

# LIVEWIRE USER'S MANUAL v. 1.1

by **Celso T. N. Suzuki** <celso.suzuki@ic.unicamp.br>  
and **Alexandre X. Falcão** <afalcao@ic.unicamp.br>



INSTITUTE OF COMPUTING  
STATE UNIVERSITY OF CAMPINAS  
Avenida Albert Einstein, 1251  
Caixa Postal 6176  
13083-970 Campinas, SP, Brazil

## Contents

<b>1</b>	<b>Overview</b>	<b>2</b>
<b>2</b>	<b>Platform</b>	<b>2</b>
<b>3</b>	<b>Prerequisites</b>	<b>2</b>
<b>4</b>	<b>Download</b>	<b>2</b>
<b>5</b>	<b>Getting Started</b>	<b>2</b>
<b>6</b>	<b>User's Manual</b>	<b>2</b>
6.1	Menus . . . . .	2
6.1.1	File . . . . .	2
6.1.2	View . . . . .	3
6.1.3	Postprocessing . . . . .	3
6.1.4	Volumetry . . . . .	4
6.1.5	Help . . . . .	5
6.2	Tools . . . . .	5
6.2.1	Image Controls . . . . .	5
6.2.2	Training . . . . .	6
6.2.3	Orientation . . . . .	7
6.2.4	Tracing . . . . .	7
6.2.5	Object Controls . . . . .	8
6.2.6	Orthogonal Views . . . . .	8
6.3	Step-by-step Segmentation . . . . .	8
6.3.1	Using semi-automatic training . . . . .	8
6.3.2	Using manual preprocessing . . . . .	12
<b>7</b>	<b>Contact the author</b>	<b>17</b>
<b>8</b>	<b>Acknowledgements</b>	<b>17</b>

# 1 Overview

This software is a 2D interactive tool for medical image segmentation. The segmentation consists of tracing, interactively, a closed contour which describe the boundary of an object. The segmentation process is described step-by-step in section 6.3.

# 2 Platform

LiveWire can be used in Windows, Linux and Solaris platforms, and is recommended at least a Pentium III 1GHz or similar processor with 512Mb of RAM memory or more.

# 3 Prerequisites

You must have installed Tcl/Tk 8.1 or higher. The Tcl/Tk sources can be found at the site <http://www.tcl.tk>, and binary releases can be found at <http://aspn.activestate.com/ASPN/Tcl>.

# 4 Download

LiveWire can be downloaded free of charge from the website <http://www.ic.unicamp.br/~afalcao/livewire/>.

A tool to convert files from DICOM image sequences to SCN volume files is available at <http://www.ic.unicamp.br/~afalcao/dicom2scn/>.

# 5 Getting Started

Extract the files to a preferred directory and run the livewire executable file. The main window will appear.

# 6 User's Manual

## 6.1 Menus

This section describes the menus and its options.

### 6.1.1 File



**Open File** - Load a scene (.scn) or an image file (.pgm).

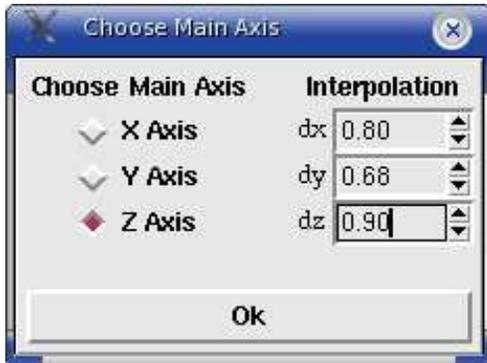
**Load Objects Labels** - Load a previously saved label scene.

**Save Objects Labels** - Save current label scene.

**Save Objects Values** - Save current segmented object scene.

**Quit** - Exit program.

### 6.1.1.1 Main Axis Selection and Scene Interpolation



This window will appear after a file is loaded. The user can select the plane of the scene that will be shown on the main window. The other two planes will be shown on the orthogonal views window (6.2.6), i.e. planes ZY and XZ if plane XY is selected for the main window. Also, the user can change the size of the voxels of the loaded scene (parameters dx, dy and dz). The input scene will be interpolated according the new values.

### 6.1.2 View

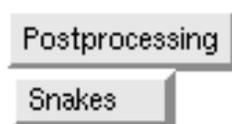


**Original Image** - Show the original image slice.

**Orientation Image** - Show the image used for orientation of the contour.

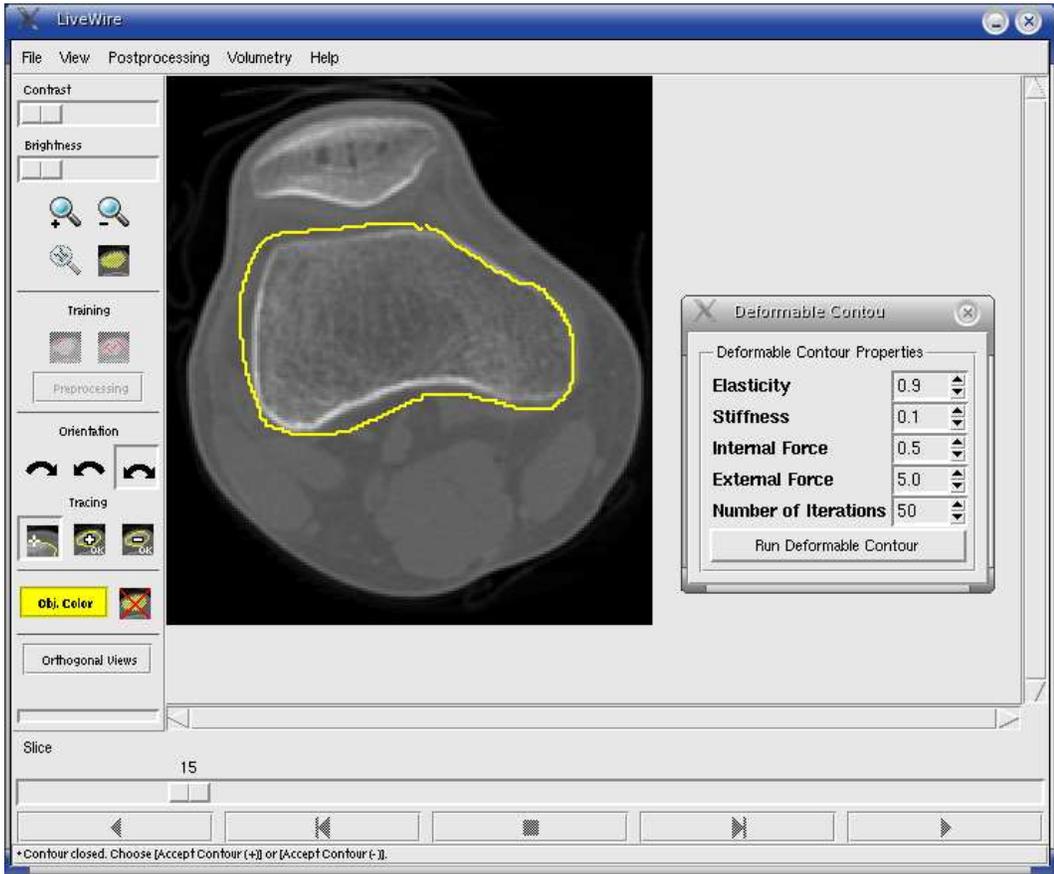
**Local Cost Image** - Show the image used for local costs.

### 6.1.3 Postprocessing



**Snakes** - Show the deformable contour window.

### 6.1.3.1 Deformable Contour Window



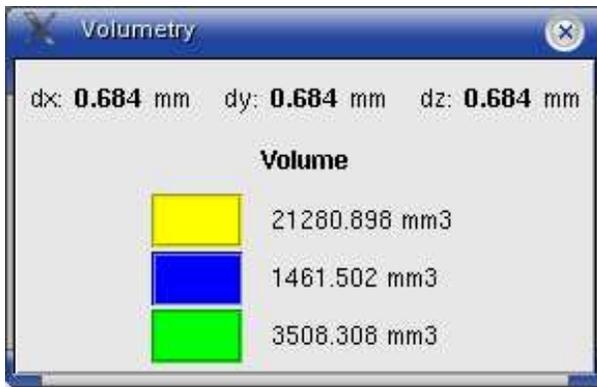
In this window the user can adjust the parameters of the **Snakes** method, used as a post-processing filter to alleviate the crispness of the contour. Before running this method, the user must create a closed contour around the object, either by the live-wire or manual segmentation method. After running the method, the user can add the segmented region to the overlay mask, or remove the segmented region from the overlay mask (6.2.4).

### 6.1.4 Volumetry



**Volumetry** - Show the volumetry window.

### 6.1.4.1 Volumetry Window



This window shows the volume of the segmented objects in  $mm^3$ , for analysis purposes.

### 6.1.5 Help



**Manual** - This manual.

**About** - Show a small about screen.

## 6.2 Tools

### 6.2.1 Image Controls



- Adjust the image contrast.



- Adjust the image brightness.



- Zoom in ( $\times 2$ ).



- Zoom out ( $\div 2$ ).



- Assigns zoom commands to mouse buttons. The point clicked by the mouse cursor is centered on screen. The left mouse button executes zoom in, the right mouse button executes zoom out and the middle button resets the zoom.



- Show/Hide the overlay with segmented objects.

## 6.2.2 Training



- Start/Cancel semi-automatic boundary training. In this training the user draws some segments following the object boundary. The left mouse button is used to draw the segments and the right mouse button is used to finish the training.

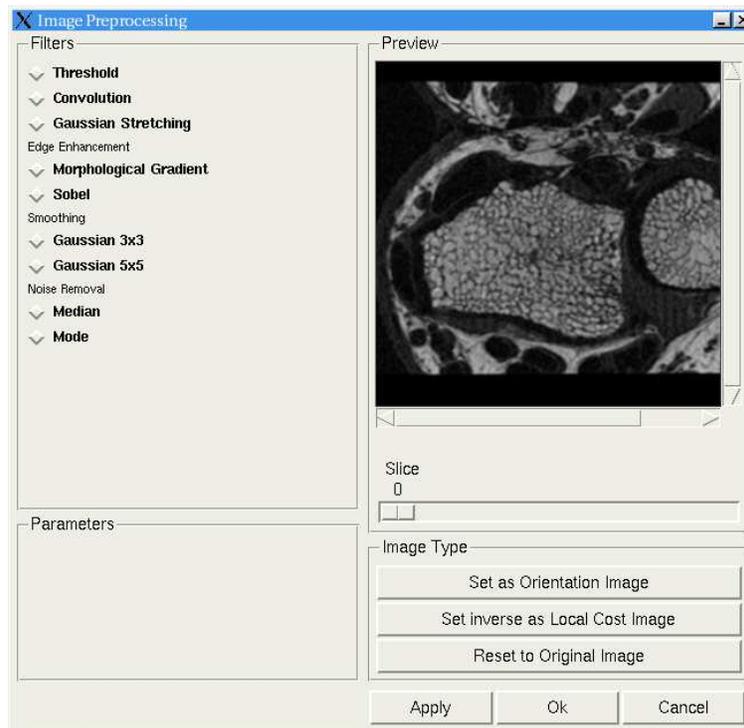


- Start/Cancel semi-automatic region training. In this training the user draws some segments inside the desired object. The left mouse button is used to draw the segments and the right mouse button is used to finish the training.

Preprocessing

- Open the image preprocessing window. The user must choose and manually apply the filters, and set the processed image as boundary orientation image or local cost image.

### 6.2.2.1 Image Preprocessing Window



**Preview** - The filtered preview image will be shown here. The user can view the original image using the left mouse button.

**Filters** - The user can choose any sequence of filters. After each selected filter, the user must click on **Apply** or **Ok** to filter all slices.

- **Threshold** - This filter outputs a binary image, based on minimum and maximum pixel values selected by the user. The pixels outside the range are eliminated from the output image (value zero), and the rest of the pixels are defined as one. This threshold filter is used to generate orientation images.

- Convolution - Filter the image with a customizable convolution kernel.
- Gaussian Stretching - This stretching filter fits the original histogram to a Gaussian distribution.
- Morphological Gradient - Edge enhancement filter based on the erosion and dilation of the original image.
- Sobel Edge Enhancement - This filter extracts all of the edges in an image, using Sobel's vertical and horizontal masks.
- Gaussian Smoothing 3×3 - This filter is a 3×3 convolution operator which is used to blur images and remove detail and noise.
- Gaussian Smoothing 5×5 - This filter is a 5×5 convolution operator which is used to blur images and remove detail and noise.
- Median Noise Removal - This noise removal filter uses the middlemost pixel value from an ordered pixels value list of an adjacency.
- Mode Noise Removal - This noise removal filter uses the most common pixel value from a pixels value list of an adjacency.

**Image Type** - The user determines where the filtered image will be used.

- Set as Orientation Image - Set the filtered image as contour orientation image.
- Set Inverse as Local Cost Image - Invert the filtered image, to make the object boundary darker than the rest of the object, and set it as local cost image.
- Reset to Original Image - Cancel all filters applied and reset the filtered image to the original image.

### 6.2.3 Orientation



- Set the boundary orientation to clockwise.



- Set the boundary orientation to counter-clockwise.



- Set the boundary orientation to none.

### 6.2.4 Tracing



- Start/Cancel interactive segmentation. The user can add new contour points with the left mouse button, or manually draw a segment keeping the button pressed. The middle button is used to cut the contour at the nearest clicked point, and the right mouse button is used to close the contour and finish the segmentation.



- Accept the segmentation and add the segmented region to the overlay mask.



- Accept the segmentation and remove the segmented region from the overlay mask.

## 6.2.5 Object Controls

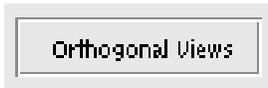


- Change the tracing contour color.



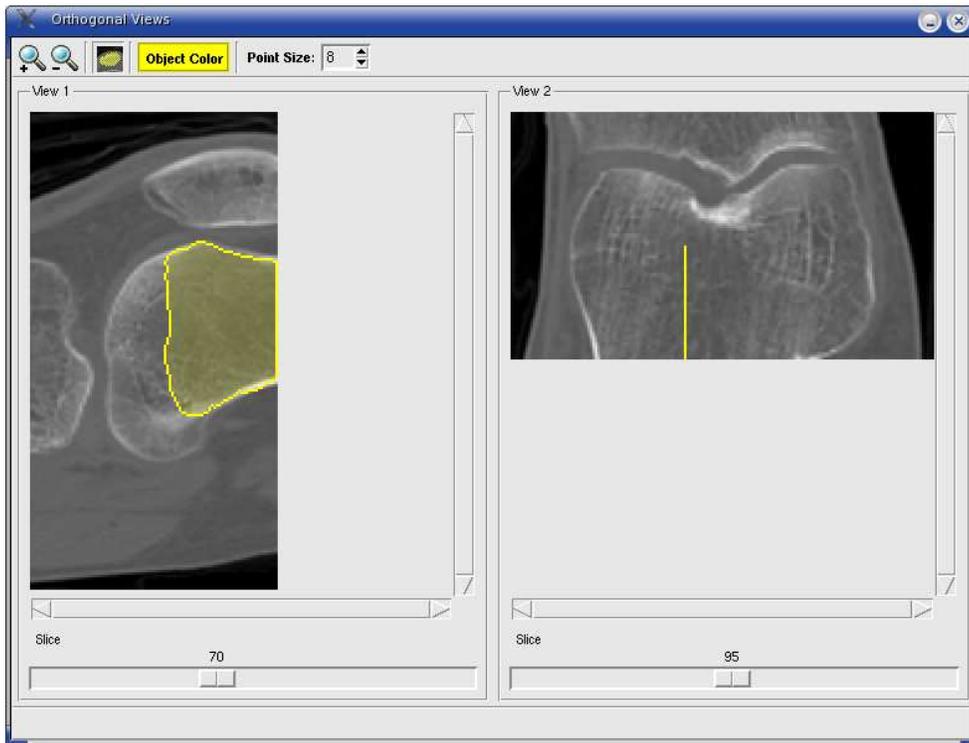
- Delete from current slice all objects with the selected color.

## 6.2.6 Orthogonal Views



- Show the orthogonal views window.

This window shows the input scene from two different planes (i.e. planes ZY and XZ if plane XY is selected to be shown on the main window). It is used to verify the segmentation of the 3D object, and manually make small corrections if necessary. The left mouse button is used to paint a region, and the right mouse button is used to erase. The segmented region is automatically updated on other views.



## 6.3 Step-by-step Segmentation

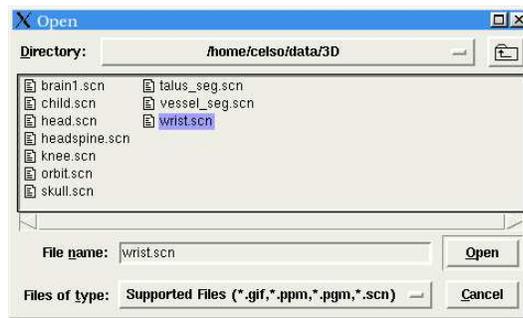
### 6.3.1 Using semi-automatic training

This section describes all the steps to segment an object, using semi-automatic training.

#### 6.3.1.1 Loading an image

1. Click on the menu item **File**→**Open File...**

A file selection window will appear. You can open **GIF**, **PPM**, **PGM** and **SCN** image files.

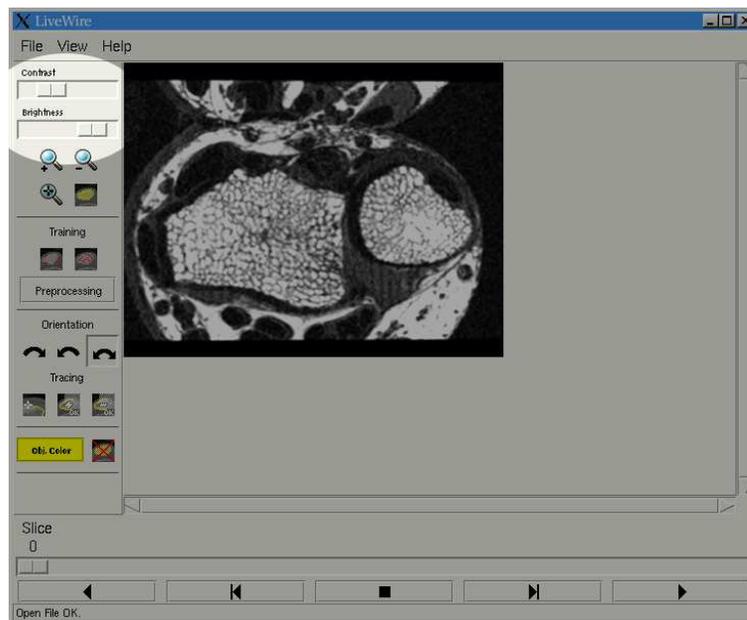


2. Select the desired file and click **Open**.

The image will be loaded and shown at the main window.

### 6.3.1.2 Adjusting image contrast/brightness

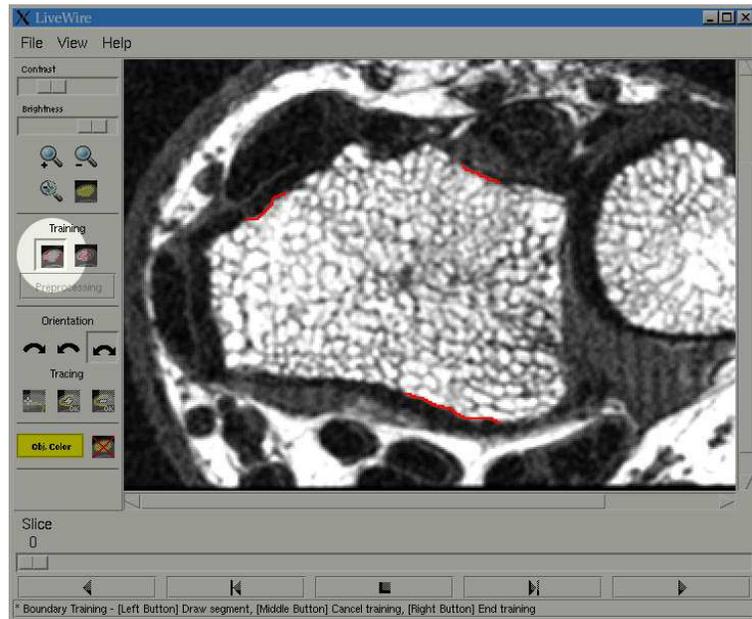
1. Use the **Contrast** and **Brightness** controls to improve the image visualization. These controls will not affect training and preprocessing filters.



### 6.3.1.3 Training

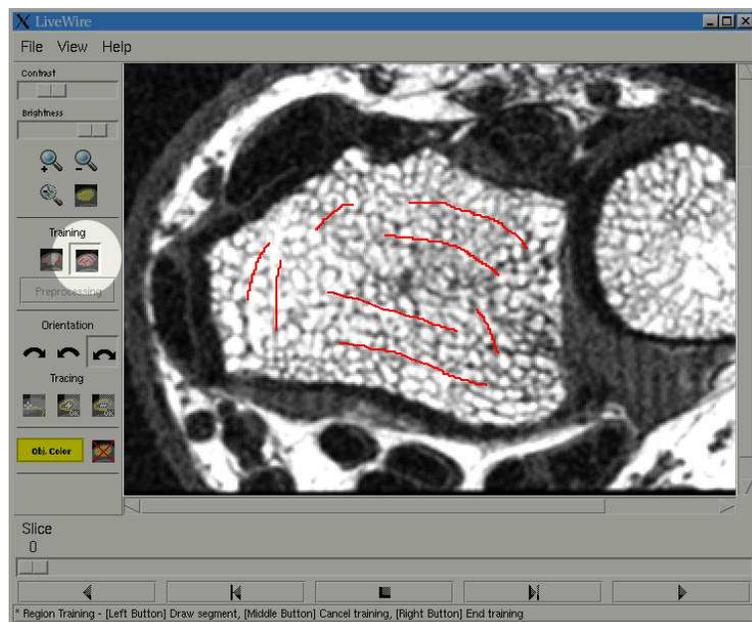
- Using Boundary Training

1. Click on the **Boundary Training** button to activate it.
2. Use the left mouse button to draw some segments at the boundary of an object, and then press the right mouse button when done.



- Using Region Training

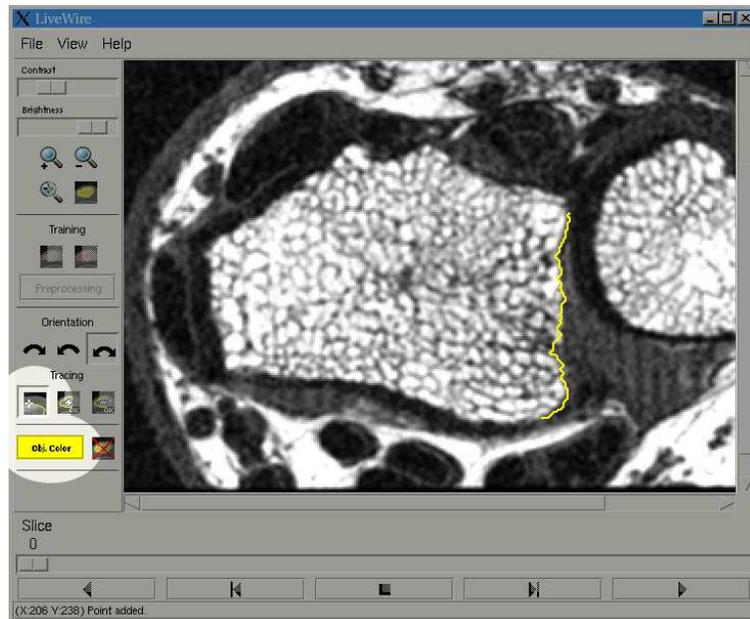
1. Click on the **Region Training** button to activate it.
2. Use the left mouse button to draw some segments inside the desired object, and then press the right mouse button when done.



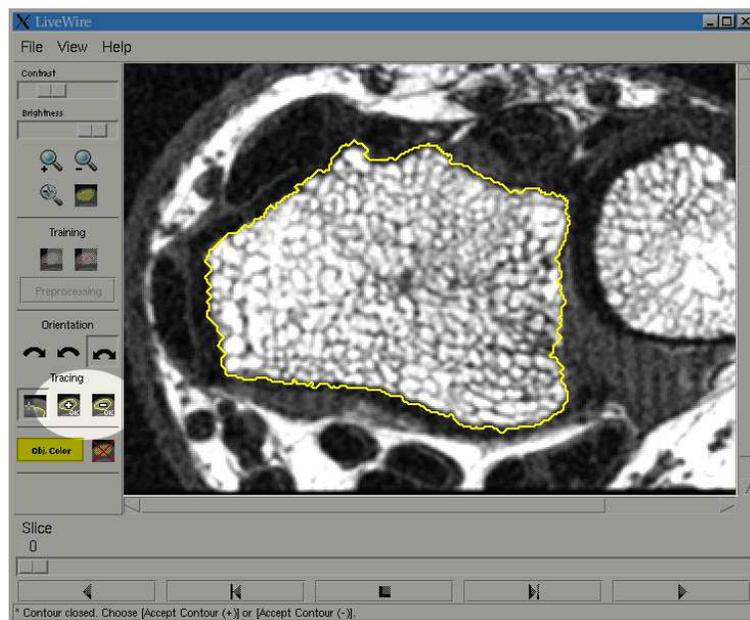
#### 6.3.1.4 Interactive Segmentation

1. Select an object color.
2. Click on the **Interactive Segmentation** button to activate it.

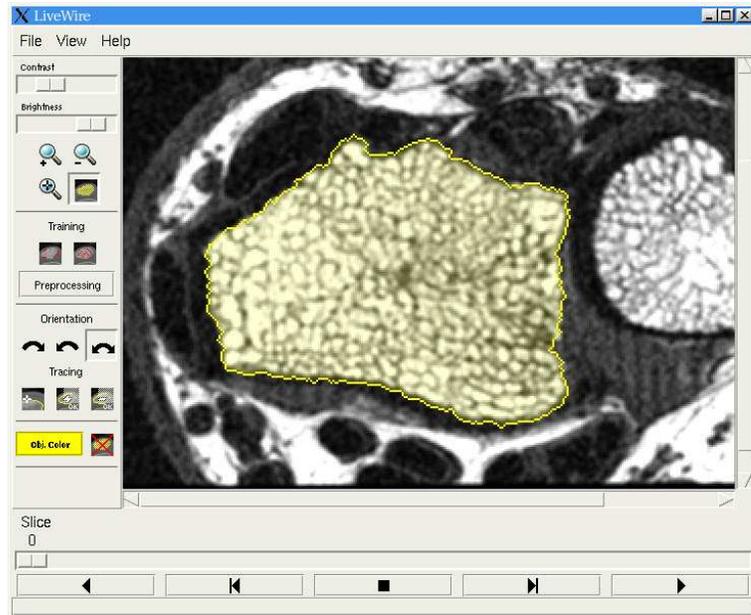
- Click the left mouse button on an initial point of the object boundary to start segmentation.
- Move the mouse to another boundary point. The live-wire segment will follow the object boundary. Click the left mouse button again to accept the segment shown and to start a new segment.



- The live-wire algorithm could find a wrong path if the object boundary is too weak or noisy. In this case, keep the left mouse button pressed and manually draw the segment.
- Click the right mouse button to close the contour.



- Click on the **Accept Contour (+)** button to add the segmented region to the overlay mask, or click on the **Accept Contour (-)** button to remove the segmented region from the overlay mask.



### 6.3.1.5 Saving segmented objects

1. Click on the menu item **File**→**Save Objects Labels...** to save the overlay masks.  
A file selection window will appear. The image can be saved in **SCN** and **PGM** formats.
2. Click on the menu item **File**→**Save Objects Values...** to save the segmented objects.  
A file selection window will appear. The image can be saved in **SCN** and **PGM** formats.



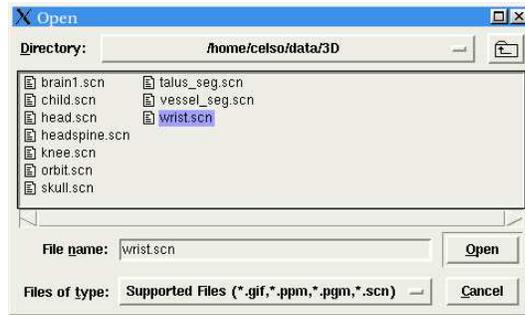
3. Select the desired directory and filename and click **Save**.

## 6.3.2 Using manual preprocessing

This section describes all the steps to segment an object, using manual preprocessing.

### 6.3.2.1 Loading an image

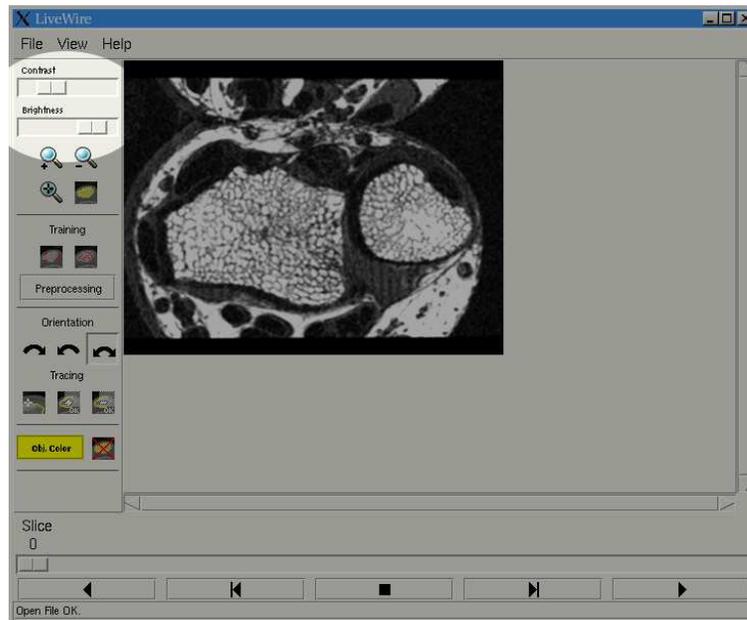
1. Click on the menu item **File**→**Open File...**  
A file selection window will appear. You can open **GIF**, **PPM**, **PGM** and **SCN** image files.



2. Select the desired file and click **Open**.  
The image will be loaded and shown at the main window.

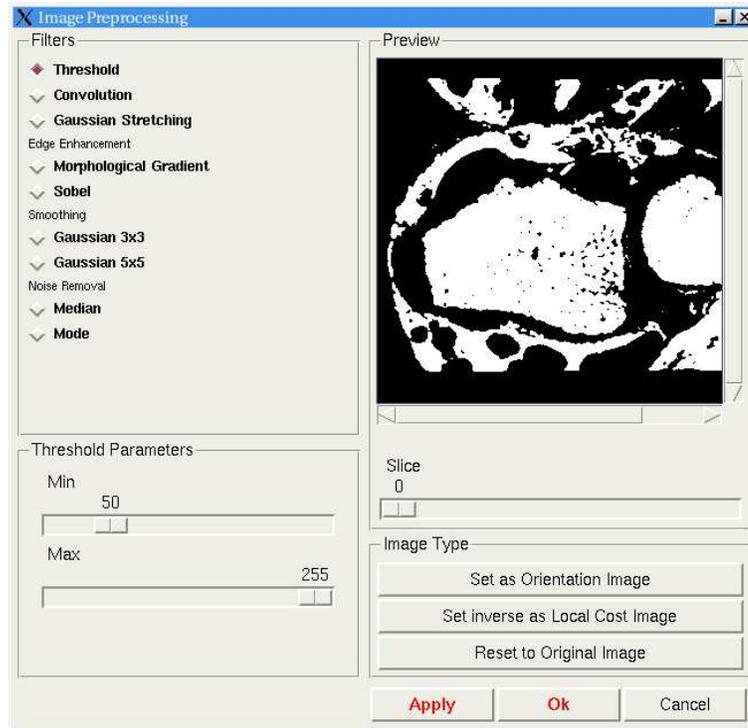
### 6.3.2.2 Adjusting image contrast/brightness

1. Use the **Contrast** and **Brightness** controls to improve the image visualization. These controls will not affect training and preprocessing filters.



### 6.3.2.3 Preprocessing

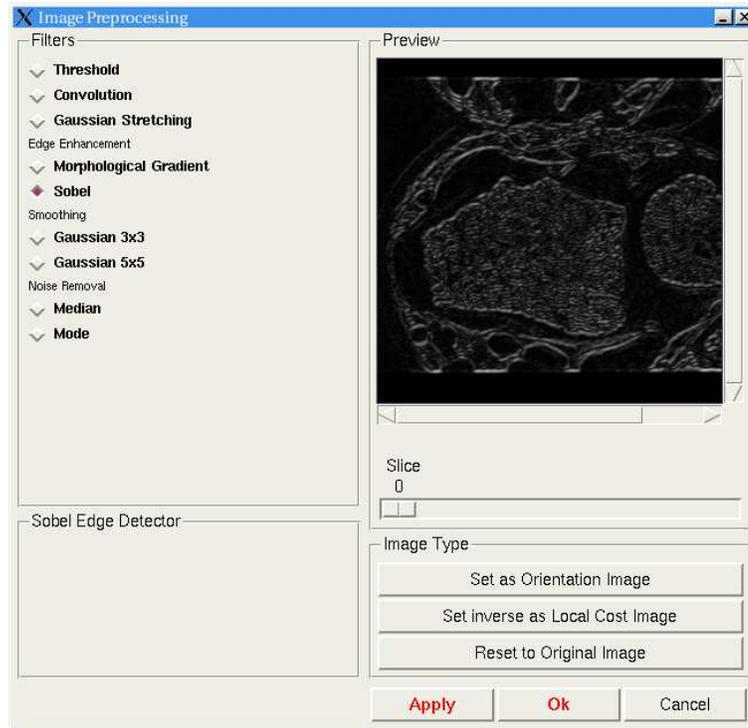
- Setting the Orientation image:  
This image is used by the live-wire algorithm as a guide of the object boundary. The inside part of the desired object must be brighter than the outside.
  1. Click on the **Preprocessing** button to open the Image Preprocessing window.
  2. Select the **Threshold** filter.
  3. Adjust the **Min** and **Max** controls to make most of the object boundary visible.



4. Click on the **Apply** button.
  5. Click on the **Set as Orientation Image** button.
- Setting the Local Cost image:

This image is used by the algorithm to compute the segment costs. The object boundary must be brighter than the rest of the image.

    1. Click on the **Preprocessing** button to open the Image Preprocessing window.
    2. Select the **Sobel** filter.



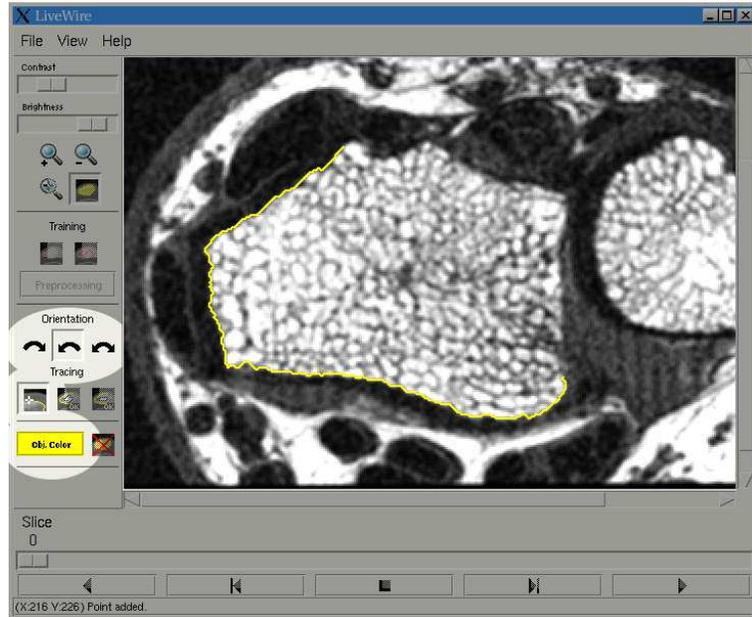
3. Click on the **Apply** button.
4. Click on the **Set Inverse as Local Cost Image** button.

If necessary, use the **Gaussian Stretching** filter to make the desired object boundary brighter than other objects.

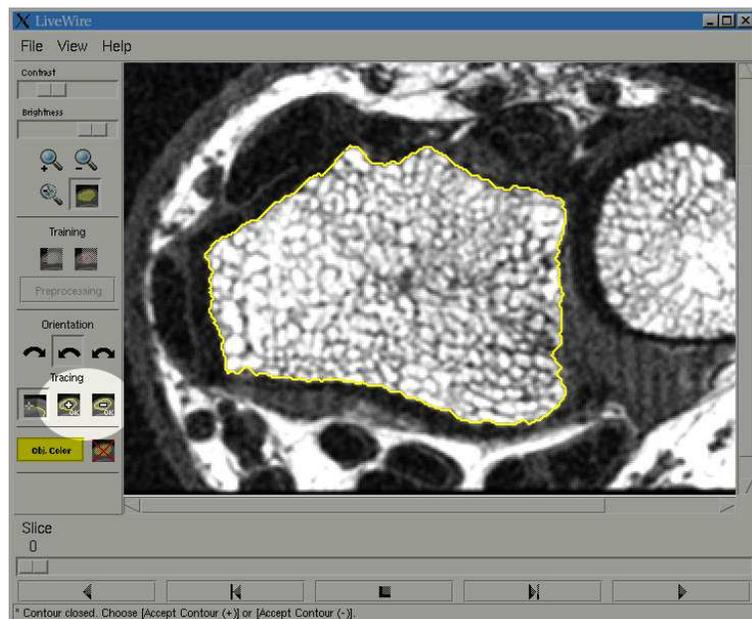
You can use any combination of filters. If you applied a filter by mistake, you can reset the filtered image clicking on the **Reset to Original Image** button.

#### 6.3.2.4 Interactive Segmentation

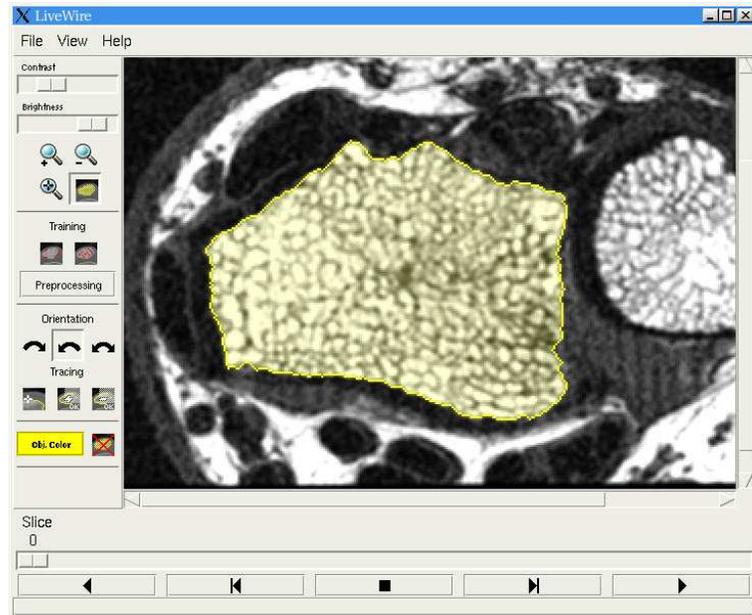
1. Select an object color.
2. Click on the **Interactive Segmentation** button to activate it.
3. Click the left mouse button on an initial point of the object boundary to start segmentation.
4. Select an appropriate orientation and move the mouse to another boundary point. The live-wire segment will follow the object boundary. Click the left mouse button again to accept the segment shown and to start a new segment.



5. The live-wire algorithm could find a wrong path if the object boundary is too weak or noisy. In this case, keep the left mouse button pressed and manually draw the segment.
6. Click the right mouse button to close the contour.



7. Click on the **Accept Contour (+)** button to add the segmented region to the overlay mask, or click on the **Accept Contour (-)** button to remove the segmented region from the overlay mask.



### 6.3.2.5 Saving segmented objects

1. Click on the menu item **File**→**Save Objects Labels...** to save the overlay masks.  
A file selection window will appear. The image can be saved in **SCN** and **PGM** formats.
2. Click on the menu item **File**→**Save Objects Values...** to save the segmented objects.  
A file selection window will appear. The image can be saved in **SCN** and **PGM** formats.



3. Select the desired directory and filename and then click **Save**.

## 7 Contact the author

If you find bugs or have problems in using LiveWire, send an e-mail to [celso.suzuki@ic.unicamp.br](mailto:celso.suzuki@ic.unicamp.br) or [afalcao@ic.unicamp.br](mailto:afalcao@ic.unicamp.br).

## 8 Acknowledgements

This software is part of a scientific initiation project funded by **FAPESP** and advised by **PhD. Alexandre Xavier Falcão** of **State University of Campinas, Brazil**.