2D TO 3D RECONSTRUCTION OF MRI BRAIN ABNORMAL IMAGES

M.Priyanka[1], M.Nivethitha[1], K.Annalakshmi[1], T.Pandiselvi[2]
[1]UG Students, [2] Assistant Professor
Department of Electronics and Communication Engineering
Kamaraj College of Engg & Technology, Virudhunagar, Tamilnadu
priyankamanikandanece@gmail.com nivethitha.219@gmail.com annalakshmisks@gmail.com, pandstk@gmail.com

ABSTRACT: **Brain Tumor is an abnormal 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. This work presents an efficient and effective approach to 3D reconstruction. It involves the implementation of various steps like image classification, image segmentation ACO algorithm and finally mesh generation using marching cube algorithm and rendering to give realistic effects [1]. In this the marching cube algorithm is implemented in Matlab and 25 slices of segmented images are merged for 3D reconstruction of tumor.**

Keywords--- Brain tumor, Magnetic Imaging (MRI), 3D Reconstruction, Meshing, Rendering.

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 cross sectional images of the tumor. 3D visualization enables better understanding 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.

PROPOSED METHODOLOGY

The block diagram for the 3D Reconstruction of tumor from an abnormal image set is as follows,

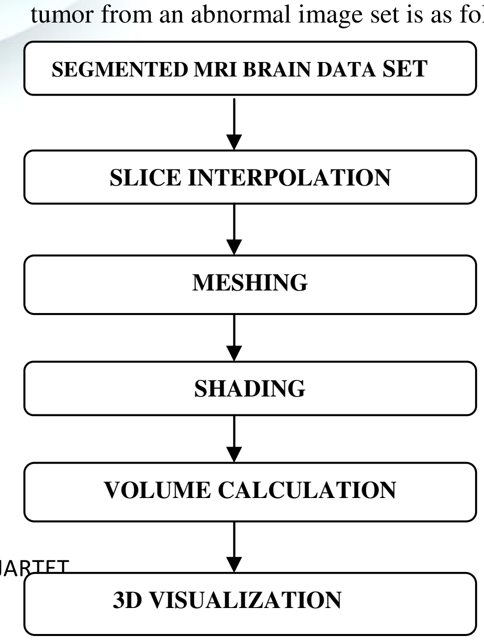


Fig 1.Block diagram of proposed methodology

3D RECONSTRUCTION

The 3D Reconstruction involves the use of slice, from the segmented brain tumor slice the 3D construction is done. This paper present a new algorithm called Marching cube that creates triangle models of constant density surface of 3D medical data [6]. Using a Divide and conquer approach to generate inter-slice connectivity, we create a case table that defines triangle topology. The algorithm process the 3D medical data in scan line order and calculate triangle vertices using linear interpolation [4]. Find the gradient of the original data, normalize it, and uses it as a basic for shading the models. The detail in images produced from the generated surface models is the result of maintaining the inter-slice connectivity, surface data and gradient information present in the original 3D data. There are two primary steps in our approach to the surface construction problem. First, the surfaces are located corresponding to a user-specified value and create triangles. Then to ensure the quality image of the surface, we calculate the normals to the surface at each vertex of each triangle.

Marching cubes uses a divide and conquer technique to locate the surface in a logical cube created from eight pixels, four from each to adjacent slices.

The algorithm determines how the surface intersects this cube, then moves to the next cube. Christo Ananth et al. [7] proposed a method in which the minimization is per-formed in a sequential manner by the fusion move algorithm that uses the QPBO min-cut algorithm. Multi-shape GCs are proven to be more beneficial than single-shape GCs. Hence, the segmentation methods are validated by calculating statistical measures. The false positive (FP) is reduced and sensitivity and specificity improved by multiple MTANN. Complementary cases , were vertices greater than the surface value are interchanged with those less than the value, or equivalent. Thus, only cases with zero to four vertices greater than the surface value need be considered, reducing the number of cases to 128. Using the second symmetry property rotational symmetry, we reduced the problem to 14 patterns by inspection.

The simplest pattern, 0, occurs if all vertex values are above (or below) the selected value and produced no triangles. The next pattern, 1, occurs if the triangle defined by the three edge intersection. Other patterns using complementary and rotational symmetry produces the 256 cases.

The index is created for each case, based on the state of the vertex. This index serves as a pointer into an edge table that gives all edge intersections for a given cube configuration [6].

Using the index to tell which edge the surface intersects, we can interpolate the surface intersection along the edge. We use linear interpolation [9]. But have experimented with higher degree interpolation. Since the algorithm produces at least one and as many as four triangles per cube, the higher degree surfaces show little improvement over liner interpolation.

The final step in marching cubes calculates a unit normal for each triangle vertex [4]. The rendering algorithm use this normal to produce Gouraud-shaded images. A surface of constant density has a zero gradient component along the surface tangential direction; consequently, the direction of the gradient vector, g, is normal to the surface. We can use this fact to determine surface normal vector, n, if the magnitude of the gradient,|g|, is nonzero. Fortunately, at the surface of interest between to tissue types of different densities, the gradient vector is nonzero. The gradient vector, g, is the derivative of the density function

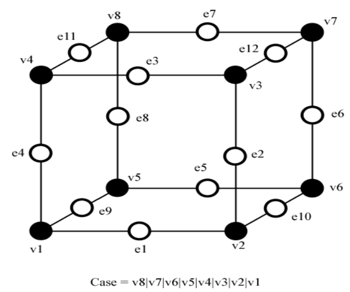
$$G(x,y,z)= \Delta f(x,y,z)$$

To estimate the gradient vector at the surface of interest, we first estimate the gradient vectors at the cube vertices and linearly interpolate the gradient at the point of intersection. The gradient at cube vertex (i, j, k), is estimated using central differences along three co-ordinates axes by,

$$Gx = \frac{D(i+1,j,k) - D(i-1,j,k)}{\Delta x}$$

$$Gy = \frac{D(i+1,j,k) - D(i-1,j,k)}{\Delta Y}$$

$$Gz = \frac{D(i+1,j,k) - D(i-1,j,k)}{\Delta Z}$$



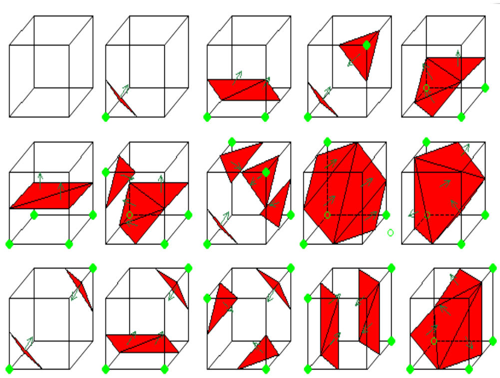


Fig 2. 15 patterns for meshing

Where D(i, j, k) is the density at pixel (i, j) in slice k and x, y, z are the lengths of the cube edges. Dividing the gradient by its length produces the unit normal at the vertex required for rendering. It linearly interpolate this normal to the point of intersection. Note that to calculate the gradient at all vertices of the cube, This keep four slices in memory at once [8]. Three dimensional set of data are processed [6] as follows

1. Read four slices into memory.
2. Scan two slices and create from four neighbors on one slice and four neighbors on the next slice.
3. Calculate an index for the cube by comparing the eight density values at the cube vertices with the surface constant.
4. Using the index, look up the list of edges from a pre-calculated table.
5. Using the densities at each edge vertex, find the surface edge intersection via Linear interpolation.
6. Calculate a unit normal at each cube vertex using central differences. Interpolate the normal to each triangle vertex.
7. Output the triangle vertices and vertex normals.

RESULT AND CONCLUSION

Marching cubes, a new algorithm for 3D reconstruction complements 2D, CT, MR, SPECT data by giving physicians 3D view of anatomy. The new algorithm uses a case table of edge intersection to describe how a surface cuts through each cube in a 3D data set. The resulting polygonal structure can be displayed on conventional graphics displays systems. The density of surface points is chosen to cover the raster display. It provides the good quality image and the shading governs the perceived quality of the image. The input taken for construction of a 3D surface is the segmented abnormal image slice. Figure 3 shows the segmented sample MRI brain image,

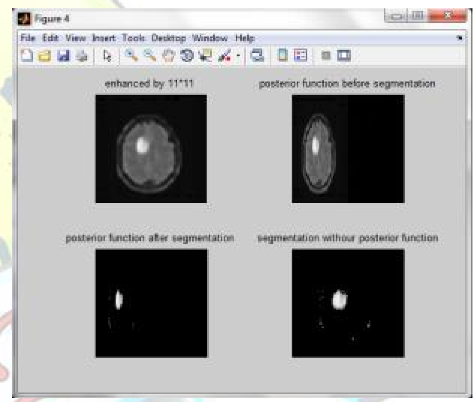


Fig 3, A sample of segmented MRI brain image by ACO algorithm.

Figure 4 shows the set of contours for the 25 segmented interconnected slices.

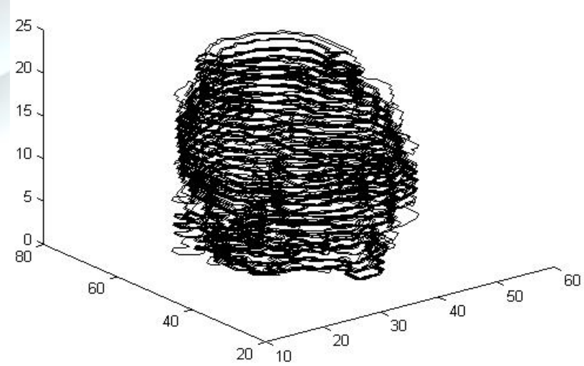


Fig 4. Contour plot of set of segmented tumor slices

Figure 5 shows the output of 3D reconstructed tumor part and it helps in obtaining the volume, that is calculated by product of length, breadth and height.

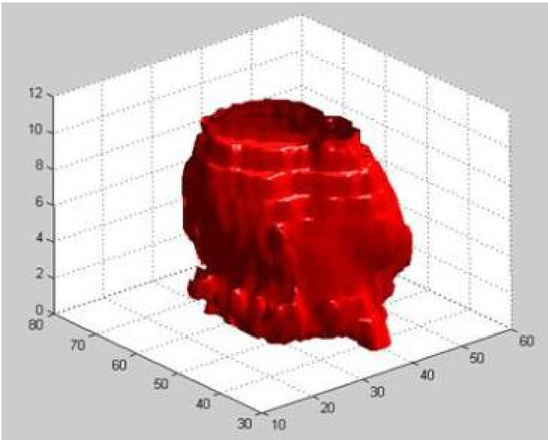


Fig 5. 3D Reconstructed output

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