PhD Fellowship on Radiation imaging (PET, CT) Tomographic Reconstruction using Neural Network Approaches

Thesis Location: Laboratory of Medical Information Processing (LaTIM), French Institute of Health and Medical Research (INSERM UMR 1101), Brest, France

Thesis Supervisors: Didier BENOIT, Dimitris VISVIKIS

Period: 3 years, starting on October 2018

Context and Objectives:

During the last decade, dose reduction during a PET or CT examination has become a crucial issue. This reduction strongly impacts the results from the tomographic reconstruction. Indeed, iterative reconstruction algorithms are based on a noise model, with the statistical quality of the acquired data (number of detected photons) having a significant impact in the reconstructed image quality which can in turn strongly influence patient management. In the past, many different denoising techniques have been proposed but over the last couple of years new algorithms from the visual computing field (segmentation, object detection and super-resolution) using neural networks have been introduced in nuclear [1-2] and CT imaging [3-4]. These techniques have gained ground within the context of tomographic reconstruction given the computational power offered by dedicated hardware such as GPUs (Graphics Processing Unit) and multi-CPU processors.

The aim of this thesis is to propose new iterative reconstruction methods using neural networks for radiation based imaging.

Within this context different training databases (clinical and/or simulated raw datasets and images) will be constructed and evaluated for the training of neural networks using existing libraries such as Tensorflow or Caffe. Different implementations can be envisaged based on the combination of raw datasets (sinograms/projections) and corresponding reconstructed images both in the field of PET and CT imaging for training convolutional neural networks (CNN, [5]). Simulated datasets using GATE [6] or GGEMS [7] will be used. The performance of the proposed approaches will be finally compared with current state of the art in iterative image reconstruction in PET and CT imaging. The open source platform CASToR [8] dedicated to the generic tomographic reconstruction will be used within this context.

Education: The candidate must hold a Master degree in Physics, Computer Science or Applied mathematics. Experience on neural networks and/or tomographic reconstruction programming would be appreciated but not required

Scientific Interests: Tomographic reconstruction, numerical simulation, neural networks

Programming Skills : C/C++, OpenCL (or CUDA)

Languages: English, French optional

Contact: Send CV, cover letter, grades/marks (Master, License/Bachelor) by e-mail to: dimitris@univ-brest.fr and didier.benoit@inserm.fr

References:

[1] Litjens G., Kooi T., Bejnordi B. E., Setio A. A. A., Ciompi F., Ghafoorian M., van der Laak J. A. W. M., van Ginneken B. and Sánchez C. I. "A survey on deep learning in medical image analysis." arXiv 2017

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[6] Jan S, et al "GATE: a simulation toolkit for PET and SPECT" Phys Med Biol. 2004; 49(19):4543-61
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