Contribution ID: **49** Type: **Oral**

An unsupervised deep learning framework for respiratory motion correction in PET

Tuesday, 31 May 2022 16:30 (20 minutes)

Introduction: Breathing related patient motion during PET scans causes image artifacts, notably spatially variant blurring and degradation of contrast recovery. Dealing with these artifacts commonly involves respiratory gating, i.e. splitting the acquisition data into several temporal bins ("gates") depending on the respiratory cycle. With registration of the different gated images to one reference gate and subsequent averaging, motion artifacts can be minimized without increasing noise. However, traditional registration algorithms are frequently slow or of limited accuracy. In recent years, it has been shown that deep learning methods can be applied to image registration tasks. Once a neural network is trained, it can perform image registration in one pass, accelerating the process significantly. This work proposes an unsupervised deep learning framework for the registration of gated PET images.

Methods: Image pairs consisting of a fixed gate and a second moving gate serve as input to a convolutional neural network which predicts a deformation vector field (DVF) mapping the moving image to the fixed image. A spatial transformer layer is then used to warp the moving image accordingly. The network is trained in an unsupervised manner by optimizing a similarity metric between the fixed and warped images. Thus, ground truth DVFs are not required. A regularization loss is added to constrain the DVF to physically feasible motion. Fourteen gated FDG PET/CT scans (8 gates) were available and partitioned into 11 training scans and 3 validation scans. For network training, 130 coronal slices per scan were used. With consideration of all possible gate combinations per slice that resulted in 80080 training image pairs. The normalized cross correlation (NCC) between a mid-expiration reference gate and the remaining 7 gates was calculated before and after registration as a measure of registration accuracy. The motion correction performance was evaluated for one validation scan. The motion corrected image was obtained by averaging of all gates after registration and compared to the uncorrected image, the single reference gate, and the clinically available motion correction method "OncoFreeze". Lesion SUV_max and noise levels in the liver were determined.

Results: The developed network improved the average NCC by 0.013-0.050 for all validation scans. Motion related artifacts were virtually eliminated in the investigated scan. Compared to the ungated image, the lesion SUV_max was increased (8.1 vs. 4.4, respectively) while maintaining the noise level (at 8.3%).

Conclusion: In this work, we have proposed an unsupervised registration network for respiratory motion correction in PET. Our preliminary results indicate that the framework is suitable for efficient reduction of motion related artifacts without increasing image noise compared to the uncorrected images.

Primary author: ROSIN, Bia (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiopharmaceutical Cancer Research, PET Department)

Co-authors: NIKULIN, Pavel (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiopharmaceutical Cancer Research, PET Department); HOFHEINZ, Frank (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiopharmaceutical Cancer Research, PET Department); MAUS, Jens (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiopharmaceutical Cancer Research, PET Department); BRAUNE, Anja (Universitätsklinikum Carl Gustav Carus, Klinik und Poliklinik für Nuklearmedizin); KOTZERKE, Jörg (Universitätsklinikum Carl Gustav Carus, Klinik und Poliklinik für Nuklearmedizin); VAN DEN HOFF, Jörg (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiopharmaceutical Cancer Research, PET Department)

Presenter: ROSIN, Bia (Helmholtz-Zentrum Dresden-Rossendorf, Institute of Radiopharmaceutical Cancer Research, PET Department)

Session Classification: Image reconstruction for PET/MR and TB-PET

Track Classification: Image reconstruction for PET/MR and TB-PET