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AUTOMATIC ATLAS-BASED BRAIN REGIONAL 18F-FLUORODEOXYGLUCOSE (FDG) UPTAKE QUANTIFICATION

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Summary: Brain metabolism is affected by a multitude of health factors. The healthy brain requires high glucose metabolism, which can be affected by ageing, neuro-degenerative disease or metabolic alterations of pharmacological origin. With brain diseases, such as Alzheimer's and Parkinson's disease, becoming serious social issues, brain Positron Emission Tomography (PET) studies of [18F] fluorodeoxyglucose with higher performance in terms of both spatial resolution and sensitivity have been proposed and developed over the past two decades. In this paper, a phantom PET volume is used to validate a quantification method of regional brain metabolism. The 3-D Hoffman phantom has become a standard tool in Nuclear Medicine, used for research purposes such as performance characterization of PET scanners or image analysis algorithms. We present the design and evaluation of an atlas based segmentation algorithm for regional brain metabolism based on PET images. The atlas-based segmentation of PET volumes is based on brain tissue segmentation followed by co-registration with the atlas brain tissue probability map. The registration transform is subsequently used to co-register the brain region atlas with the PET segmented brain volumes. The result is an individual pixel labelling of the PET brain volumes according to the corresponding brain regions. Two automatic segmentation algorithms, HMRF (Hidden Markov Random Fields) and Chan-Vese method, were used to perform brain tissue segmentations from PET images into white and grey matter. A non-rigid Affine registration based on mutual information algorithm was used for the volume-to-atlas co-registration. The adequacy of the two segmentation algorithms is validated with a ground truth volume given by a Digital Reference Object (DRO) of the brain phantom. The optimal registration matrix of the two images is calculated, and used for the final registration of the PET volume with the brain region atlas. The segmentation method is then used to extract brain regional Standard Uptake Values (SUVs) from an [18F] FDG PET human study. The results validate the usage of such a method to perform statistical evaluation of regional metabolic differences over different subjects.