

NEW OPEN-SOURCE TOOLS FOR 3D RECONSTRUCTION FROM MEDICAL IMAGES

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INTRODUCTION

With the advent of new medical imaging technologies and options for non-invasive means of patient diagnosis, the need for better 3D segmentation and reconstruction tools for research and clinical practice is increasing. Unfortunately, segmenting and generating 3D anatomical models from 2D medical images is currently a time consuming process, usually requiring large amounts of manual labor and expensive, proprietary software. The available commercial software [1] is “closed-source”, restricting research and experimentation with the underlying algorithms. Also, commercial software is often not well suited to reconstruction of complex tissues from noisy magnetic resonance images (MRIs).

Because of these limitations of commercial software, the purpose of this research was to develop new software tools (“Super//Slicer”) for 3D segmentation and reconstruction from medical images, with an emphasis on reconstructing connective tissues. In this report we describe the basic components of the software. Super//Slicer is written in Matlab (Mathworks, Inc.) and is freely available [2].

METHODS

A graphical user interface (GUI) was developed to maximize interactivity and user control. Image sequences can be loaded and saved, as well as entire segmentation sessions. The software has for main components: (1) a set of filters, including cropping, thresholding, noise reduction, and other filters, (2) a threshold-based contouring algorithm, (3) manual contour tracing and editing, and (4) a surface generation algorithm for generating spline-smoothed contour data and 3D “water-tight” triangular polygon surfaces. The contours and surfaces are output in “obj” format (Wavefront format, Alias, Inc.) compatible with most 3D solid modeling software. Once a contour is selected, the software uses an automatic selection algorithm to identify and select contours in adjacent images that are associated with the object that is being segmented. The user can specify multiple threshold values to vary the shape of the contour (“keyframing”). Manual tracing and editing functions were also included to enable the user to trace regions that could not be segmented with the contour function.

A typical process of segmentation and reconstruction is: (1) open the image files, (2) crop to the region of interest, (3) adjust the contour threshold and set keyframes to best fit the object to be segmented (i.e. ligament, muscle, bone, etc.), (4) automatically detect and select similar object contours (i.e. “super slice”), (5) add or delete contours as needed, using manual editing if necessary, and (6) automatically generate and output the contour data and resulting surface mesh.

Super//Slicer was designed to be easy to understand and program. The user can reprogram filters, add new filters, and otherwise modify the segmentation and surface generation

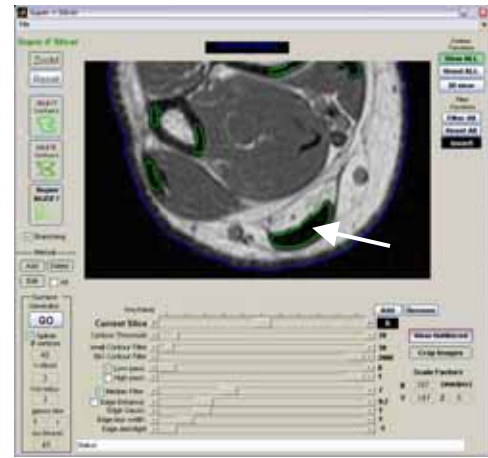


Figure 1: GUI and contoured image of the Achilles tendon.

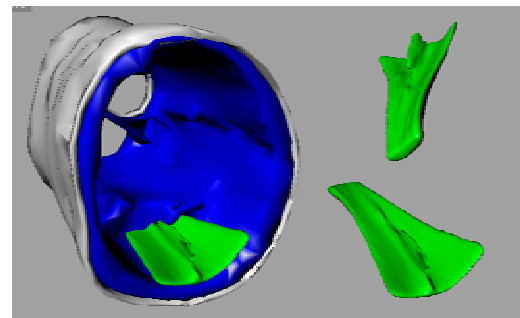


Figure 2: Reconstructions of lower leg skin, fatty tissues, and Achilles tendon (shown in two views for clarity).

codes. The current contouring and segmentation algorithms are simple, however, more advanced methods, such as active contours and neural network training are under development.

RESULTS AND DISCUSSION

Development of Super//Slicer is ongoing, but already several complex 3D reconstructions of foot-related tissues have been performed (Fig. 2).

CONCLUSIONS

The goal of this project was to construct a simple and efficient framework for development of new methods for 3D segmentation and model generation from medical images. Super//Slicer has exhibited potential in its ease of use, and ability to generate accurate models in a short amount of time. It is hoped that open-source availability will spark new research and development of improved methods for analysis of MRI and CT medical images.

REFERENCES

1. <http://biocomp.stanford.edu/3dreconstruction/software/>
2. Email doehrint@ccf.org for code and information.

ACKNOWLEDGEMENTS

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