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A quantitative study of the effects of white matter multiple sclerosis lesions on tissue segmentation methods

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Background: Automatic brain tissue segmentation of MR images is important for quantitative analysis of tissue volume measurements in the diagnosis and monitoring of the Multiple Sclerosis (MS) pathology. However, including White Matter Lesions (WML) into the tissue distributions estimated by automated methods influences the average intensity of tissue segments and boundaries leading to volumetric tissue estimation errors

Aim: To perform a quantitative evaluation of the impact of WML on six brain tissue segmentation.

Methods: FAST, SPM5, SPM8, FANTASM, a classic Fuzzy-C-Means (FCM) approach, and an Artificial Neural Network (ANN) approach

Materials and Methods: From a set of 30 MS T1-w image patients with different lesion load we compute the differences in volume estimation between images with lesions and the same images where the lesions have been manually masked before segmentation and relabelled as WM after. We compute first the percentage of classification as GM, WM and CSF on WML regions. Afterwards, we analyse the percentages of change on total tissue estimation between masked and lesion images. Finally, we analyse the percentages of change caused by WML on tissue outside lesion regions

Results: Our experiments show that all methods tend to overestimate total GM tissue in images with MS lesions when lesion volume increases. SPM8 is the method from the study with the lowest incidence of WML in volume estimation while FCM produces the highest GM overestimation. Furthermore, the effects of WML intensities and lesion size on tissue distributions estimated by automated methods also induce changes in tissue outside lesion regions. All methods tend to overestimate GM tissue outside lesion regions with differences up to $20cm^3$ in images with high lesion loads (~50 ml). These differences are lower in SPM8 and FANTASM, while the influence of WML in tissue outside lesion regions is more important in methods such as FCM and FAST

Conclusion: Our results suggest that cancelling the effect of WML voxels classified as GM or CSF by relabelling them after is not enough, because the artificial increase of GM introduced by methods outside lesion regions could hide possible changes in healthy tissue, such as tissue loss in brain atrophy. The impact of WML can be specially relevant in the presence of hidden lesions, for instance in intra-patient studies with several MRI scans along time to measure the effect of drug therapies, changes in brain atrophy or monitor disease progression

Nothing to disclose