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Segmentation of Brain Tumors Using Diffusion Tensor Imaging

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Diffusion Tensor Magnetic Resonance Imaging (DT-MRI) is capable of sensitizing MRI signal intensities as functions of random motions of water molecules, usually referred to as diffusion. Water diffusion measurements have been shown to be sensitive to tissue cellular size, extra cellular volume, and membrane permeability. Therefore, DT-MRI can be used to characterize highly cellular regions of tumors versus acellular regions, distinguishing cystic regions from solid regions.

Volume and characteristics of the brain tumors are useful for their diagnosis as well as treatment planning and evaluation. Conventionally, experts segment tumors manually from anatomical images acquired with different contrast mechanisms such as FLAIR, T1, T2, and Gd-enhanced T1. However, acquisition of these anatomical images is time consuming. Manual segmentation of tumor is also time consuming and expensive. To overcome these limitations, we propose to segment brain tumors using DT-MRI data that are acquired very quickly. To this end, we have developed and evaluated an automatic segmentation that segments brain tumors using DT-MRI.

The proposed method is based on a multi-phase clustering algorithm. It has been developed and optimized using a sequential backward selection algorithm. The proposed segmentation method has been applied on DT-MRI of 20 patients with 4 different types of brain tumors. Tumors have also been segmented by the eigenimage filtering of the anatomical images. The DT-MRI segmentation results have been evaluated using the anatomical segmentation results and the biopsy results. The DT-MRI results have been 92% accurate when compared to the segmentation results obtained from the anatomical images and 100 % accurate when compared to the biopsy results.

In conclusion, it is possible to segment brain tumors using DT-MRI such that the segmentation results are in full agreement with the biopsy results and segmentations obtained from the anatomical images.