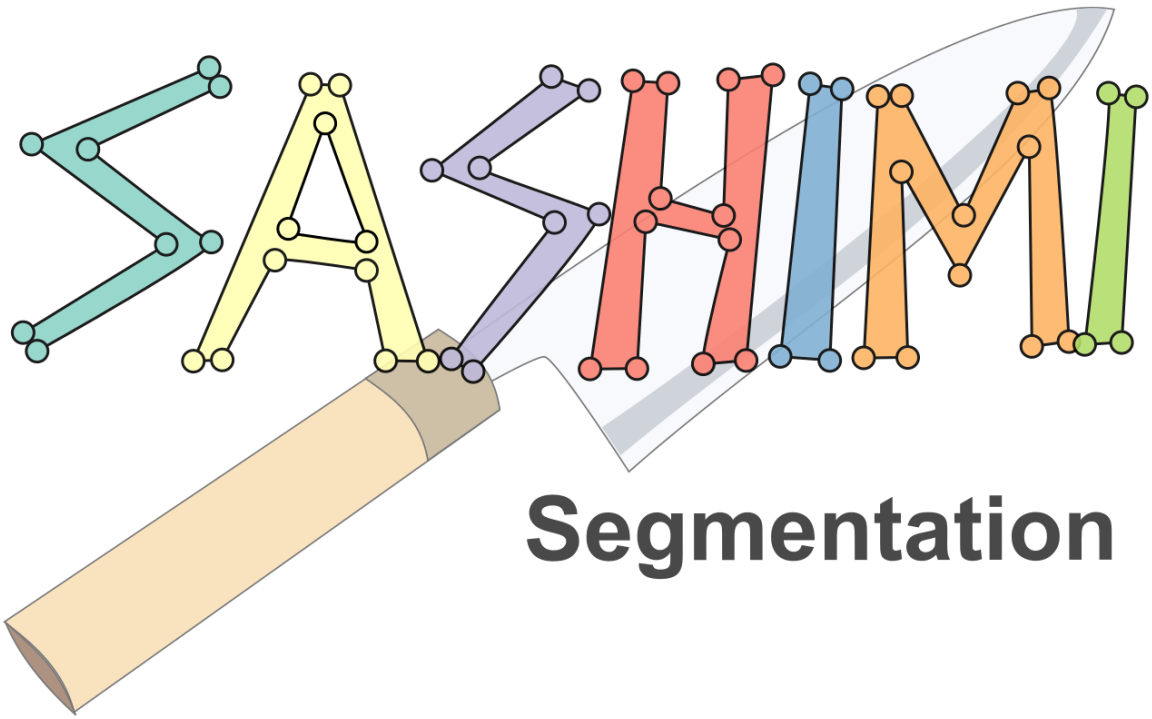
DOCUMENTATION



VERSION 1.0

Contents

About SASHIMI

SASHIMI Segmentation stands for:

Semi-
Automatic
Supervised
Human
Interactive
Multi-slice
Image Segmentation

SASHIMI Segmentation is a Matlab App to assist with image segmentation of 3D volumes. Structures are outlined on one slice and subsequently tracked on adjacent slices using demons image registration. The tracking results can be inspected and adjusted interactively.

SASHIMI has been designed specifically for segmentation of muscles from magnetic resonance imaging (MRI). While most features and settings have been optimized for this purpose, SASHIMI may prove useful for other applications as well.

SASHIMI can be run directly through Matlab 2019b (or higher) and requires the Curve Fitting and Image Processing Toolbox to be installed. No Matlab, no problem: a stand-alone executable is provided as well, which can be run after installing the freely available Matlab Runtime version 9.7.

Questions and/or feature requests can be directed to:

Bart Bolsterlee
Neuroscience Research Australia & University of New South Wales
b.bolsterlee@neura.edu.au

Tutorial videos

Most of the instructions in this documentation can also be learned by watching the tutorial videos on YouTube: https://www.youtube.com/playlist?list=PLCgxZJMGTw9c7BVhrIMy-jtjIMyiX8leH

Getting started

SASHIMI can be downloaded or cloned from GitHub:

https://github.com/bartbols/SASHIMI

There are two options to use SASHIMI.

Option 1 (through Matlab)

Directly through **Matlab 2019b or higher** by opening the file SASHIMI_<version>.mlapp.

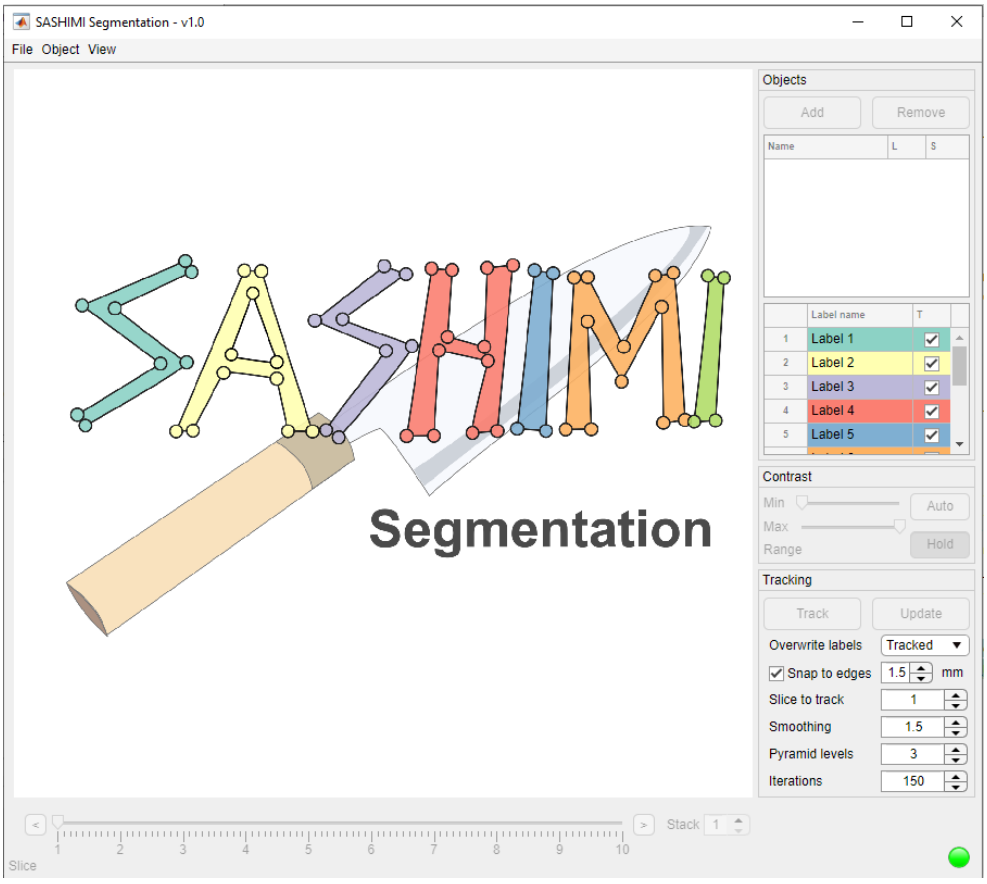
SASHIMI requires the Image Processing Toolbox and Curve Fitting Toolbox to be installed. If your Matlab installation does not have those toolboxes installed, install them before using SASHIMI.

Option 2 (standalone – no Matlab required)

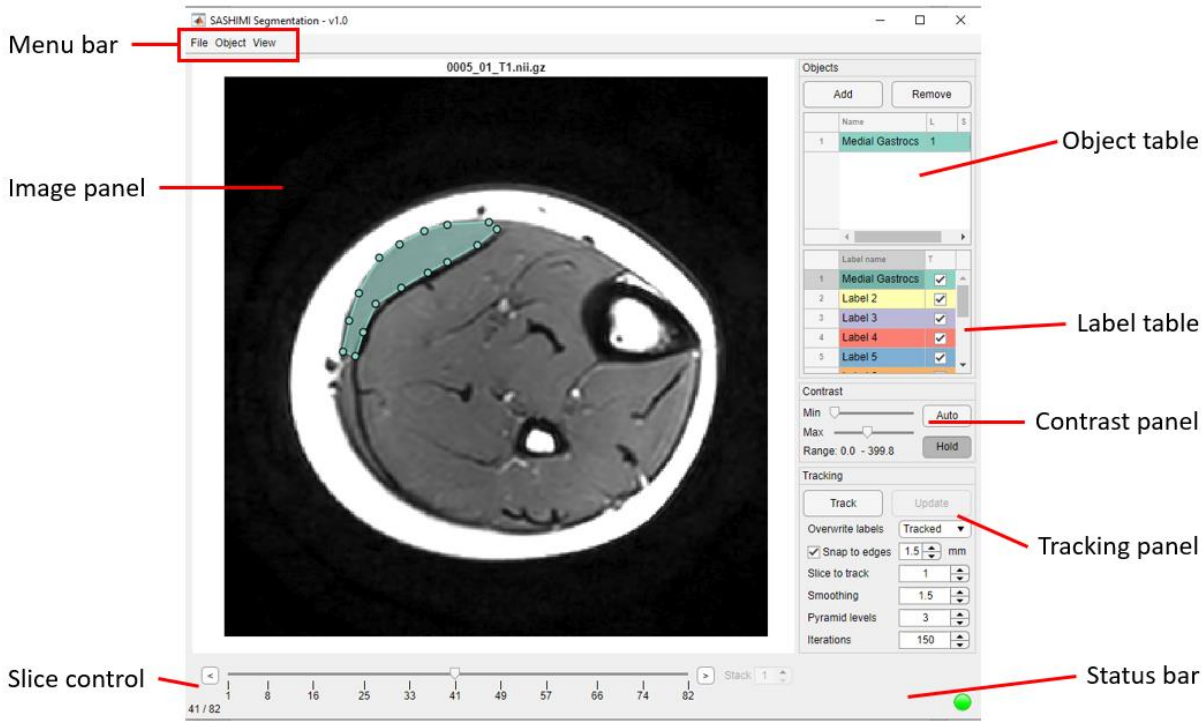
Open the file SASHIMI_<version>.exe in the folder 'standalone'.

This file is a Matlab-compiled executable version of SASHIMI which **does not require Matlab to be installed**. However, **you do need to install Matlab Runtime R2019b (9.7)**, which can be downloaded here: https://www.mathworks.com/products/compiler/matlab-runtime.html

After opening the app or .exe-file, you should see the following SASHIMI opening screen.



The SASHIMI Interface



Menu bar: Open images, edit objects, and change view settings.

Image panel: This is where the images and objects are displayed.

Slice control: Scroll through the slices of the 3D volume using the slice slider and arrows.

Object panel: Lists objects in current slice

Labels: List of label names and colors.

Contrast panel: Adjust image contrast for display purposes.

Tracking panel: Settings for tracking, including settings of demons registration.

Status bar: Shows which actions SASHIMI is busy with.

Instructions

Step 1: Open an image

Open an image through File > Open image… in the File menu in the Menu bar (or by typing Ctrl+O). Currently SASHIMI only supports images in NIfTI format.

- If your images are in DICOM format, convert them to NIfTI using the popular dcm2niix converter: https://github.com/rordenlab/dcm2niix
- Another excellent open source tool for converting various file formats to NIfTI is Convert 3D: http://www.itksnap.org/pmwiki/pmwiki.php?n=Downloads.C3D

If you have previously saved objects and you want to continue where you left off, load the objects through File > Load objects…

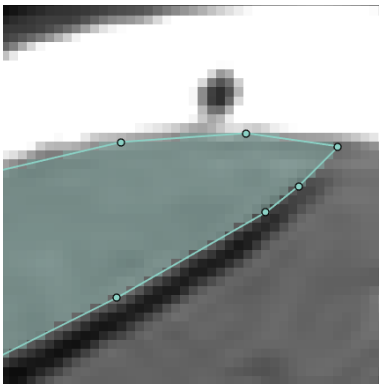
Scroll through the slices of the image using the slider underneath the image, the left/right arrows on the keyboard or with the mouse scroll wheel while holding Ctrl. Zoom using the mouse scroll wheel. Pan the image by moving the mouse while holding the scroll wheel.

Step 2: Add objects

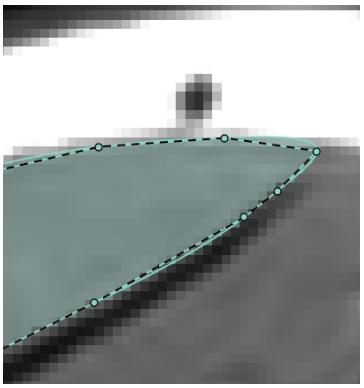
Scroll to the slice where the object(s) to be segmented are clearly visible on. Add as many objects as necessary. To draw (add) an object, click the 'Add' button, or use hotkey 'a'.

- Draw a polygon by clicking on the image. A minimum of three points is required. Close the polygon by double clicking on the first point or by using the Enter key.
- Each object will be assigned a label. New objects will be assigned the current label number.
- Change the current label number by clicking on a label in the label table (below the object panel).
- In the label table, set the name of the label by double clicking in the column 'Label name' and typing the new name.
- A new object will appear on your image and in the object table.
- Decide whether your object is best presented by a *polygon* or a *spline object*. A polygon object connects the object's control points using straight lines; a spline object fits a smooth curve through the points. If a spline is selected, the polygon will still be visible as a dashed line. Toggle between spline/polygon objects using the checkbox in the object table in the column S. If checked, a spline is used.

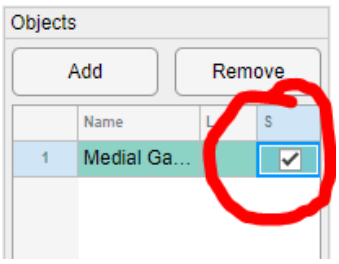
polygon

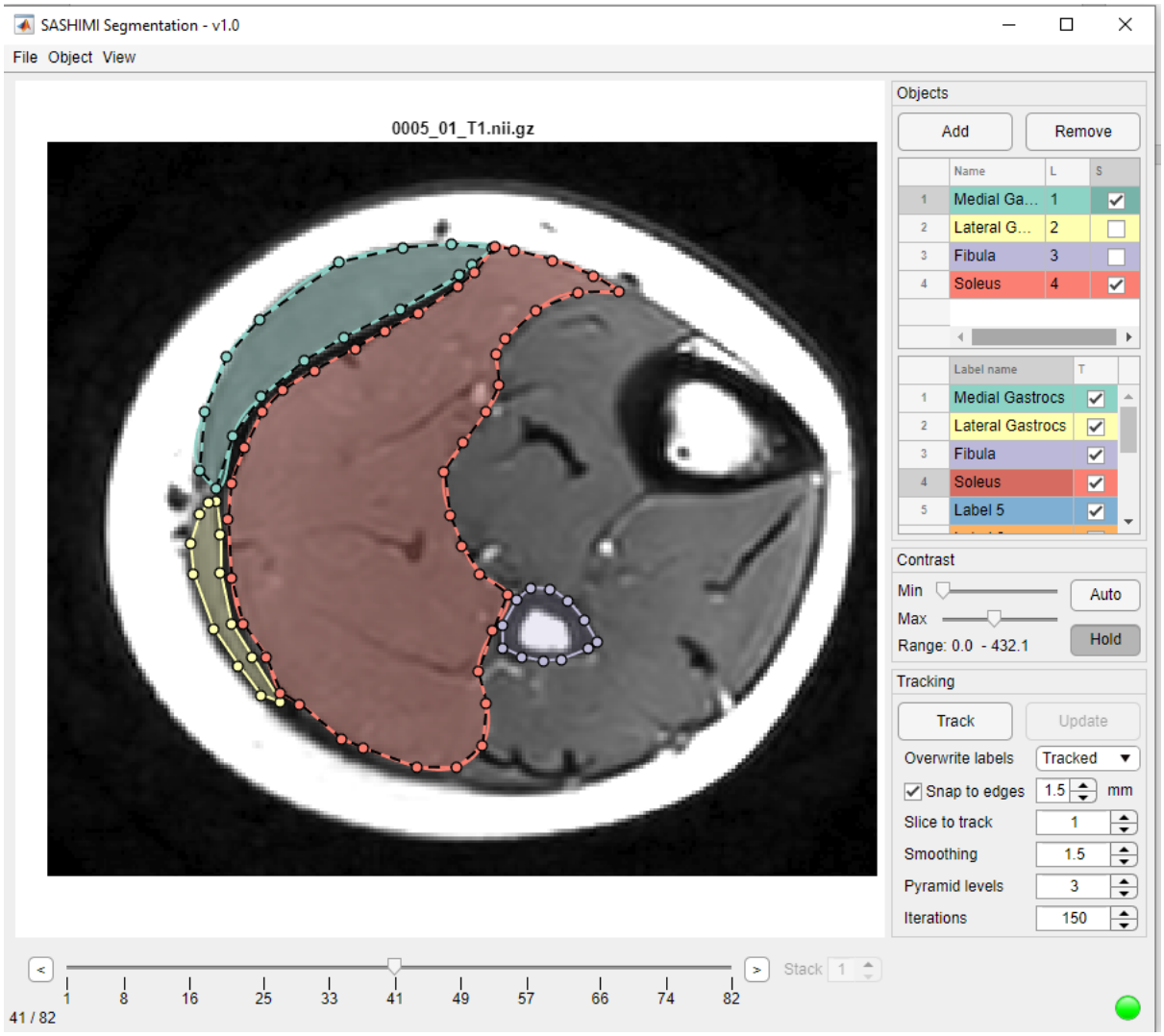


spline



Toggle spline/polygon





Example of a slice with multiple objects.

The following options are available for manipulating objects after they have been added/tracked:

- **Remove objects** by clicking the Remove button or hotkey ‘r’ and clicking inside the object.
- **Move points** by clicking on a point and dragging them to a new location.
- **Insert a point** by double-clicking on a line of the polygon. (Note that if the object is a spline, you can only insert a point by clicking on the dashed line.)
- **Delete points** by selecting Object > Delete point or hotkey ‘d’ and dragging a rectangle containing the points to be deleted. If fewer than three points are left in an object, the entire object will be removed.
- **Snap points to the nearest edge** by selecting Object > Snap to edge or hotkey ‘q’ and dragging a rectangle containing the points to be snapped. The maximum distance to snap over can be set in the Tracking panel next to the checkbox ‘Snap to edges’.

- **Change the label number** of an object using the dropdown menu in the column 'L' in the object table.
- **Toggle between polygon/spline objects** using the checkbox in the column 'S' in the object table.

Change what is visible on the image using the options in the View menu:

- By default, the mask (voxels with labels) is displayed as a semi-transparent overlay. Change the transparency using the dot and comma key.
- Show/hide the mask using hotkey 'm'.
- Show/hide the object outlines (the polygon and/or spline curves) using hotkey 's'.
- Show/hide the label names using hotkey 'l'.

Step 3: Track objects

Track objects between slices by clicking the Track button in the tracking panel or hotkey 't'. This will call Matlab's built-in non-rigid demons registration (function *imregdemons*) to register adjacent slices. The predicted deformation field will be used to deform the control points of objects.

Decide which labels to track using the checkbox in the label table in column 'T. If a label is checked, all objects with that label will be tracked.

The following options for tracking are available:

- **Overwrite labels:** decide which objects to overwrite on the slice to be tracked:
  - **All:** All prior existing objects on the tracked slice will be removed.
  - **None:** All prior existing objects will be kept. The tracked objects will be added.
  - **Tracked (default):** Only objects with tracked label numbers will be removed. For example, if the slice to be tracked contains objects with labels 1 and 2, but only label 1 is tracked, objects with label number 1 will be removed but objects with label number 2 will be kept.
- **Snap to edges:** If checked, points will be snapped to edges automatically after tracking. The maximum distance to snap over can be set.
- **Slice to track:** Slice number relative to the current slice to track. For example, if the current slice is 20 and 'Slice to track' is 1, slice number 20+1=21 will be tracked. If 'Slice to track' is set to -1, slice 20-1=19 will be tracked. If a value above 1 or below -1 is chosen, slices will be skipped.

The following options are settings of demons registration. For details see Matlab's documentation (type *doc imregdemons* in the command window):

- **Smoothing:** This parameter controls the amount of diffusion-like regularization. *imregdemons* applies the standard deviation of the Gaussian smoothing to regularize the accumulated field at each iteration. Larger values result in smoother output displacement fields. Smaller values result in more localized deformation in the output displacement field.
- **Pyramid levels**: Number of multi-resolution image pyramid levels to use.
- **Iterations**: Number of iterations per resolution level.

When tracking is finished, the tracked slice containing the tracked objects will be displayed in the image panel. Inspect the results, manipulate the objects when necessary, and continue tracking the next slice. If the tracking result is poor, change the track settings (for example increase the number of

pyramid levels and/or iterations or change the smoothing factor) and press the 'Update' button to track again with the updated settings.

Step 4: Save/export data

Objects can be saved as a Matlab MAT-file through the menu File > Save objects… or Ctrl+S. Previously created object files can be loaded as well (File > Load objects… or Ctrl+L).

To create an image mask, voxels inside objects are assigned the label number of the object. The mask can be exported as a NIfTI file through File > Export to NIfTI segmentation… or Ctrl+E).

The default color/label scheme in SASHIMI contains 12 labels. You can load a custom label file through File > Load custom labels… The label-file should be a Matlab MAT-file with the following variables:

- LabelNames: n x 1 cell-array with label names.
- colors: an n x 3 array of rgb-color triplets per label.

n = number of labels

SASHIMI hotkeys and mouse actions

Keyboard	Action
Arrow left/right	Scroll down/up slices.
a	Add object – click on the image to create a polygon object.
d	Select points for deletion.
r	Remove object – click inside object to remove it.
t	Track objects.
u	Update tracking with updated settings.
q	Select points for edge-snapping.
s	Toggle object (polygon+spline) visibility.
m	Toggle mask visibility.
. (dot)	Increase mask opacity.
, (comma)	Decrease mask opacity.
1 to 9	Select label 1 to 9. (Labels 10 and higher can only be selected by clicking on the label in the label table.)
l	Toggle label name visibility.
Ctrl + o	Open image.
Ctrl + l	Open object file.
Ctrl + s	Save object file.
Ctrl + e	Export segmentation mask as NIfTI file.
Ctrl + z	Undo last action.
Ctrl + y	Redo last action.

Mouse	Action
Scroll wheel	Zoom in/out.
Ctrl + scroll wheel	Scroll down/up slices.
Hold scroll wheel + move	Pan axes.