BSc/MSc-project for students in Biomedical Engineering, DTU/KU

Title: Implementation of open-source tomographic reconstruction algorithm for preclinical PET data and comparison to vendor software

Description:
At Cluster for Molecular Imaging, we perform thousands of positron emission tomography (PET) scans every year, using a variety of radioisotopes and animal models. One example is the examination of myocardial perfusion using ^{82}Rb in rats [1, 2], an investigation also performed in hundreds of patients at RH every year. While it is already established as an excellent diagnostic and prognostic marker, our understanding of the underlying physiology, how medicaments affect it, etc. is still very limited [3].

This makes it interesting to evaluate the technique further in animal studies. However, the high energy of the positron emitted by ^{82}Rb makes imaging small animals a challenge, which is also an issue with many new ^{68}Ga-based tracers for cancer imaging. Correcting this is far from trivial and an ongoing research effort, and becomes increasingly relevant as new imaging methods emerge [4, 5].

We currently use the vendor supplied software for reconstruction of the PET images and some analysis, but these software are limited and no longer developed. Fortunately, other research groups have developed open-source tomographic reconstruction frameworks, which could potentially be a better, more flexible and advanced solution for us [6-8].

Your task would be to implement one or more of frameworks in practice; reading raw PET data from our scanners, reconstructing using different algorithms, implementing attenuation correction from CT images, etc. Depending on progress and your interests, it would also be relevant to build a graphical user interface, compare the performance to the vendor software and implement advanced corrections, such a positron range correction. Furthermore, implementing machine-learning algorithms and GPU acceleration could be interesting [9, 10].

You should have an interest for medical imaging, feel comfortable with binary file formats and terminals and exhibit a good work discipline. You would then be part of a young, thriving, multi-disciplinary department that consists of doctors, human biologists, computer scientist, chemists, engineers, etc. We work hard and have lots of fun, both at work and outside.

References

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2. Ghotbi, A.A., et al., Rubidium-82 PET imaging is feasible in a rat myocardial infarction model. J Nucl Cardiol, 2017.
3. Murthy, V.L., et al., Clinical Quantification of Myocardial Blood Flow Using PET: Joint Position Paper of the SNMMI Cardiovascular Council and the ASNC. J Nucl Cardiol, 2018. 25(1): p. 269-297.

4. Cal-Gonzalez, J., et al., Improving PET Quantification of Small Animal [(68)Ga]DOTA-Labeled PET/CT Studies by Using a CT-Based Positron Range Correction. Mol Imaging Biol, 2018. 20(4): p. 584-593.
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6. Thielemans, K., et al., STIR: software for tomographic image reconstruction release 2. Phys Med Biol, 2012. 57(4): p. 867-83.
7. Pedemonte, S., et al., GPU Accelerated Rotation-Based Emission Tomography Reconstruction. 2010 Ieee Nuclear Science Symposium Conference Record (Nss/Mic), 2010: p. 2657-2661.
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9. Wang, G., et al., Image Reconstruction is a New Frontier of Machine Learning. IEEE Trans Med Imaging, 2018. 37(6): p. 1289-1296.
10. Xu, J., et al. 200x Low-dose PET Reconstruction using Deep Learning. ArXiv e-prints, 2017.

Required qualifications: interest for image analysis, competent in MatLab

Responsible institution: University of Copenhagen

Contact information: overlæge Rasmus Ripa, ripa@dadlnet.dk

Allowed no of students per report (1-2): 1-2

KU supervisor: Prof. Andreas Kjær

DTU supervisor: To be considered