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Skull Extraction for Quantification of Brain Volume in Magnetic Resonance Imaging of Multiple Sclerosis Patients

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Abstract : Multiple Sclerosis (MS) is an immune-mediated disease of the central nervous system characterized by neurodegeneration, inflammation, demyelination, and axonal loss. Magnetic resonance imaging (MRI), due to the richness in the information details provided, is the gold standard exam for diagnosis and follow-up of neurodegenerative diseases, such as MS. Brain atrophy, the gradual loss of brain volume, is quite extensive in multiple sclerosis, nearly 0.5-1.35% per year, far off the limits of normal aging. Thus, the brain volume quantification becomes an essential task for future analysis of the occurrence atrophy. The analysis of MRI has become a tedious and complex task for clinicians, who have to manually extract important information. This manual analysis is prone to errors and is time consuming due to various intra- and inter-operator variability. Nowadays, computerized methods for MRI segmentation have been extensively used to assist doctors in quantitative analyzes for disease diagnosis and monitoring. Thus, the purpose of this work was to evaluate the brain volume in MRI of MS patients. We used MRI scans with 30 slices of the five patients diagnosed with multiple sclerosis according to the McDonald criteria. The computational methods for the analysis of images were carried out in two steps: segmentation of the brain and brain volume quantification. The first image processing step was to perform brain extraction by skull stripping from the original image. In the skull stripper for MRI images of the brain, the algorithm registers a grayscale atlas image to the grayscale patient image. The associated brain mask is propagated using the registration transformation. Then this mask is eroded and used for a refined brain extraction based on level-sets (edge of the brain-skull border with dedicated expansion, curvature, and advection terms). In the second step, the brain volume quantification was performed by counting the voxels belonging to the segmentation mask and converted in cc. We observed an average brain volume of 1469.5 cc. We concluded that the automatic method applied in this work can be used for the brain extraction process and brain volume quantification in MRI. The development and use of computer programs can contribute to assist health professionals in the diagnosis and monitoring of patients with neurodegenerative diseases. In future works, we expect to implement more automated methods for the assessment of cerebral atrophy and brain lesions quantification, including machine-learning approaches. Acknowledgements: This work was supported by a grant from Brazilian agency Fundação de Amparo à Pesquisa do Estado de São Paulo (number 2019/16362-5).

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