Interactive manipulation of contour data using the Layers program

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Abstract

The "layers" program is useful for visualizing and editing large sets of contour data. These datasets arise frequently when trying to extract geometry from MRI slices. Due to the imprecise nature of the MR imaging and segmentation processes, the contours extracted may not accurately reflect the human geometry. The "layers" program has been designed to allow the effecient editing of these contours in order to provide human control over the contour generation process.

1 Introduction

The process of modelling the electrical activity in the human thorax has been a research focus for the Scientific Computing and Imaging research group at the University of Utah. In a typical simulation, hundreds of MRI slices of a human thorax are segmented into different conductivity regions. These segmented "contours" are then composed into surfaces and volume meshes in order to perform large scale finite element simulations. Due to the imprecise nature of the MR imaging and segmentation processes, the contours extracted may not accurately reflect the human geometry. The "layers" program has been designed to allow the effecient editing of these contours in order to provide human control over the contour generation process.

Layers allows the movement of entire slices or individual points at each contour level. The user edits one layer at a time, while two bordering layers are also shown for context and alignment purposes. The user may employ multiple view of the data in order to provide simultaneous coarse and fine-grained editing of the data set.

Layers is written in C++, using Motif and OpenGL. The main user interface is shown in Figure 1.

2 Loading and saving files

Contours may be loaded with the "Load .pts file" or "Load many .pts files" options in the file menu. In order to load several files using the "Load many .pts files..." option, type in a regular expression which specifies the desired files into the "Filter:" field. All of the selected files will be shown in the list on the right of the file box. For example to select the epicardium, type "epi*.pts" in the filter field. A sample .pts file is:

```
-24.0  -2.0 365.0
-23.0  -1.0 365.0
-22.0   0.0 365.0
-21.0   1.0 365.0
-21.0   1.0 365.0
-13.0  -4.0 370.0
-14.0  -5.0 370.0
```

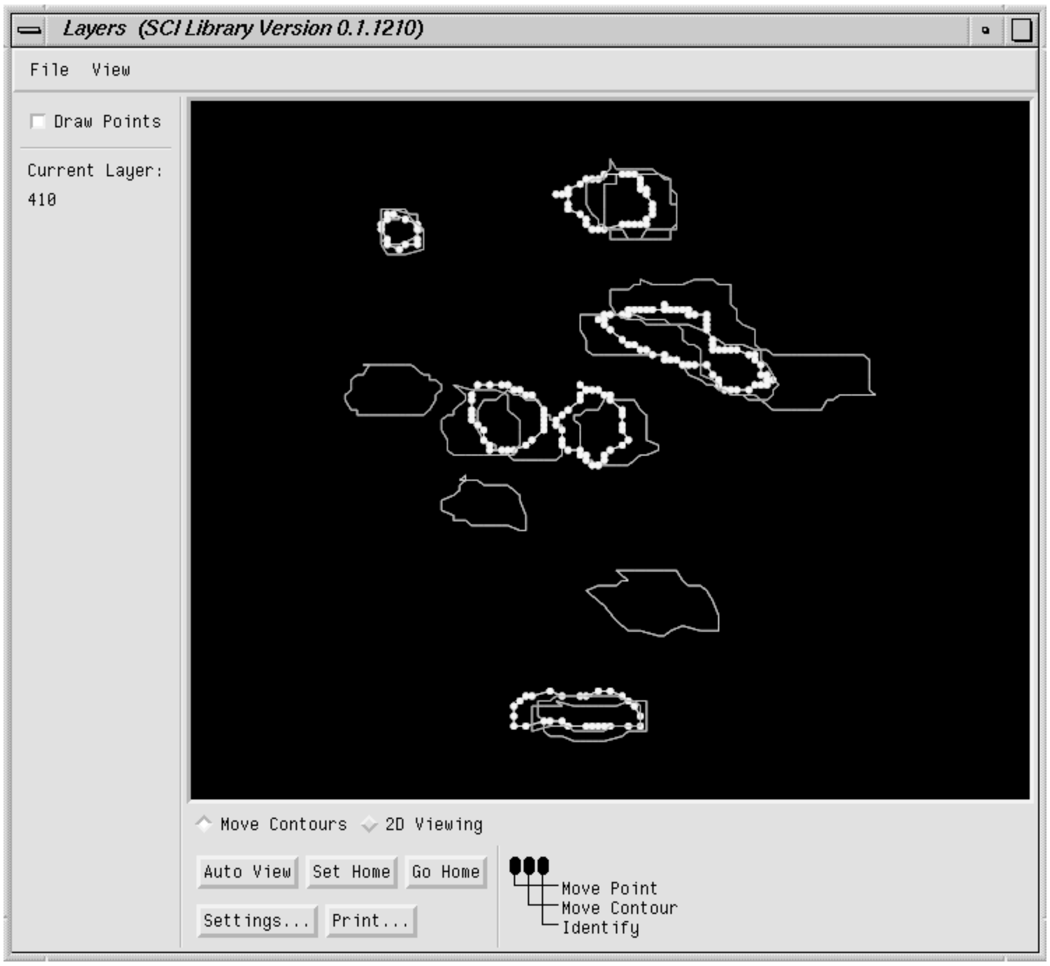

Figure 1: Basic histogram in a local window

```
-15.0  -5.0 370.0
-16.0  -6.0 370.0
-17.0  -6.0 370.0
```

This file contains two contours, one at z=365, and one at z=370. Currently, only contours in Z are supported.

The files may be saved with the “Save .pts files...” menu item. Select a **directory** where the files are to be stored. They will be stored with the same name as the original, so specifying the original directory will cause the old files to be overwritten.

3 Display

After reading the files, the topmost contour should be displayed in white in the main window. The slice is displayed as if you were looking down from the top of the slice. Pressing the “page up” and “page down” keys allows you to rapidly select different slices for display. At each point, the current slice is displayed in white, the slice above is displayed in red, and theslice below is displayed in blue. The current slice’s “Z” value is displayed to the left of the main window.

A checkbutton to the left of the main window allows you to turn off the display of small squares to represent the individual points. This can help reduce clutter, but disables the ability to move individual points when editing.

To change the current view of the slice, select the radiobutton below the main window to “2D viewing”. The left mouse button controls scale, the middle mouse button controls rotation and the right mouse button controls translation. Don’t forget to switch the radiobutton back to “Edit contours” before editing.

Using the “New view...” option in the View menu, you can create an additional layers window which views the same data. The translation, scale and rotation parameters are seperate for each view, so you can look at the data differently in each window. The current slice is synchronized and kept the same for all windows. Using this feature, you can make fine changes in one window, while maintaining “the big picture” in another window. Changes made in one window are automatically reflected in the other window.

A view may be saved using the “Set home” button, and may be later retrieved using the “Go home” button. If you are hopelessly lost, use the “autoview” button to locate a reasonable view. The “Print..” button may be used to obtain postscript output of the

4 Editing

Once a contour is selected, the slice may be edited using the mouse. The left mouse button is used to move individual points, and the middle mouse button is used to move entire contours. The right mouse button can be used to identify particular slices and control points without making changes. There is no undo feature, so be careful when making changes. The slice name and index number of the point are displayed in the bottom of the window, along with the X,Y,Z coordinates of the edited point.

5 Conclusions

The layers program is a simple method for editing large sets of contour slices. An interactive user interface provides instant graphical feedback of these changes. Contours from several slices are edited together to allow inter-slice comparison and adjustment of contours.

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