A Novel Segmentation Approach for Brain Tumor in MRI

Submitted to the Faculty Research Day 2015 at University of North Georgia

Yong Wei
Department of Computer Science & Information Systems
University of North Georgia

Abstract

Brain MR image segmentation is one of the most important applications of image segmentation technique in medicine, and is an important part of clinical diagnostic tools. Segmented image can help physicians to identify tumor tissues in brain, estimate tumor size, and monitor effectiveness of chemotherapy treatments. Manual segmentation of tumor regions in MR images is not only inaccurate, but also time consuming.

In a ColorMRI^{TM} fusion image of axial brain shown in Figure 1, the active tumor is pink exhibiting some heterogeneity and the adjacent white matter is edematous (pale green). Segmentation using pixel color intensities directly will group together specific areas of gadolinium uptake in the tumor as well as some non-specific uptake in the posterior orbital fat together (Figure 2). Obviously, using Figure 2 can not measure tumor region area correctly.

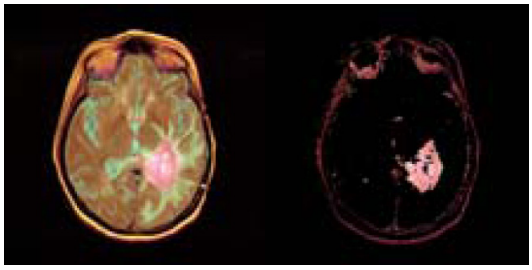

Figure 1 **Figure 2**

Fuzzy *c*-means (FCM) is a clustering method that allows a data point to belong to more than one cluster. Each point has a degree of belonging to a cluster. However, FCM along can not correctly segment tumor tissues in brain MR images. Intensity Space Map (ISM) is a region growing segmentation algorithm for medical images. The assumption for ISM is that pixels inside the region of interest not only have similar color intensities but also connect to other pixels inside the anatomical region. For color MR images, there are multiple intensity channels, i.e. red, green and blue channels respectively. Hence, an Intensity Space Map (ISM) is proposed for each color channel in a color image.

The ISM algorithm starts with a pre-selected seed point inside the region of interest. Initial values of all pixels in the ISM image are set to zero. During each iteration, the ISM values of pixels of each intensity channel which satisfy both of the following conditions are incremented by 1: Condition 1: pixel intensity difference from the seed point is within a threshold T; Condition 2: the pixel belongs to a structure which overlaps the seed point.

In this work, we use the intensity space map (ISM) and fuzzy c-means algorithms to perform brain tumor segmentation in images extracted from longitudinal relaxation time T_1 and transverse relaxation time T_2 MR images. ISM utilizes both pixel color intensity and image topological information. It is a promising candidate as a predicate used for segmentation. Experimental results show that fuzzy c-means segmentation applied on ISM can effectively segment brain tumor regions in MR images. It provides a solid foundation for tumor volume estimation for physicians to evaluate progress of the cancer and effectiveness of chemotherapy treatments.

Some experimental results:

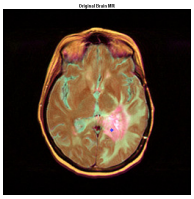

Figure 3 MRI of a Brain Tumor Patient, seed point is shown

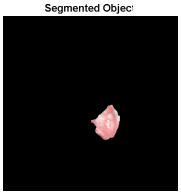

Figure 4 Segmented Tumor Region

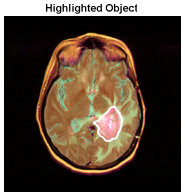

Figure 5 MRI with Segmented Tumor Region Highlighted