Post-doctoral position on dual-tracer PET tomographic reconstruction

Host institutions:
- University Hospital of Nantes, Nuclear Medicine Department / French Institute of Health and Medical Research (INSERM, CRCINA, Nuclear Oncology Team, UMR1232), Nantes, France

Supervision:
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Duration: 2 years

Context and objectives: Personalized medicine is one of the major goals of oncology. With the help of major technological breakthroughs, the fine characterization of tumors has led to the identification of diagnostic biomarkers, which are prognostic of survival or predictive of the response to therapeutic agents. PET/CT imaging is an integral part of this approach by enabling the distribution and accessibility of biomarkers expressed by tumor or microenvironment in vivo in a non-invasive way.
The use of different tracers can provide useful information on intra-tumoral heterogeneities at the voxel level due to different biological processes. However, the registration without loss or modification of quantitative information between two different PET/CT acquisition challenging due to internal and external movement especially when the precision targeted is at the voxel level. It is however possible to consider a single-scan dual-tracer using equal half-life isotope injected with or without adapted delay.
Several studies proposed different methods to separate the two PET signals from an unique acquisition [1, 2, 3]. The goal of this post-doctoral 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. A first work has been already conducted [4] 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. First acquisitions on pre-clinical data were realized (^{18}F-FDG and ^{18}F-FCH but also ^{18}F-FDG and ^{11}C-Acetate).
The candidate will be part of a large multidisciplinary team which aims at developing new radiopharmaceuticals for theranostic application. This position is funded by a large project called SIRIC (ILIAD Imaging and Longitudinal Investigations to Ameliorate Decision making in multiple myeloma and breast cancer) involving several teams (from biology to applied mathematics) in Nantes. Data will be reconstructed using CASToR [5] which is a reconstruction framework developed by a collaboration of which our team is part of. This project is conducted in strong partnership with the Numerical Science Laboratory of Nantes.

Requirements:
- *Education*: The candidate must hold a PhD in Physics, Computer Science or Applied Mathematics
- *Programming Skills*: C/C++, Python

References

[1] N. F. Black, S. McJames, and D. J. Kadrmas, "Rapid multi-tracer PET tumor imaging with [^{18}F]FDG and secondary shorter-lived tracers," *IEEE transactions on nuclear science*, vol. 56, no. 5, pp. 2750–2758, 2009.

[2] J. L. Zhang, A. M. Morey, and D. J. Kadrmas, "Application of separable parameter space techniques to multi-tracer PET compartment modeling," *Physics in Medicine & Biology*, vol. 61, no. 3, p. 1238, 2016.

[3] C. Bell, S. Puttick, S. Rose, J. Smith, P. Thomas, and N. Dowson, "Design and utilisation of protocols to characterise dynamic PET uptake of two tracers using basis pursuit," *Physics in Medicine & Biology*, vol. 62, no. 12, p. 4897, 2017.

[4] 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.

[5] T. Merlin, S. Stute, D. Benoit, J. Bert, T. Carlier, C. Comtat, M. Filipovic, F. Lamare, and D. Visvikis, "CASToR: a generic data organization and processing code framework for multi-modal and multi-dimensional tomographic reconstruction," *Physics in Medicine & Biology*, vol. 63, no. 18, p. 185005, 2018.