PhD position on dual-tracer PET tomographic reconstruction

Host institutions:

- University Hospital of Nantes, Nuclear Medicine Department & French Institute of Health and Medical Research (CRCINA, Nuclear Oncology Team, Nantes & LaTIM, Action team, Brest)

Supervision:

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Context and objectives: Multi-tracer positron emission tomography aims to image two or more tracers in a single acquisition, allowing to simultaneously characterize multiple aspects of biological functions within one single dynamic PET scan. The methodology relies on specially designed kinetic modelling approaches in order to extract physiological parameters of interest for each involved radiotracer from the time-activity curves of pre-defined regions or individual voxels. In particular, the process of separating and recovering separate parametric images or measurements for each tracer usually requires specific algorithms incorporating kinetic constraints related to the radiotracers. This approach presents some additional challenges in comparison to standard kinetic modelling.

Different studies explored the use of various signal separation techniques for different combination of tracers [1, 2, 3]. The difficulty and feasibility of tracer signal separation directly depends on their underlying kinetics and several factors of the dynamic acquisition such as the delay between tracer injections, metabolites correction, the mathematical model used to describe the tracer kinetics, and the input function whose estimation is usually performed with blood samples, or derived from pre-reconstructed images. Multi-Tracer imaging could introduce additional problems in the case the multiple radiotracers use different isotopes. Positron range impacts both quantitatively and qualitatively the reconstructed images [4], and as the spatial resolution has been regularly improved the past decade thanks to the recent progress in time-of-flight, its impact on image resolution becomes relatively more critical. The research for enhanced positron range correction methods should be investigated, in particular if their magnitude differs among the radiotracers involved in the multi-tracer acquisition. Additionally, their compatibility with other typical corrections (scatter, random correction, partial volume effect, etc..) inside a reconstruction algorithm must be further evaluated. The goal of this PhD position will be to develop the methodology for dual-tracer parametric image reconstruction. More specifically, one objective will be to develop a new methodology to reconstruct two separate PET dynamic images from a single dataset that comprises of two mixed tomographic projections using CASToR [5]. A first work has been already conducted [6] and demonstrated the relevance of building a generic framework for reconstructing dual-tracer PET acquisitions as two separated dynamic images using a spectral model together with the NNLS (Non-Negative Least Squares) algorithm. Multi-positron range corrections will be also investigated from pre-existing work based on the use of Monte-Carlo simulation within reconstruction [7].

Requirements:

- *Education*: The candidate must hold a Master degree (or equivalent) in Physics, Computer Science or Applied Mathematics
- *Programming Skills*: C/C++, Python
- Prior knowledge in tomographic reconstruction would be an advantage

References

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[6] B. Le Crom, A. Bousse, M. Chérel, N. Costes, S. Gouard, S. Marionneau-Lambot, T. Merlin, D. Visvikis, S. Stute, and T. Carlier, "A single dual-tracer pet imaging acquisition to provide information on tumor heterogeneities," in *Proceedings of IEEE Nuclear Science Symposium and Medical Imaging Conference*, 2020.

[7] D. Autret, "Amelioration qualitative et quantitative de reconstruction tep sur plate-forme graphique," Ph.D. dissertation, Telecom Bretagne, Departement Image et Traitement de l'Information, 2015.