

Extracting STL Files from Measured CT Data: Application to Biomedical Modeling

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1. Introduction

Extraction of STL (sterolithography) file from three dimensionally scanned data has recently paid attention both in medical and industrial applications for computer-aided diagnosis and computer-aided design, respectively. Although there are several 3D scanning methods, such as mechanical contact scan and laser scan, X-ray computed tomography (CT) is most desirable because it can provide internal information of subjects invasively. If we convert the measured CT data into a file which contains 3D geometrical information and thus could be easily read by the conventional CAD software such as Pro/Engineer™, the biomedical modeling to support analysis/diagnosis or the mechanical modeling for further design/NDT&E (nondestructive testing & evaluation) is benefited [1].

We are making progress in the development of a graphical solution to extract STL file from the measured CT data. In this study, we present the extraction procedure and demonstrate it with a measured CT data for human chest.

2. Methods

The STL file is a mesh data containing geometrical information describing subject details, and consists of vectors designating three vertices of a triangle and its surface normal vector. The procedure to construct STL file from the CT data is mainly consisted of two steps: (1) Segmentation of CT data in binary form and (2) triangulation of the segmented binary data.

For the segmentation procedure, we employed *semi-auto-segmentation method* [2], which is an on-off thresholding based on the histogram:

$$Seg(x, y) = \begin{cases} 1 & \text{if } T_L < f(x, y) \leq T_U \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

where $Seg(x, y)$ is an image after segmenting the original image $f(x, y)$. T_L and T_U are lower and upper values of the threshold, respectively. Therefore it costs somewhat expensive in time and effort. Further correction for small noises is made by using labeling method based on *Grass Fire algorithm* [2]. Figure 1 illustrates the segmentation procedure.

To generate meshes with triangles, we applied the well-known *marching cube algorithm* [3], which is the successive comparison of the segmented image data with a look-up table. As shown in Fig. 2, a cube is eight-pixel (or eight vertices) values between two slices of

vertically consecutive image data. Therefore, the algorithm determines how the slice surfaces intersect the cube by comparing the vertex, which is prescribed as a value of unity, with the value of image data. Since possible triangles (256 cases) are already prepared as a look-up table, the triangulation is automatic. And then the cube marches to the next location and the process is repeated. However, due to the limited 256 cases the marching cube algorithm is tackled to the free-curved surfaces. Reducing the gap between slices might be a way to overcome this restriction. It is completed that the triangulated meshes are exported according to the STL file format.

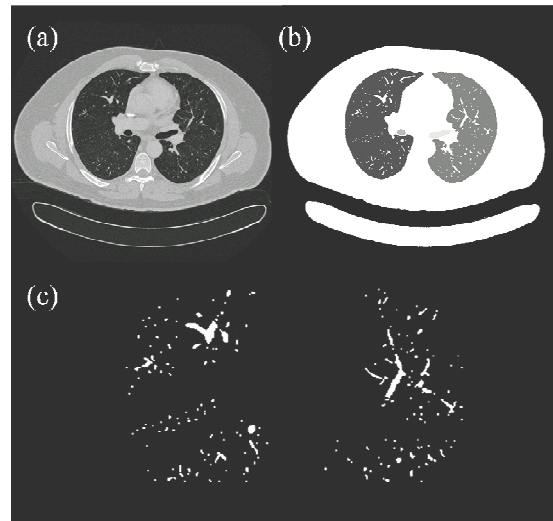


Fig. 1. Segmentation procedures and examples. (a) Original CT data. (b) Image after segmentation and applying labeling method. (c) Segmented image of lung vessels.

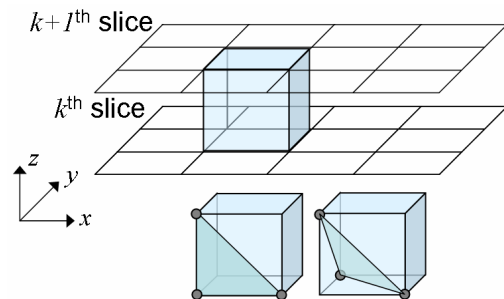


Fig. 2. Schematic illustration depicting the marching cube algorithm.

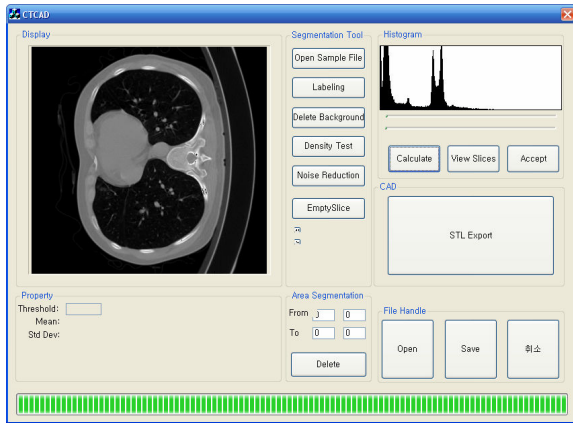


Fig. 3. A developmental graphic solution for the extraction of STL files from the CT data.

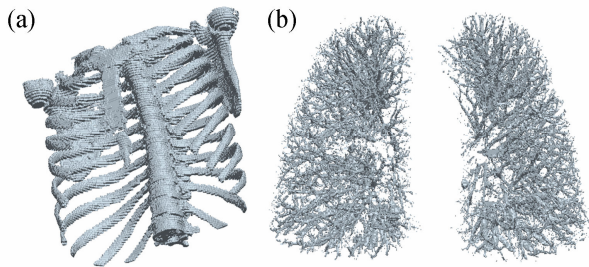


Fig. 4. STL files read by Pro/Engineer™. (a) Human breast bones. (b) Lung vessels.

3. Results

Figure 3 shows a developmental graphical solution made by using Microsoft Visual C++™. For a human chest data obtained by the spiral CT with 512×512 image format, 512 slices, and a slice thickness of 1 mm, we applied the solution and extracted STL files depicting breast bones and lung vessels. We read those with Pro/Engineer™ as shown in Fig. 4.

4. Conclusion

In this manuscript, a simple procedure to extract STL files from the measured CT data is addressed. Based on the given procedure, the graphical solution has been developed and we successfully implemented it to the spiral CT data. For the improvement of the reliability of the exported data, we are making in progress.

ACKNOWLEDGMENT

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REFERENCES

- [1] H. K. Kim, "Cone-beam microtomography and its application," J. Kor. of Soc. of Prec. Eng. 22, pp. 7-14, (2005).
- [2] I. Pitas, *Digital Image Processing Algorithm*, Prentice Hall, 1993.
- [3] W. E. Lorensen and H. E. Cline, "Marching cubes: A high resolution 3D surface construction algorithm," Computer Graphics 21, pp. 163-169 (1987).