CTMRedit: a Matlab-Based Tool for Segmenting and Interpolating MRI and CT Images in Three Orthogonal Planes

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Abstract

CTMRedit is a GUI tool for viewing CT and MRI images in three orthogonal planes, for manually or automatically segmenting regions of interest (ROI), and for interpolating between outline contours to create a 3D outline surface. Features of CTMRedit include display and I/O of 8-bit and 16-bit image formats, easy navigation of a large image database, and easy-to-use ROI editing tools. CTMRedit is written in the Matlab programming language, so the code is platform-independent, and easy to extend or re-use.

I. Introduction

CTMRedit was written because an existing research project needed image segmentation tools. Good medical image segmentation tools exist (e.g. NIH image [1]), but when the project began, existing tools lacked the easy extensibility and platform-independence we had come to expect from Matlab, a high-level programming language sold by the Mathworks (Natick, MA) which we use for many signal processing problems. Our image manipulation needs were modest, and our extensibility needs great, so we wrote our own segmentation tool in Matlab. CTMRedit is available for free, and new functionality can be added by anybody familiar with Matlab.

II. Features

CTMRedit can read and write standard 8-bit images (including JPG, BMP, TIF, and GIF), and it can also read and write images in the 16-bit GE MR image format. The CTMRedit display routines assume that images have a 16-bit intensity scale (65536 levels), but that the monitor only has an 8-bit intensity scale (256 grayscale levels). CTMRedit allows the user to brighten or darken an image to enhance the contrast of interesting features, in a manner similar to the functionality of NIH image [1].

When loading a "main image," CTMRedit also looks for images of the same subject in orthogonal image planes, which can be displayed next to the main image as "locator images." As a result, if the user needs to segment some area from an axial image, he/she can use information from both the coronal and sagittal images to help identify and eventually segment the axial image. A "locator line" is drawn on each locator image to mark the location of the main image plane, and "zoom lines" show the edges of the main image window. Both of these lines are calculated using an auxiliary text file (the ".cor" file) in which the user has specified positions of 4 corners of the image plane in 3D Cartesian coordinates.

When CTMRedit is started, it searches for images in a format it understands, loads one, and lists the full path of the loaded image in a series of popup menus. The user can easily navigate a large image database by choosing new files or new directories using these popup menus.

Tools for editing ROI outlines are also user-friendly. Tools include the "add point," "add line," and "delete region" tools, and a "magic wand," which uses a seeded region-growing algorithm to automatically outline a dark region selected by the user.

To avoid a "pixelly-looking" display, images in CTMRedit are upsampled and interpolated to the resolution of the user's monitor. With an upsampled main image, it is possible for users to draw an ROI outline with errors that are smaller than the size of an image pixel. For example, water-filled test tubes with known radii of 3.9mm, 7.8mm, and 11.4mm were imaged using MRI, with an image pixel size of 0.9375mm. CTMRedit outlines, combined with a least-squares fitting technique, yielded radius estimates with an average error of only 0.20 pixels. For comparison, a standard pixel-counting approach yielded radius estimates with an error of 0.37 pixels.

Once a series of image planes have been segmented, the segmentation contours can be interpolated using the included "shape-based interpolation" [2] function to create a three-dimensional outline surface. Other interpolation algorithms are planned.

III. Conclusion

CTMRedit is a 3-plane, 16-bit, easy-to-use tool for medical image viewing, ROI editing, and 3D contour interpolation. CTMRedit was written in the Matlab programming language, so the code can be extended or re-used by any user familiar with Matlab. The code is available for free, from the web address:

http://www.icsl.ucla.edu/~spapl/CTMRedit/index.html

IV. Acknowledgements

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V. References

[1] W.S. Rasband and D.S. Bright, "NIH Image: A Public Domain Image Processing Program for the Macintosh," *Microbeam Analysis Society Journal* vol. 4, pp. 137-149, 1995.

[2] S.P. Raya and J.K. Udupa, "Shape-Based Interpolation of Multidimensional Objects," *IEEE Trans. on Medical Imaging* vol. 9, pp. 864-868, 1990.