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MRI-based attenuation correction and quantification tools for combined MRI/PET

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Objectives: A combined human MRI/PET system consisting of Siemens 3T Trio MRI and LSO PET scanners has been installed at Emory University. However, its present design does not offer measured AC. Atlas-based, segmentation-based, and ultrashort TE (UTE) sequence-based methods have been proposed for AC. This study presents new segmentation and classification algorithms that are automatic, more personalized than the atlas-based method but don't require UTE sequences.

Methods: A multiscale segmentation method based on the Radon transform of MR brain images has been developed in order to overcome the difficulty of identifying the skull on T1-weighted MR images. Segmentation was evaluated by simulated data and Vanderbilt Database. A modified fuzzy C-means classification scheme was developed to segment the brain tissue into gray and white matter, and cerebrospinal fluid. Classification was validated by the SORTEO database. Each classified tissue is assigned an attenuation coefficient to generate AC factors. PET emission data are reconstructed using a 3D OSEM method with the MRI-based AC map. Ten subjects had separate MRI and PET scans while PET with [11C]PIB were acquired from a dedicated HRRT PET system. MRI and PET images were registered using our automatic registration method. MRI-based AC was compared with transmission (TX)-based AC from HRRT. Seventeen volumes of interest were manually drawn on each patient image to compare the PET activities between MRI and TX-based AC.

Results: The overlap ratio between our segmented results and ground truth is 92.2%±3.2%. Classification achieved an overlap ratio of >90.0%±1.0%. AC results from the 10 patients show that the difference between the MRI and TX-based methods was <6.5%. The correlation between the two AC methods was 93.6%.

Conclusions: Efficient quantitative MRI-based tools that include registration, segmentation, classification, and attenuation correction have been developed for combined MRI/PET.

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