Proceedings IRF2018: 6th International Conference Integrity-Reliability-Failure
Lisbon/Portugal 22-26 July 2018. Editors J.F. Silva Gomes and S.A. Meguid
Publ. INEGI/FEUP (2018); ISBN: 978-989-20-8313-1

PAPER REF: 7315

BIOMEDICAL RAPID PROTOTYPING OF FREE-FORM SURFACES BY PLANAR CONTOURS METHOD

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ABSTRACT

In this paper, an interactive application tool has been developed for creating 3D models of dental implants and other body structures from 2D medical imaging data. 3D models are generated by using reverse engineering algorithm and planar contour method by SolidWorks developed in Visual Basic Language. The research includes transferring Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) images into digital matrixes, entering digital matrixes into SolidWorks environment, building feature library for 3D reconstruction, creating medical rapid prototyping models, and performing biomedical rapid design and manufacturing. 3D reconstruction models is created by edge configuration, generation and triangulated cube configuration generation in capturing section contour points from medical image per slice, creating B-spline curve with the control points in each layer, producing solid model construction in planar contours method. Medical rapid prototyping models are performed in SolidWorks, including three views or any combination of views, for biomedical rapid designing and manufacturing according to the biomedical needs. Layered manufacturing techniques are used for producing parts of arbitrary complexity. The results of this paper are to develop image processing 3D visualization in SolidWorks Application Programming Interface (API) using Visual Basic Language. The system performance is tested using truth CT and or MRI data, and 3D physical models dental for MRP are created directly from SolidWorks. The results reveal that the accuracy of 3D reconstruction is acceptable.

Keywords: rapid prototyping, free form surfaces, planar contours method.

INTRODUCTION

The three-dimensional (3D) reconstruction of human anatomical organs and structures from a series of cross section image has been an intriguing problem in recent decades. New challenges have been created in the field of image analysis and pattern recognition by the introduction of modern image data collection techniques such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI). With the development of advanced bio-medical techniques, 3D geometric representations of human anatomical organs rather than the two-dimensional (2D) photographic images using CT or MRI are frequently required. These 3D geometric models, either simulation generated by computer or 3D Rapid Prototyping (RP), can be used for diagnosis of physical disorders, visualization of anatomical organs for surgical planning, and the implantation of human organs and other structures. RP is the process of converting a 3D Computer Aided Design (CAD) file into a 3D physical model "rapidly". Medical Rapid Prototyping (MRP) is the production of the medical models using rapid prototyping methods [1-3].

RESULTS AND CONCLUSIONS

Although non invasive modalities, such as CT, Micro-CT, MRI and Optical Microscopy can be used to produce accurate 3D tissue descriptions, voxel-based anatomical imaging representation cannot be effectively used in many biomechanical engineering studies. Effective methods for the conversion of CT data into CAD solid models still need to be developed. We have evaluated process path for generating a CAD model from Reverse engineering interface approach.

The reverse engineering interface approach uses a 3D voxel model as the starting point created from the region grow process (Figure. 1). The 3D voxel model is converted to point cloud data form and are loaded into the reverse engineering software. The points are then used to create triangular facets to form a surface model. The faceted model is further refined and enhanced to reduce file sizes and unwanted features. The freeform surfaces of NURBS patches are used to fit upon the outer shape of the model.

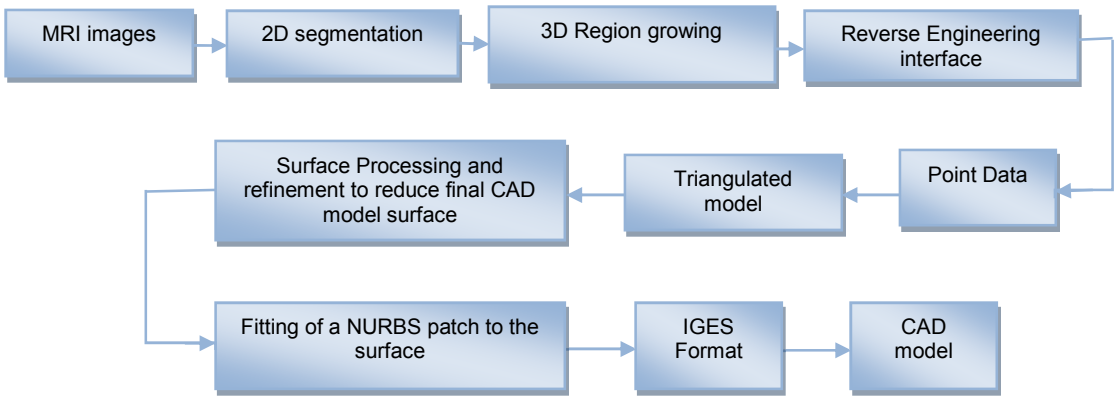

Fig. 1 - Process definition to arrive at a CAD model from CT/MRI data

The results of this paper are the first step towards 3D reconstruction from original CT scan data. The manufacturing of Medical Rapid Prototyping will serve as the initial clinical study. The true advantages of 3D reconstruction in SolidWorks have yet to be determined through long-term study and clinic application. It is my opinion that 3D reconstruction in SolidWorks can provide STL format data for Medical Rapid Prototyping manufacturing to help plan implant surgeries because SolidWorks can export STL files for direct reading by Rapid Prototyping machine.

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