An Interactive Tool for Fitting Surfaces to Volume Data

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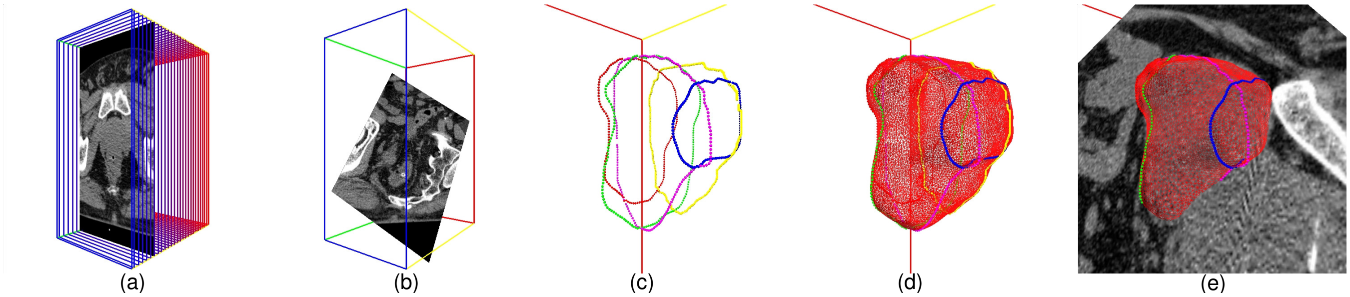

Figure 1: *(a) The input is a 256x512x256 volumetric dataset. One slice of the input data is shown, along with rectangles outlining the locations of every 10th slice. (b) The user can view a cross section of the data at any location and any angle. (c) Five oblique contours are drawn to segment the bladder. (d) A surface is reconstructed from the input contours. (e) The surface can be viewed along with the image data and edited interactively.*

1 Introduction

MRI and CT scanners have long been used to produce three-dimensional samplings of anatomy elements for use in medical visualization and analysis. From such datasets, it is often desired that a smooth, parameterized surface be reconstructed. Such models are useful not only for visualization, but also as finite element models on which simulations and further processing can be performed.

Many algorithms have been proposed for reconstructing surfaces from a series of contours. [Keppel 1975] and [Fuchs et al. 1977] proposed the first algorithms for "contour stitching". Many improvements have been made since then, but the general approach remains the same: reconstruct a surface by connecting the vertices of adjacent contours in order to generate a mesh that passes through all contours. These methods all assume that a series of parallel contours on the input data are given. Unfortunately, the act of marking these contours is currently a time-consuming problem involving a great deal of manual intervention. In this process, an experienced scientist or physician must manually segment the original volume dataset by going through two-dimensional slices of the data one by one, and marking a series of contours that outline the object of interest.

In this paper, we present a tool that reduces the manual component of this process. Our tool allows the user to generate a surface from just a few contours drawn on arbitrarily oriented planes. The user can then edit the model globally and interactively, rather than marking many parallel contours on a slice-by-slice basis.

2 Our Approach

We begin with a volumetric dataset. Figure 1 is an example of a computed tomography scan of a human prostate. There are 256 slices, and in Figure 1(a) we render one input slice, along with rectangles that outline the locations of every tenth slice.

Next, we perform linear interpolation between each slice in the input dataset, and now we can render arbitrarily oriented image planes. Figure 1(b) shows one such plane. The user can then sketch contours on any plane, having any location and angle. Figure 1(c) shows an example where the user has segmented the bladder, using five oblique contours.

After a set of contours have been drawn, we can reconstruct a surface from the nonparallel contours using the technique of [Liu et al. 2008]. The result of this reconstruction from the five input contours is shown in Figure 1(d).

Once an initial surface is reconstructed, it can be viewed simultaneously with the volume data for evaluation. We provide many tools for editing the surface directly, rather than simply editing the contours. The user can sketch a contour on any plane, and nearby parts of the surface will automatically adjust accordingly. The interface will also provide the user with tools to snap the surface to local thresholds, and provide the user control over the region of influence for editing.

Currently, our reconstruction is based solely on the input contours. We should be able to use the information contained in the volumetric data to guide our reconstruction in a way that results in a more accurate initial model. We intend to compare our method with reconstructions of the same data using parallel contouring. We hypothesize that our method will result in reconstructions that are at least as accurate as traditional parallel contouring, while requiring far less time and effort on the part of the user.

References

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