EP1448

Automated tissue segmentation of magnetic resonance images of multiple sclerosis patients

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Background: Focal white matter (WM) lesions in multiple sclerosis (MS) reduce the accuracy of automated tissue segmentation methods. Although there are several methods focusing on automated MS lesion segmentation and lesion filling, few studies have tackled the brain tissue segmentation in images containing MS lesions as a standalone tool.

Aim: To propose a new, fully automated, multi-channel T1 and T2-FLAIR tissue segmentation method capable to deal with brain images that have WM lesions.

Methods: The proposed method combines a partial volume segmentation with multi-channel WM outlier post-processing on spatial and intensity characteristics attributes with respect to prior anatomical and morphological atlases. Resulted outliers are then refilled as WM, and segmented again using the same partial volume estimator. The method is evaluated with the MRBrainS13 challenge public database, which enables a quantitative comparison with well-known state-of-the-art segmentation methods, and with a set of 24 MS patient images, where manual lesion annotations are available. Furthermore, we also analyse the differences in performance when using only T1-w images or when using the multi-channel approach that includes T1-w and T2-FLAIR images.

Results: Our approach using T1-w and T2-FLAIR images was ranked in 7th position out of 31 participants, being the best non-supervised strategy. The performance was clearly superior to methods such as FAST and SPM12 (ranked 17/21th), even if they used both image modalities. With MS data, differences in grey matter (GM) and WM volumes between the segmentation masks and the same images where lesions had been lesion filled before segmentation were below 0.15% when using the T1-w and T2-FLAIR modalities. The performance was also similar or better when comparing with pipelines that combined state-of-the-art automated lesion segmentation and filling. The use of both T1-w and T2-FLAIR modalities also reduced the error in tissue volume compared with the pipelines using only T1-w.

Conclusion: Our results show that the proposed method is able to compute accurate brain tissue volume measurements in images containing MS WM lesions, without requiring manual intervention.

Disclosure

S. Valverde: nothing to disclose.
A. Oliver: nothing to disclose.
S. González-Villà: nothing to disclose.
E. Roura: nothing to disclose.
D. Pareto: has received speaking honoraria from Novartis and Genzyme.
J.C. Vilanova: nothing to disclose.
Ll. Ramió-Torrentà: has received speaking honoraria and travel expenses for scientific meetings and has participated in advisory boards in the past years with Bayer Schering Pharma, Biogen, EMD Merck Serono, Sanofi Genzyme, Novartis, Sanofi-Aventis, Teva Phramaceuticals, Almirall and Roche.
A. Rovira: serves on scientific advisory boards for Biogen Idec, Novartis, Genzyme, and OLEA Medical, has received speaker honoraria from Bayer, Genzyme, Sanofi-Aventis, Bracco, Merck-Serono, Teva Pharmaceutical Industries Ltd, OLEA Medical, Stendhal, Novartis and Biogen Idec, and has research agreements with Siemens AG.
X. Lladó: nothing to disclose.