3-D Representation System of Brain Tumors Using Magnetic Resonance Images (MRI)

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To my dear Mom in Heaven.

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Abstract

THE brain is the most sophisticated and crucial organ to human beings. It controls all the functions of the body, from the involuntary actions such as respiration, digestion and blood circulation, to motor control and sensing and finally feelings, cognition and perception.

Brain tumors are considered one of the most dangerous threats to the health of the human brain. They have various types and classifications, some are treatable and others are not. Diagnosis of brain tumors is mainly done by Magnetic Resonance Imaging (MRI) which has the ability to show the abnormal tissues. After thorough diagnosis, the treatment plan should be set which may include one or more of surgical resection, radio therapy and chemotherapy. For treatable types of tumors, the patient can be totally cured after total tumor resection. While for high grade malignant types, total resection can increase the survival time and the quality of life of the patients significantly.

One of the factors that help in efficient surgical resection of tumors is the prior knowledge of the precise shape, location and size of the tumor. MRI cannot perform this task because the output images of the scan are in the form of a series of 2-dimensional images containing slices of the brain. Hence, the presence of accurate 3-dimensional images for the tumor will help in the resection efficiency.

This thesis presents a modified shape-based interpolation method to form a 3-D model of brain tumors using a series of MRI images. Due to some technical properties of MRI scanners, the output images have intermediate gaps, this missing information prevents accurate 3-D reconstruction for the tumor volume. Hence, the problem is to interpolate the values of tumor volume at the gap areas to get a complete 3-D model for the tumor.
First, the MRI images are segmented using Wavelet Multiresolution Expectation Maximization (WMEM) method, then, the tumor image is extracted forming a binary image. Next, all binary tumor images are converted to distance images using a distance transform function. Then, the B-spline interpolation is applied to calculate the gap area. Finally, the resulting values are thresholded to form the interpolated slices. The tumor volume is then displayed as an isosurface in a 3-D view.

To calculate the accuracy of the method, a slice is removed from the images' series, then the proposed method is used to interpolate its value. The original and interpolated slices are compared showing the accuracy. The proposed method results were compared with the original shape-based interpolation method and another method that uses Hermite interpolation. The proposed method demonstrated improvement of 5.61% and 2.78% on the original shape-based method and the Hermite interpolation method respectively.

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