



## 3D reconstruction and segmentation method of Multiple Sclerosis with Fuzzy Connectedness, Binarization, Mathematical Morphology and Pattern Recognition

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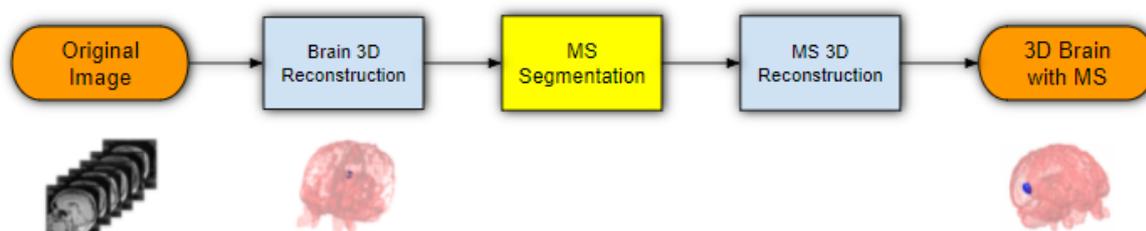
**Background, Motivation and Objective.** Multiple sclerosis (MS) is one of the leading causes of disability in young adults, related to the central nervous system (DOI: 10.1159/000342779). The diagnosis is clinical and complemented by magnetic resonance imaging (MRI). Despite being a robust tool for data collection, this exam provides subject information on MS (DOI:10.1109/42.491417). Thus, segmentation technique is important in the quantitative analysis of the disease. Although MS is an incurable disease, follow-up of the disease may help in the treatment of patients, determining the area and volume of the temporal lobe region through segmentation. However, manual segmentation of the temporal lobe may take up to 75 minutes per image (DOI: 10.1007/978-81-322-2517-1\_7). In addition, segmentations performed by different specialists may present divergences. Literature has good MS segmentation practices with deviation detection, variation of stochastic relaxation in 3D and probability model. Although accurate, the authors prior only the method's automaticity, without focusing on accuracy and precision. Consequently, this work is being developed with a semi-automatic method of 3D segmentation and reconstruction of MS with growth by region based on Fuzzy Connectedness, pattern recognition and mathematical morphology.

**Methods.** This work aims to present the methodology, to segment a set of magnetic resonance images and to evaluate the accuracy of the proposed method, comparing the results obtained with the Gold Standard done manually by specialists. A total of 4 MRIs, adding 480 slices, were obtained from the diagnostic imaging department (DDI) of UNIFESP - Campus of São Paulo, to which the ethics and study protocol was directed for approval by the competent committee. The methodology is divided into three stages. The reconstruction of the brain in 3 dimensions from the slices of the patient's MRI. MS segmentation extracts specific information through Fuzzy Connectedness (DOI: 10.1109/42.640750), binarization, and mathematical morphology. And the 3D reconstruction of MS that provides better visualization of the areas of the brain affected by the disease. The methods are indicated in the **Figure 1**.

**Results.** The results obtained with the initial phase of the work are stimulating and are shown in **Table 1** with mean and standard deviation. It has not yet been possible to compare many Gold Standard (GS) segmentations made manually by specialists, however it is possible to observe that Fuzzy Connectedness is a good method of 3D segmentation. In total, 24 slices indicating MS with their GS made by specialists. The evaluation parameters used are based on UDUPA (DOI: 10.1006/gmip.1996.0021), True Positive, False Negative, False Positive and Overlap Ratio.

**Discussion and Conclusions.** The affinity function for the beginning of the work was of dynamic weights, that is, for each pixel it is computed which is better, homogeneity or intensity. Other affinity functions will still be tested to compare with the GS and get the best result. Rebuilding the brain in 3D along with Multiple Sclerosis is already an achievement for the initial phase of the project. The values reached in the evaluation parameters are also satisfactory, indicating that the error rate FP and FN is low, and can be compared to the divergence among different specialists.

**Figure 1.** Methods applied in this work



**Table 1.** Evaluation parameters

TP (%)	FN (%)	FP (%)	OR (%)
0.81 ± 0.06	0.06 ± 0.03	0.06 ± 0.03	0.92 ± 0.03

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**Keywords.** Multiple Sclerosis; Reconstruction; Segmentation.