Post-doctoral position at
In Vivo Molecular Imaging Lab

We are looking for a talented fellow for a post-doctoral position in our lab at Orsay (located 25km south from Paris). The lab is focused on In Vivo Molecular Imaging (IMIV). The post-doctoral fellow will be part of the biomedical physics team. We currently have fundings for 18 to 24 months, depending on the previous experience of the fellow. The employer will be the CEA (French Atomic Agency).

The position is part of a large collaborative effort around the GE Signa PET/MR recently installed in our facility (PIM project: Physics and Engineering in Medicine). More specifically, it is part of the PRUDoM project, in collaboration with another lab from the CEA (Systems Modeling and Simulation Lab). This project and the post-doctoral position are described below.

PRUDoM: PET Reconstruction of Uncertainties for an improved guided Diagnosis by taking advantage of Multi-Modal imaging

Context:
In PET, the most advanced reconstruction methods are all based on a fully parametric approach that aims at maximizing an objective function, leading to images with single-valued voxels, i.e. without associated uncertainties. Using such methodologies, beneficial constraints can be applied through the use of side images (CT or MRI) in order to improve image quality. However, the strength of such constraints is mainly governed by a single parameter that has to be manually tuned and assessed for each case. Such constrained methods thus have never reached standard practice.

Aims:
The project aims at investigating an innovative PET reconstruction method that breaks with what has been used and proposed so far in the domain. The proposed reconstruction method should have the following three characteristics: (i) reconstructed images of higher signal-to-noise ratio (SNR) and spatial resolution than those obtained with current standard methods, (ii) systematic association of tightened confidence intervals to the reconstructed values, (iii) fast enough for clinical use. To that aim, the idea is to exploit a Bayesian non-parametric framework that allows taking full advantage of the PET/MR multi-modality by using additional information from any side images (T1, T2, UTE, DIXON, etc) during the reconstruction of PET data. Such methods allow to compute the complete *a posteriori* probabilistic distribution, as opposed to Maximum A Posteriori (MAP) approaches that only aim at reconstructing a single image (*i.e.* the most likely). However, they are known to be slow when willing to extract such distributions precisely. To tackle this specific problem, a new prior was developed in order to benefit from current state-of-the-art fast algorithms based on voxelized images. The problem of attenuation estimation in the absence of transmission data has also been fully integrated in the method, so that it is able to reconstruct an attenuation map along with the emission map.

Tasks plan:
A current 2D implementation of the method, based on simulated data, has just been developed. First preliminary results are very satisfying. As the method breaks with what has been used so far in the domain, the first aim will be to thoroughly assess its behavior and performances with respect to several common situations where the truth is known and using acquired patient data, in 2D (task 1). The second aim of the project is to extend the method to 3D so that it can be fully interfaced with the Signa PET/MR scanner in order to reconstruct complete 3D datasets (task 2). To be used in standard clinical research practice, the method must run within practical amounts of time. Advanced optimization and parallelization techniques will be used to achieve such a requirement on a powerful single multi-cores machine (task 3). As a perspective, the outcomes of using such a method will be evaluated within different clinical research investigations supported by the PIM project and the UIMIV (tumor or lesion monitoring, tracer kinetics modeling, etc). As another perspective, the method may be extended to 4D (including time in the sense of tracer kinetics).

Partners:
The project involves two PIM's partners. CEA/DSV/I2BM/SHFJ/UIMIV (Simon Stute and Claude Comtat) and CEA/DRT/LIST/DM2I/LM2S (Eric Barat, Thomas Dautremer and Thierry Montagu).

More details about our lab:
UIMIV: Unité d'Imagerie In Vivo (In Vivo Molecular Imaging lab). It is located inside the Service Hospitalier Frédéric Joliot, a facility which is part of the CEA Saclay. The lab (UMR 1023) is sponsored by the CEA, the CNRS, the INSERM and the Paris Sud University. There are four teams working together: radiochemistry, biomedical physics, preclinical imaging and clinical investigations. More details can be found on the website: http://i2bm.cea.fr/dsv/i2bm/SHFJ/IMIV.

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