Overhaul of Three-D Image Based on Metamorphosis and Fabric Growing of Two-D Images

Indira S. P., Shreedhara K S

Abstract*: *Shape is a critical physical property of normal and artificial three-D images that describes their outside appearances. Understanding differences among shapes and displaying the inconstancy inside and outside the shape classes are considered for shape analysis, and are the major issues in numerous applications, from normal image visualization to medical imaging. During diagnosis in medical image processing it is impossible to analyze the diseased areas some time from three-D images. So for the purpose of diagnosing the diseased areas of three-D image, medical experts need two-D images. This paper addresses the overhaul of three dimensional models from two-D images. In the initial step the image is segmented using level set method. Later segmented image is extracted and registered for overhaul of three dimensional images using metamorphosis and fabric growing methods. The practical result shows the implementation of the suggested method.

Keywords: Overhaul of Three-D Image, Two-D Image, Segmentation, Metamorphosis, Fabric Growing.

I. INTRODUCTION

The main physical property of both natural as well as artificial objects is shape. Shape characterizes the external appearances of objects. Understanding the differences between shapes is the variability between the objects and these are the fundamental problems and building blocks to many applications such as computer vision and medicine. In medical field the shape study of three dimensional anatomical structures and modeling their growth patterns are main interesting character. Since many diseases can be linked to alter different shapes structures [1], [2], [3].

In computer graphics [8], the shape of three dimensional modeling from low level primitives is a difficult process. Three dimensional models can be used as geometrical and structural priors for preferring the three dimensional overhaul and modeling processes.

The main goal of this paper is to present an overhaul of three dimensional models from segmentation of two dimensional data in the initial step. Segmented image is extracted and used for overhaul of three dimensional model using metamorphosis and fabric growing of two dimensional images in the step.

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The frame format of this current paper is as follows: the next section describes the background of segmentation process. Section III gives the method of extraction and registration of two D segmented image. Section IV describes a methodology of proposed system. The experimental details and discusses experimental results in section V. Finally, the work is concluded.

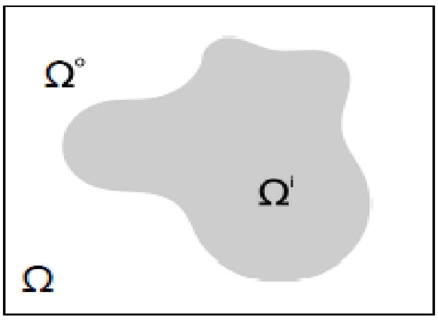
II. BACKGROUND

A. SEGMENTATION

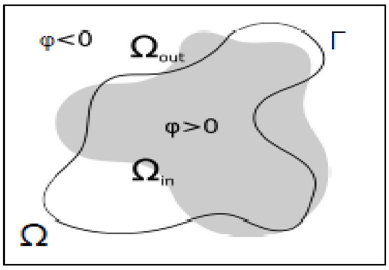
It is a method of automated detection of objects in a given image 'I'. A procedure is of dividing a given region into parts depending on some chosen characteristics of technique is called 'Segmentation'. The Level Set method is used for segmentation of images.

Level-set method was introduced by Stanley and Sethian [6].This method describes the numerical representation of curves and surfaces. These methods are important in holding topological changes of objects.

Consider closed curves in a sub region of a two dimensional Euclidean space. Closed curve is classified into two regions, 'Ω in' and 'Ω out' is shown in figure 1(a). It is called as 'inside region' and 'outside region' respectively. The arbitrary curve of finite length can be specified parametrically as a function $\Gamma : [0; 1] \rightarrow \Omega$, with $\Gamma(0) = \Gamma(1)$ implying that it is closed, this representation is in convenient for numerical computations and for changing the curve 'Γ' in time is shown in figure 1 (b). However, it can be represented alternatively as a Zero Level-Set of some function $ø: \Omega \rightarrow R$. For numerical approximations and sampling the function ø, smoothness is a desirable property, the stationary curve is shown in figure 1(c). That is $ø > 0$ in Ω in and $ø < 0$ in Ω out. Then Ω in = Γ = Ω out.

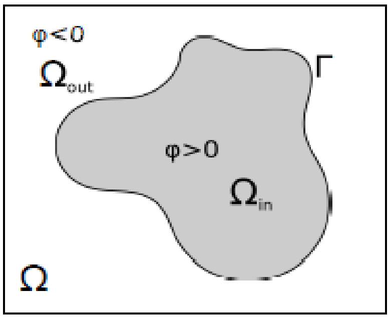


Ω- Euclidean space:'Ω^I in' region and 'Ω^o out' region
a) Binary image



Γ: Closed curve, ø: zero level-set function

b) Evolving curve



c) Stationary curve

Figure 1: Binary image

B. PROCESSING STEPS

The Overhaul of Three-D Image with segmentation, extraction and registration of segmented data includes following steps.

Step 1: Input CT/MR image

Step 2: Identify the Interest Region (ROI) from the input image.

Step 3: Identified Interest Region (ROI) undergoes segmentation process.

Step 4: ROI is segmented using Level Set (LS) method.

Step 5: Segmented image (ROI) is used for extraction and registration process.

Step 6: Display of the Overhaul of Three-D Image is based on extraction and registration of segmented image using Metamorphosis method in the first stage.

Step 7: Display of the Overhaul of Three-D Image is based on extraction and registration of segmented image using fabric growing method in the second stage.

Step 8: Visualization of Overhaul of Three-D Image.

III. EXTRACTION AND REGISTRATION OF TWO-D SEGMENTED IMAGE

A.USING METAMORPHOSIS METHOD

The motion of an object is classified into two categories under metamorphosis method.

- **Relocation:** Here the object is shifting from one location to another location using relocation parameters.
- **Revolving:** Here the object is moved in circular path with fixed point as reference point and body is moved from one place to next place with suitable angle of reference.

B. USING FABRIC GROWING METHOD

The moving of an object is classified under relocation and revolving. Consider motion of plane in which the plane contains the center, and treat the body as a thin slab.

Let $GL(n,R)$ denote the group of dimension $'n'$. The manifold $GL(n,R)$ is considered as subset of R^2.

RG(n) is referred as the rotation group on R^n.

The Euclidean set is denoted by $SE(n)$ == RG(n)×R^n and also it represents the all displacements in R^n.

C. Consider an object RO, movement in free space and assume any initial reference fabric denoted by ‘ F ‘in fixed space and another fabric denoted by ‘ M ‘to an object fixed at point $'O''$ is shown in figure 2.

At each instance the aim of the RO is described by a homogeneous metamorphosis matrix (MM). The $'A'$, related to the displacement from fabric $'F'$ to fabric $'M'$. Where FOM is the fixed object metamorphosis set in two-dimensions:

$$FOM = \{A | A \begin{bmatrix} R & d \\ 0 & 1 \end{bmatrix}, R \in R^{2\times 2},$$

$d \in R^2, R^T R = I, \det(R) = 1$ }

The FOM is another small set of closed general linear group.

$$= \{\widehat{\omega} \epsilon R^{\ 2\times 2}, \widehat{\omega}^T = -\widehat{\omega}\}$$

$$FOM = \{\begin{bmatrix} \widehat{\omega} & v \\ 0 & 0 \end{bmatrix} | \widehat{\omega} \epsilon R^{2\times 2}, v \epsilon R^2, \widehat{\omega}^T = \widehat{\omega}\}$$

A 3x3 skew symmetric matrix $\widehat{\omega}$ can be uniquely identified with a vector $\omega \,\epsilon R^3$ so that for arbitrary $x \,\epsilon R^3$, $\widehat{\omega} x = \omega \times x$, where $'\times'$ is the cross product operation in R^3.

Each element $S \,\epsilon\, FOM$ can be thus identified with a vector pair $\{u, v\}$.

Given a curve

$$A(t): [-a, a] \to FOM, A(t) = \begin{bmatrix} R(t) & d(t) \\ 0 & 1 \end{bmatrix}$$

An element $S(t)$ of the linear algebra FOM is related to the tangent vector $A(t)$at an arbitrary point ‘t' by,

$$S(t) = A^{-1}(t)\hat{A}(t) = \begin{bmatrix} \widehat{\omega}(t) & R^T d \\ 0 & 0 \end{bmatrix}$$

Where $\widehat{\omega}(t) = R^T \hat{R}$ is the related element from FOM

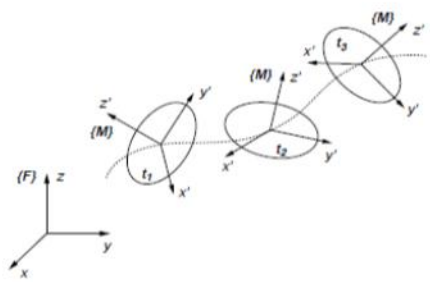


Figure 2: The fixed fabric (FF) and moving fabric(MF) related to the fixed object(FO)

A curve on FOM denotes a movement of the fixed object.

Consider a vector pair $\{\omega(t), v(t)\}$ corresponding to $S(t)$, then ‘ ω’ related with the speed of the fixed object.

While $'v'$ is the velocity of the inception $'o''$of the fabric $\{M\}$, both demonstrate in the fabric $\{M\}$. Since the FOM is a vector space, the element can be given by a 3x1 vector of components corresponds to a selected basis. The standard basis for FOM is

$$L_1^{\cdot} = \widehat{e_1}, \quad L_2^{\cdot} = \widehat{e_2} \quad L_3^{\cdot} = \widehat{e_3}$$

Where

$e_1 = [1 \quad 0 \quad 0]^T$

$e_2 = [0 \quad 1 \quad 0]^T$

$e_3 = [0 \quad 0 \quad 1]^T$

is the canonical basis of R^3. Where as $\dot{L}_1, \dot{L}_2$ and $\dot{L}_3$ represents an instant revolving's with respect to axes x, y and z respectively.

Then the standard basis form for FOM is given by

$$L_1 = \begin{bmatrix} \dot{L}_1 & 0 \\ 0 & 0 \end{bmatrix} \quad L_2 = \begin{bmatrix} \dot{L}_2 & 0 \\ 0 & 0 \end{bmatrix} \quad L_3 = \begin{bmatrix} \dot{L}_3 & 0 \\ 0 & 0 \end{bmatrix}$$

$$L_4 = \begin{bmatrix} 0 & e_1 \\ 0 & 0 \end{bmatrix} \quad L_5 = \begin{bmatrix} 0 & e_2 \\ 0 & 0 \end{bmatrix} \quad L_6 = \begin{bmatrix} 0 & e_3 \\ 0 & 0 \end{bmatrix}$$

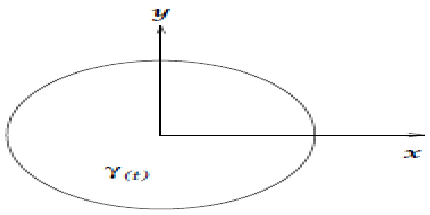
The twists L_4, L_5 and L_6 represents a instantaneous relocations about the axes x, y and z respectively[4].

IV. PROPOSED METHODOLOGY

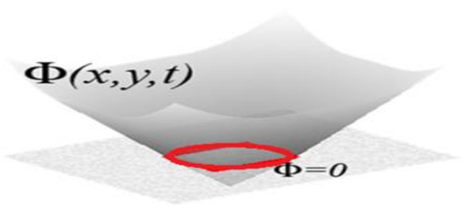
A. LEVEL SET SEGMENTATION METHOD

Segmentation is an important technique used in image processing to identify the interest region with in the image.

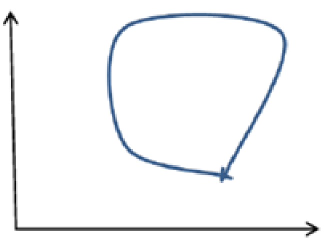
The beginning guesses are specified by the user for the contour region of interest initially. This region of interest is extracted and images moving towards the boundaries of the desired objects [5][6] by metamorphosis methods, which are used as driven forces to moving images towards the boundaries of the desired objects[5][6].



a) **Basic curve**



b) **Basic position of the level set function (LSF) 'ø'**



c) Segmented image

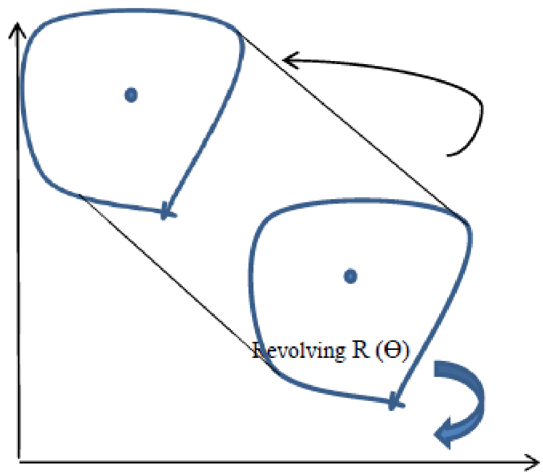
Figure 3: Position of 2D image

Given a closed two-dimensional hyper surface Γ(t). This hyper surface moved along its normal direction, with speed 'F'. This propagating interface embed as zero level set(LS) of other higher dimensional function, 'ø ' is shown in figure 3.The basic curve is shown in figure 3(a), b) Basic position of the level set(LS) function 'ø' is shown in figure 3(b) and Segmented curve is shown in figure 3(c).

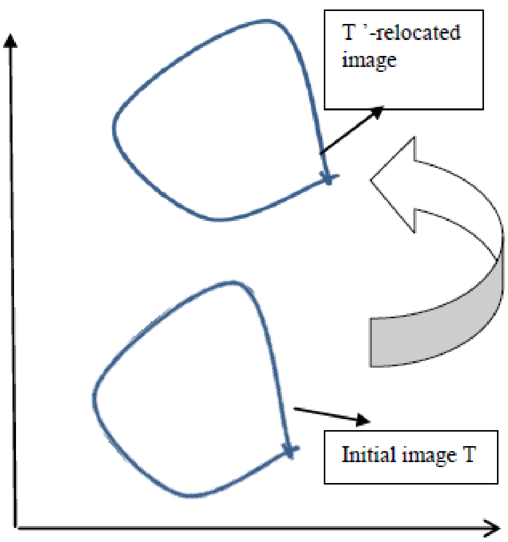
Let ø(x,t=0), where $'x'$ is a point in R^N, be defined by $ø(x, t = 0) = \pm d$, where ' d ' is the distance from $'x'$ to Γ(t=0),and the plus (minus) sign is chosen if the point $'x'$ is outside(inside) the initial hyper surface Γ(t=0). Thus an initial function $ø(x, t) = 0$): $R^N \rightarrow R$ $with$

$Γ(t = 0) = (x | ø(x, t = 0) = 0)$.

B. REGISTRATION OF SEGMENTED TWO DIMENSIONAL IMAGE USING METAMORPHOSIS METHOD.



i) Revolving of Image



ii) Relocation of Image

Figure 4: Relocation and Revolving of Images

Fixed metamorphosis can be described with relocations and revolving's of objects [7]. The dimensionality can be adapted as two dimensional, requires three parameters to representing matrix format.

The metamorphosis with matrix representation is given by

$$\mathrm{Taffine}(x,y) = \mathrm{R}(x,y) + \mathrm{t}(x,y)$$

Where *'R'* is the revolving matrix and *'t'* is the relocation vector.
Use a single matrix with homogeneous coordinates

$$\mathrm{Taffine}(x,y) = \mathrm{M}(x,y)$$

Where *'x'* is the point in homogeneous coordinates and *'M'* combines *'R'* and *'t'*.
In two dimensional, the relocation (T) parameters are given in terms of matrix is as follows

$$T(x,y) = \begin{bmatrix} 1 & 0 & t_0 \\ 0 & 1 & t_1 \\ 0 & 0 & 1 \end{bmatrix}$$

The revolving (R) parameters are given in terms of matrix is as follows

$$R(theta) = \begin{bmatrix} costheta & -sintheta & 0 \\ sintheta & costheta & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

The final metamorphosis can be denoted by

$$\mathrm{T}(x,y) = \mathrm{t}(x,y) + \mathrm{R}(x,y)$$

The final image is metamorphosed by this relocation and revolving, shown in figure 4(i) and 4(ii) respectively.

C. *REGISTRATION OF SEGMENTED TWO DIMENSIONAL IMAGES BY FABRIC GROWING REPRESENTATION*

Consider a basis $v_1, v_2, \ldots, v_n$. The vector is written as $v = \alpha_1 v_1 + \alpha_2 v_2 \ldots + \alpha_n v_n$. Then the list $\{\alpha_1, \alpha_2, \ldots \alpha_n\}$ is the *notation* of *'v'* w.r.t the given basis.

The representation is given as a row or column array of parameters.

$$\mathbf{a} = [\alpha_1 \ \alpha_2 \ \ldots \ \alpha_n]^T = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \cdot \\ \alpha_n \end{bmatrix}$$

These forms a '*fabric*'.

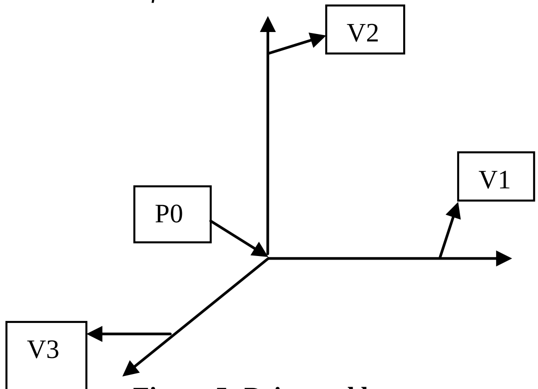


Figure 5: Point and bases vectors

Fabric given by (p_0, v_1, v_2, v_3) is shown in figure 5, and is represented as $v = a_1 v_1 + a_2 v_2 + \ldots + a_n v_n$
The corresponding parameters are written by

$$P = P_0 + b_1 v_1 + b_2 v_2 + \ldots + b_n v_n.$$

Consider two formats of the same vector with respect to two different bases.
The two formats are represented by

Where $a = [\alpha_1 \ \alpha_2 \ \alpha_3]$ and $b = [\beta_1 \ \beta_2 \ \beta_3]^T$

$$v = \alpha_1 v_1 + \alpha_2 v_2 + \alpha_3 v_3 = [\alpha_1 \ \alpha_2 \ \alpha_3][v_1 \ v_2 \ v_3]^T$$

$$= \beta_1 u_1 + \beta_2 u_2 + \beta_3 u_3 = [\beta_1 \ \beta_2 \ \beta_3][u_1 \ u_2 \ u_3]$$

Each of these basis u1, u2, u3, are vectors and are represented in terms of the first basis form, shown in figure 6.

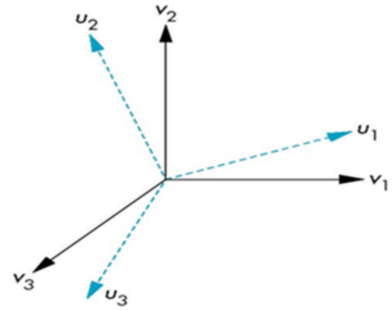


Figure 6: Representation of two bases forms

$$u_1 = \gamma_{11} v_1 + \gamma_{12} v_2 + \gamma_{13} v_3$$
$$u_2 = \gamma_{21} v_1 + \gamma_{22} v_2 + \gamma_{23} v_3$$
$$u_3 = \gamma_{31} v_1 + \gamma_{32} v_2 + \gamma_{33} v_3$$

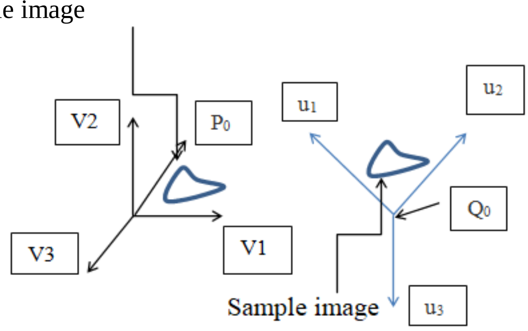
The coefficients describes a 3 x 3 matrix

$$M = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} \end{bmatrix}$$

and the bases is denoted by

$$a = M^T b$$

The same method is represented in homogeneous coordinates systems.
Consider two fabrics: shown in figure 7.
(P_0, v_1, v_2, v_3)
(Q_0, u_1, u_2, u_3)
Sample image



Sample image
Figure 7: Two fabrics forms

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Then Q_0, u_1, u_2, u_3 represent in terms of P_0, v_1, v_2, v_3.
so extending the change of bases

$$u_1 = \gamma_{11}v_1 + \gamma_{12}v_2 + \gamma_{13}v_3$$
$$u_2 = \gamma_{21}v_1 + \gamma_{22}v_2 + \gamma_{23}v_3$$
$$u_3 = \gamma_{31}v_1 + \gamma_{32}v_2 + \gamma_{33}v_3$$
$$Q_0 = \gamma_{41}v_1 + \gamma_{42}v_2 + \gamma_{43}v_3 + \gamma_{44}P_0$$

Then defining a 4 x 4 matrix

$$M = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} & 0 \\ \gamma_{21} & \gamma_{22} & \gamma_{23} & 0 \\ \gamma_{31} & \gamma_{32} & \gamma_{33} & 0 \\ \gamma_{41} & \gamma_{42} & \gamma_{43} & 1 \end{bmatrix}$$

Within the two frames any point or vector has a representation of the same form $\mathbf{a}=[a_1\ a_2\ \ a_3\ a_4]$ in the first fabric, $\mathbf{b}=[b_1\ b_2\ \ b_3\ b_4]$ in the second fabric.

$$\mathbf{A = M^T b}$$

The matrix '**M'** is 4 cross 4 and is denoted as coordinates in fabric growing representation [8].

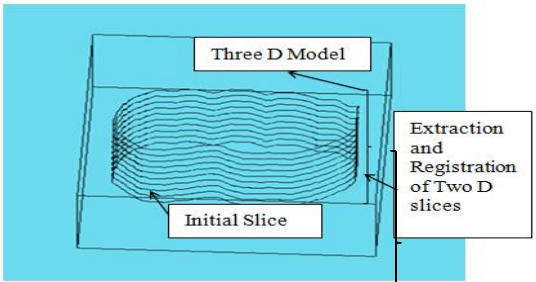
V. EXPERIMENTAL RESULTS AND DISCUSSIONS

A. SETTING UP THE PROGRAMMING PLATFORMS

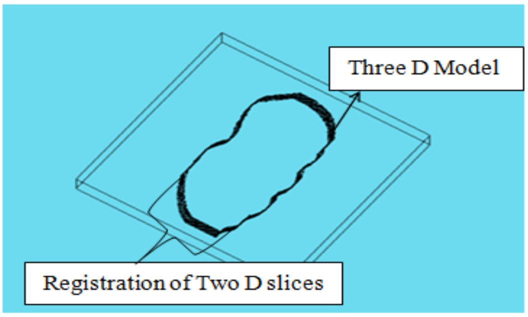
The implementation of Overhaul of 3D image is coded initially in OpenGL and MATLAB in the later step and have gone through several experimental steps.

B. EXPERIMENTAL RESULTS AND DISCUSSIONS

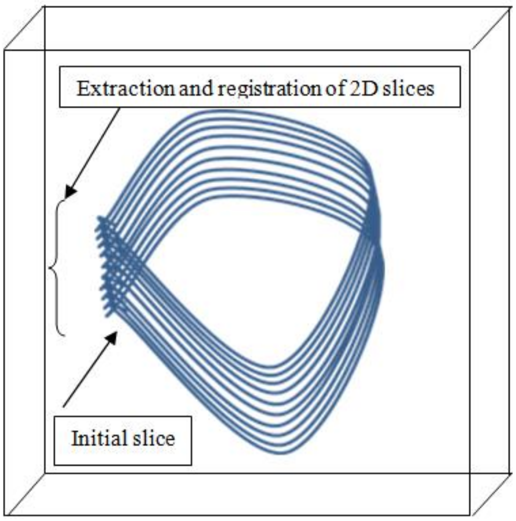
This paper addresses the implementation of Overhaul of three-D image. From a two-D input image the region of interest is recognized and segmented in the initial step. The segmented image is extracted and registered using fixed object metamorphosis method and the fabric growing method in the second step. Finally the arrangement of registration of two-D images builds overhaul of three-D models. The results from OpenGL are shown below: from result figure-1 to result figure-3. And the results from MATLAB are shown below: from figure–4 to figure-6.



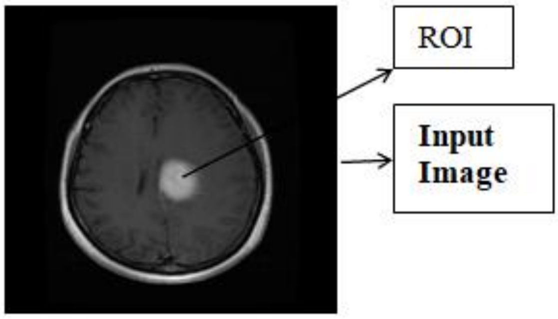
Result figure-1: Overhaul of Three-D object from extraction of segmented images



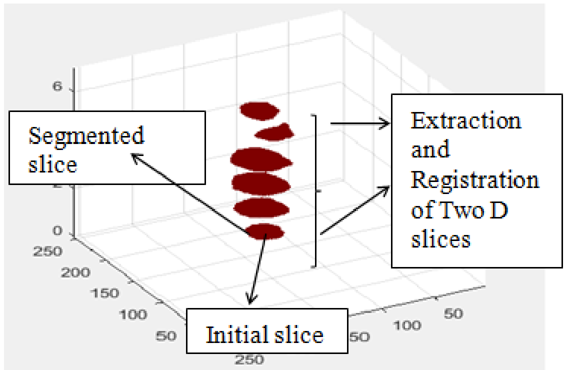
Result figure-2: Overhaul of Three-D object from extraction of segmented images and its revolving.



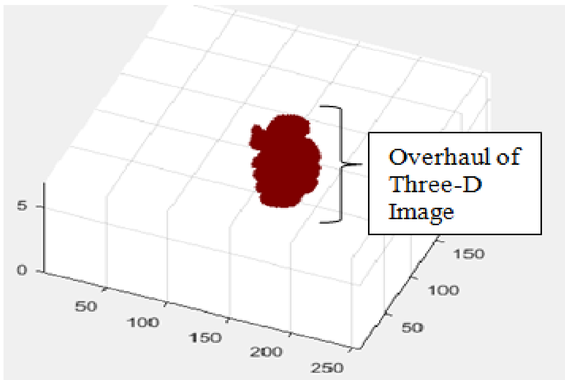
Result figure-3: Overhaul of three-D object from extraction of segmented images



Result figure-4: Input Image

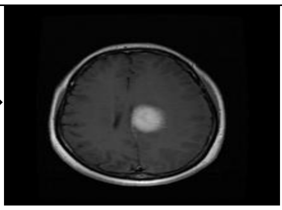
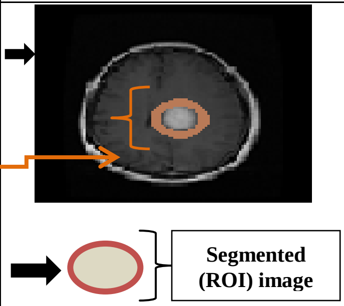
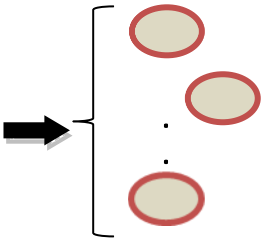
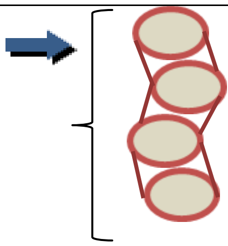
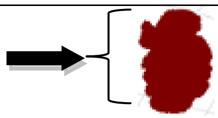


Result figure-5: Extraction of segmented Images



Result figure-6: Overhaul of Three-D Image

VI. RESULTS ARE SUMMARIZED IN TABULAR FORMAT

Step No.	Method	Result obtained in step wise manner
1	**Input Image (Initial step)**	
2	**Segmentation of Image** **(Identification of ROI)** **(Level set method)**	
3	**Extraction and Registration of two-D images** **(Metamorphosis method)**	
4	**Extraction and Registration of two-D images** **(Fabric Growing method)**	
5	**Overhaul of Three-D model (Final Step)**	

VII. CONCLUSION

This research paper describes the overhaul of three dimensional model based on registration of two dimensional images. Initially the region of interest (ROI) is identified from input image and is segmented using Level set (LS) method. The obtained Two-D segmented data (ROI) is extracted and registered using metamorphosis and Fabric growing methods for further processing step. Thus the Two-D data is extracted to form a Three-D image by using proposed techniques. The obtained results are implemented and coded by using OpenGL and MATLAB.

The proposed methods provide a possible solution for visualization of Overhaul of Three-D image. An experimental result shows that the proposed methods are efficient and effective. The proposed methodology results in accurate with identification of precise location of diseased ROI.

With the above results, we conclude that our proposed method helps in visualizing Three-D image clearly by medical experts. In the future work, different registration techniques can be used to increase the accuracy in visualization of Three-D image with real and clinical based cases.

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REFERENCES

1. U. Grenander and M. I. Miller, "Computational anatomy: an emerging discipline," Q. Appl. Math., vol. LVI, no. 4, pp. 617– 694, Dec. 1998.
2. J. Fishbaugh, M. Prastawa, S. Durrleman, J. Piven, and G. Gerig, "Analysis of longitudinal shape variability via subject specific growth modeling," in MICCAI, 2012, pp. 731– 738.
3. S. H. Joshi, Q. Xie, S. Kurtek, A. Srivastava, and H. Laga, "Surface shape morphometry for hippocampal modeling in alzheimer's disease," in DICTA, 2016, pp. 1–8.
4. Calin Belta and Vijay Kumar," On the Computation of Rigid Body Motion", General Robotics, Automation, Sensing and Perception Laboratory University of Pennsylvania, Philadelphia, PA, USA
5. Malladi, J. Sethian & B.Vemuri., "Shape modeling with front propagation: A level set approach", IEEE Trans. on Pattern Analysis and Machine Intelligence 17(2), pp. 158–175, Feb. 1995.
6. S. Osher, J. A. Sethian, "Fronts propagating with curvature dependent speed: algorithms based on Hamilton-Jacobi formulations", J. Comp. Phys., vol. 79, pp. 12-49, 1988.
7. M. McGuire, "An Image Registration Technique for Recovering Rotation, Scale and Translation Parameters," IEEE transaction on Image Processing,pp. 12-22,2005.
8. Edward Angel,"An interactive Computer Graphics–A top-Down Approach", text book computer graphics.

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