

Extracting Geometrical Information from Histological and MRI Images using *Image2 3D*, a MATLAB Application

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Abstract

Quantification of vocal fold geometry is necessary for the development of anatomically realistic and consistently defined experimental/computational models of the glottic and subglottic regions. This technical memo primarily provides the required tutorial and executable files for creating a three dimensional models from histological images as well as MRI images. Updates to this memo can be downloaded at <http://www.nrld.org/>.

Keywords: CAD model, Histological Images, MRI

1. Introduction

Development of realistic three-dimensional models of human laryngeal is necessary to produce reliable quantitative biomechanical models of voice disorders. Particularly important are dimensions of those structures which describe function in mechanical terms (e.g., laryngeal muscle orientation, cartilage length/width, and joint size/range).

Generally, anatomical information is obtained by using MRI and CT images to get a more accurate geometric representation. The drawback of MRI or CT images is that, while distinctions between different tissues may be visible to the naked eye, they may not be clearly captured by an automated program. Further, although histological images provide a better distinction between different tissue types, it is a complex task to capture the distinctions with an automated program.

The purpose of this report is to introduce a semi-automated program which will help in drawing boundaries over images to distinguish different tissues. Once the boundaries are drawn on all the working images, the data can be saved and later imported into CAD software for constructing three-dimensional geometries of various tissues.

2. Running the Application

2.1 Matlab Compiler

The application and the MATLAB runtime install software can be downloaded and unzipped from the *NRLD_0000009_v1.files.zip* file. Because the application is coded and compiled in MATLAB, the *MATLAB Compiler Runtime v713* (freely available) must be installed for the application to run on a Windows machine. Use the *MCRInstaller.exe* file to install the MATLAB compiler on your machine. After the installation is completed (only needs to be installed once), run *NCVS_Image2_3D.exe* file to start using the application.

2.2 Loading files

Initially the application gives two options: first, to load image files and, second, to load data files. This application supports image files of type *JPEG, PNG, TIF, BMP, DICOM, and DC3*. Using the first option, the user can load a series of supported image types and begin creating boundaries. The second option is used to load previously saved data files to continue working from the prior save point. Once the series image files are selected, the first image will be displayed (in case of data file the previous save point image will be displayed).

3. Creating boundaries

3.1 Calibration

Before one can start drawing boundaries, the images need to be calibrated in order to measure any length on the image in millimeters (mm) using the measure tool. For the DICOM images, the calibration is performed automatically once the calibrate button is used. For other images the user must select the scale on the image and enter its length in mm in order to calibrate. Once the calibration is performed the images are set to starting drawing boundaries and the use of measure tool.

Note: The calibration needs to be accomplished even if the user doesn't want to use the measure tool. The user can use the calibration button and then click on any two points and enter a number to get over with calibration. By doing this the measure tool will not be accurate.

3.2 Starting a New Boundary

Once the calibration is completed, the user can start drawing boundaries. Once the user decides to draw new boundaries and clicks on the new boundary button, the application asks the user to set the maximum number of boundaries on each image for all the series. Until the maximum number of boundaries is drawn on the image, no other option except the new boundary button is available. After the user draws the boundaries on the image, the user is given the option to edit boundaries and the new boundary button is no more available. Left click is used to draw points for the boundary and middle click to end that boundary.

The new boundaries drawn will be copied to the next/previous image and can be edited using the edit boundary button.

3.3 Editing Boundaries

The edit boundary button displays each boundary at a time as a movable boundary, with individual points. The boundary, as well as the individual points, can be moved to the required position. Once the required adjustment is made, double clicking on the boundary establishes that boundary and moves to the next boundary. This can be repeated until all boundaries are established.

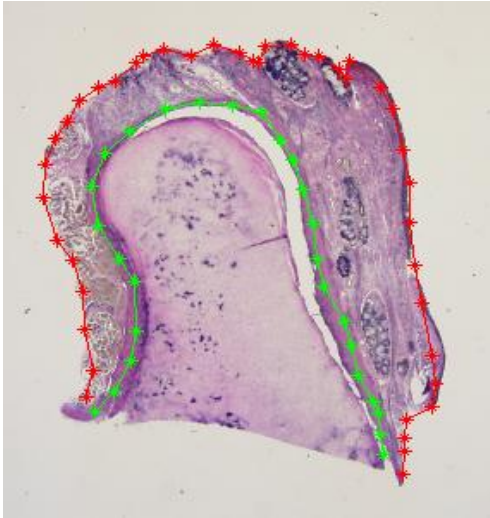


Figure 1: Two new boundaries drawn on a histological section using the new boundary button.

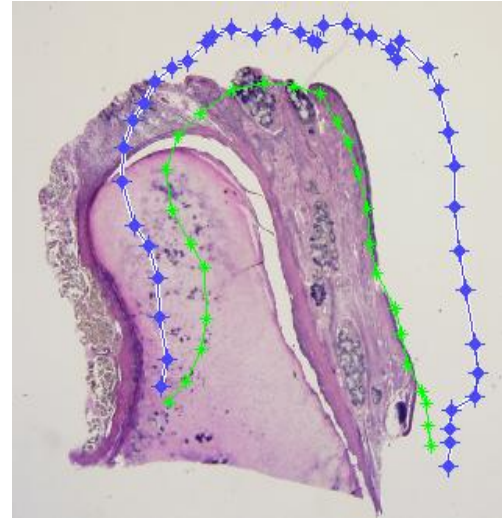


Figure 2: Boundaries displayed as an editable selections when edit boundary button is used.

4. Saving data

The established boundaries and images data can be saved using the save data button. The data can be saved at any time and later be loaded to continue establishing boundaries, by using the load data button.

The data is saved as a structure in a *.mat* file which consists of image, image name and its boundary details in the form of x,y co-ordinates.

5. Measure Tool

The measure tool can be used to take measurement of any tissues in image. The length is displayed in mm. The measure tool is a continuous one which displays the current length as well as the total overall length. Left click is used to keep measuring and middle click is used to end measuring and return to previous state.

6. Displaying a 3D wireframe Model

A MATLAB coded executable file *NCVS_wireframe3D.exe* is provided to read the saved *.mat* file from the application. The script displays a 3D wireframe model for visualization of the

drawn boundaries. The user can use the rotate 3D and pan icons in the figure toolbar for rotating and moving the displayed 3D wireframe.

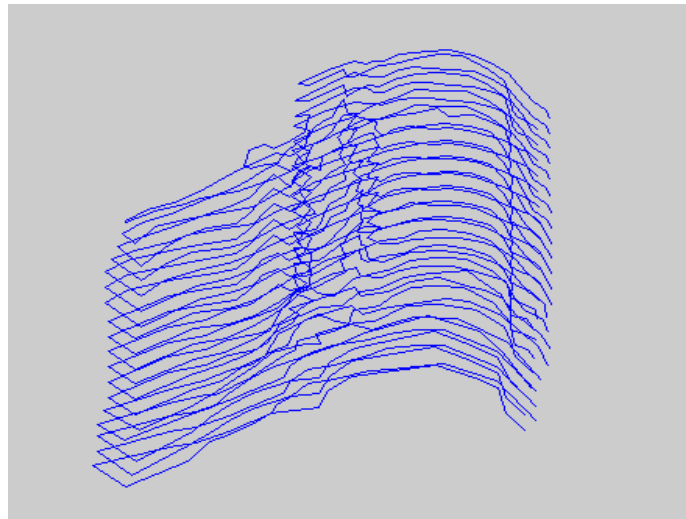


Figure 3: A sample 3D wireframe of larynx generated from the saved boundary points.

Note: The thickness of each image boundary displayed is set to 1 unit for ease of display. The boundaries displayed in three-dimension are aligned in case of MRI images but not in case of histological images.

Acknowledgements

This work was supported by NIDCD grant No DC009616 from National Institutes of Health. The NRLD is supported by the National Institutes of Health (DC009616).

Use Agreement

The scripts, images and text are open to use by the public as a service and part of the National Resource of Laryngeal Data (supported by the National Institute of Deafness and other Communicative Disorders, and hosted by the National Center for Voice and Speech). The scripts, images, model and text enclosed in this memo and accompanying this memo are open to use by the public as a service of the NRLD. However, we ask the reader to respect the time and effort put into this manuscript and research. If the text, images, or included scripts are used, the user agrees to reference to this document, the NRLD, and the source of the original data. We also ask the users to consider contacting the original contributors of the data and give them the right of refusal to (1) participate on papers using the data and (2) have their supporting project acknowledged. The user agrees to freely share with the NRLD any extension software build on the data contained.

Revisions

1.0 Sree Harsha Jampala: Main document (August 2012).