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3D Construction of Brain Tumour

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Abstract: ***Brain Tumor is an abnormal mass of tissue found in Brain. Some techniques like MRI and CT generate 2D images of internal parts of the body. As two dimensional images never give the actual feel of how a tumor exactly looks like, 3D reconstruction of the tumor is necessary for diagnosis, surgical planning and biological research. Diversity and complexity of the tumors makes it very challenging to visualize tumor in MRI. 3D image reconstruction is one of the most attractive avenues in digital signal processing especially due to its application in biomedical imaging. Work presents an efficient and effective approach to 3d construction. it involves implementation of various steps like image pre-processing, image segmentation by FCM and Wavelet, Mesh generation by marching cubes algorithm and finally rendering to add realistic effects.***

Keywords: Brain, tumour, construction 3d, biomedical

1. Introduction

Brain tumor is inherently serious and life- threatening because of its invasive and infiltrative character in the limited space of the intracranial cavity. Hence determining its pathology, volume and complexities is crucial for surgical planning and knowing the stage of cancer. Magnetic resonance imaging (MRI) is the commonly used imaging modality for non- invasive analysis of the brain tumor. MRI uses radio waves and magnetic fields to acquire a set of cross sectional images of the brain. That is anatomic details of the 3D tumor are presented as a set of 2D parallel cross sectional images. Representation of a 3D data in the form of 2D projected slices does result in loss of information and may lead to erroneous interpretation of results. Also, 2D images cannot accurately convey the complexities of human anatomy and hence interpretation of complex anatomy in 2D images requires special training. Although radiologists are trained to interpret these images, they often find difficulty in communicating their interpretations to a physician, who may have difficulty in imagining the 3D anatomy. Hence, there is a need for 3D reconstruction of the tumor from a set of 2D parallel crosssectional images of the tumor. 3D visualization enables better understanding of the topology and shape of the tumor, and enables measurements of its geometrical characteristics. The extracted information is helpful in staging of tumor, surgical planning, and biological research . Therefore, how to reconstruct a trustworthy surface from the sequential parallel 2D cross sections becomes a crucial issue in biomedical 3D visualization.

2. Literature Survey

Chethan Kumar, Anitha Kumari R.D, “3D Reconstruction of Brain Tumour from 2D MRI’s using FCM and Marching cubes “,The 3D model of the brain tumor was reconstructed from 2D slices of brain by developing methods for segmentation, inter- slice interpolation and mesh generation. The tumor was segmented by using FCM technique. Since the FCM segmentation is non deterministic algorithm, an algorithm can be proposed to minimize the time for execution. Large numbers of triangles are generated by the marching cubes algorithm; hence an algorithm is to be designed to minimize the triangles so that the reconstruction time speeds up.

Hassan Khotanlou, Olivier Colliot, Jamal Atif, Isabelle Bloch’s “3D brain tumor segmentation in MRI using fuzzy classification, symmetry analysis and spatially constrained deformable models”, hybrid segmentation method that uses both region and boundary information of the image to segment the tumor. This work shows that the symmetry plane is a useful feature for tumor detection. This method focuses on Segmentation using symmetry which can be useful in detection with area close to the edges of the skull where traditional methods don't often provide viable solution.

Megha P. Arakeri and G. Ram Mohana Reddy ’s “An Effective and Efficient Approach to 3D Reconstruction and Quantification of Brain Tumor on Magnetic Resonance Images “, The 3D model of the brain tumor was reconstructed from a given set of 2D slices of the brain by developing methods for segmentation, inter-slice interpolation, mesh generation and simplification. Slices containing tumor were extracted from a given set of slices of the brain and the tumor was segmented with the proposed segmentation technique. The centroid alignment technique in the proposed enhanced shape based interpolation helped in accurately estimating the missing slices by handling the shifts in the cross sections and the inclusion of the chamfer distance transform improved the efficiency of shape based interpolation method. Rendering phase was accelerated by simplifying the mesh with the proposed mesh simplification algorithm. The reconstructed tumor was also quantified by measuring its volume. proposed 3D reconstruction approach can generate an accurate 3D model in less amount of time and thus can assist the radiologist in the diagnosis, identifying the stage of the tumor and treatment planning.

3. Design and Implementation

1) Image pre-processing and Histogram analysis

Preprocessing is performed to improve the quality of the acquired images. The noise can mask and blur the important features in the MR image and thus make the further steps in medical image analysis difficult. Hence, to improve the perceptibility of the tumor and other structures in the brain, guassian filtering was used. Image contrast was enhanced by applying histogram equalization. The normal slice consists of three regions white matter (WM), gray matter (GM) and cerebrospinal fluid (CSF). Where as a slice with tumor consists of four regions (WM, GM, CSF and tumor). Thus in order to determine whether the given MR image of the brain is normal or abnormal, the histogram of the brain region is computed. If the histogram consists of three peaks then the given MR image is considered as the normal slice and further processing of the MR image is not carried out. Otherwise, we consider that the slice contains the abnormal region and proceed to apply segmentation.

2) Image segmentation using FCM and Wavelet

Clustering is one of the widely used image segmentation techniques which classify patterns in such a way that samples of the same group are more similar to one another than samples belonging to different groups. The algorithm minimizes intra-cluster variance Scan two slices and create a cube from four neighbors on one slice and four neighbors on the next slice. Calculate an index for the cube by comparing the eight density values at the cube vertices with the surface constant. Using the densities at each edge vertex, find the surface edge intersection via linear interpolation. Calculate a unit normal at each cube vertex using central differences. Interpolate the normal to each triangle vertex.

3) Slice Interpolation

After the segmentation, slices of the segmented tumor are stacked up to form the volume data in the 3D space. Generally, the set of slices acquired from the MRI device is such that the distance between the slices is larger than the distance between the pixels within the slice. The surface reconstructed with such a set of slices is inaccurate and not smooth. Thus in this work, the missing slices are estimated using interpolation technique.

4) Mesh generation using Marching cubes

Once we have the complete set of slices, we apply the MC algorithm to reconstruct 3D surface of the tumor from a set of 2D cross sectional images. The MC algorithm operates on a logical cube created from eight pixels; four each of two adjacent slices. It processes one cube at a time and determines how the surface intersects each cube using the isovalue of the surface and cube-isosurface intersection patterns.

5) Rendering

In the final step, realistic effects are added to the surface of the 3D model by applying Phong lighting model. First the normals of the triangle vertices in the mesh are computed by taking the average of the adjacent triangle normals. Then the shading model linearly interpolates the vertex normal and then applies the lighting model at each point on the surface to determine the intensity at that point and thus shades the entire surface.

4. Expected Results

The 3D model of the brain tumor will be constructed from 2D slices of brain by developing methods for segmentation, inter- slice interpolation and mesh generation. The tumour was segmented by using FCM technique. The slices with tumors were stacked. By using Marching cubes Meshing algorithm the tumour was reconstructed. The proposed 3D reconstruction approach can generate an accurate 3D model in less time

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