case is given of an epilepsy FDG brain study, where non-negligible motion was present. A comparison was performed between three reconstructions methods: (i) non-motion corrected, (ii) motion corrected and (iii) motion-corrected with the anatomical parallel level sets prior (PLS). It was shown that with the incorporation of motion correction, the extracted time activity curves (TACs) no longer exhibited discontinuities. Furthermore, the use of a prior helped to suppress the noise in the reconstructed image. This paper makes no attempt to find optimal parameters for the prior, rather to highlight the new functionality to SIRF's users.

Future work in SIRF will be directed towards the incorporation of the registration process into the reconstruction phase in both PET and MR, allowing for truly synergistic reconstruction.

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