BrainMask

Quick Start

Segmentation of the brain from three-dimensional MR images is a crucial pre-processing step in morphological and volumetric brain studies. *BrainMask* software implements a fully automatic brain segmentation from T1-weighted MRI. The algorithm exploits the notion that after thresholding, regions corresponding to the brain and non-brain structures are either "weakly" connected or are separated by strong edges. Due to its sub-voxel morphological erosion and constrained growth operators, *BrainMask* demonstrates high segmentation accuracy. In a recent study of 29 representative datasets, the segmentation error averaged 3.4% ± 1.3% [1]. This document represents a step-by-step walk through the program using a sample brain DICOM dataset.

[1] Artem Mikheev et al. Fully automatic segmentation of the brain from T1-weighted MRI using Bridge Burner algorithm. J Magn Reson Imag. 2008 Jun;27(6):1235-41.

Follow instructions listed in the file BrainMask_ReadMe.txt to install the program. Briefly:

- Extract files to a new folder
- Run vcredist_x86.exe
- Launch BrainMask.exe
- Paste your computer ID to the email addressed to hr18@nyu.edu
- The reply will include FireVoxel.key to be saved in your folder

Step 1

When you start *BrainMask* you will see its main window, the toolbar on the right margin and only two menu items: *File* and *Help*. The gray document area is initially empty. Make sure that the vertical resolution of your screen is fine enough to view the entire toolbar (9 icons).
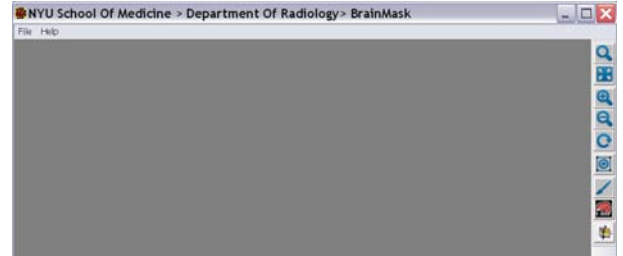
Step 2

To load the volumetric dataset, let's use a sample sagittal T1-weighted brain MRI dataset provided with the application. This dataset is in a DICOM file format. Go to *File* item of the main menu and select the *Open DICOM Data* submenu.

Browse for Folder dialog box will now appear in order to navigate to a folder that contains your (unzipped) sample dataset. You may also select a higher-level folder, but the higher the level, the longer it will take to load. If you're asked "Use existing DICOMDIR file?" press YES.

Step 3

Open DICOM Directory dialog box will next appear. You should select the desired series corresponding to a 3D dataset by expanding "PATIENT" and again expanding "STUDY." Highlight "SERIES" located at the bottom of this tree. (The sample data contains only one series, but in general you will need to inspect a more complex DICOM tree structure.) To help you choose the right series, you will see its middle slice preview on the upper right of the dialog box. Under the preview you will see a summary of the dataset.
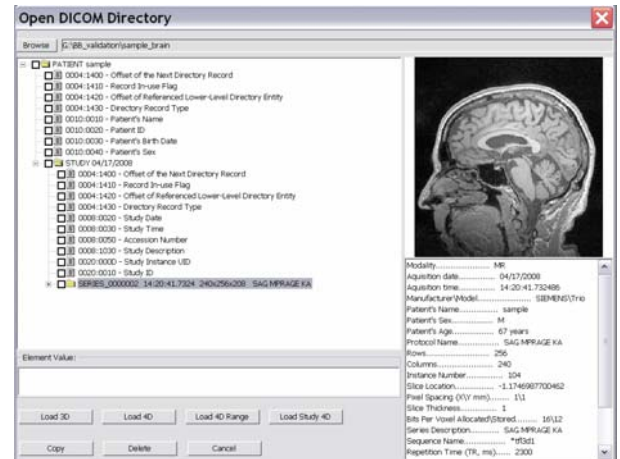
After highlighting the series, press **Load 3D** to load the volume and create a document.

Step 4

The Document window will appear inside the main window. Some new menu items (*Volume, 3D Projection, ROI, BridgeBurner, View*) will now appear. The Document window will show a set of over 100 slices.

Position the mouse cursor on the desired slice and right double-click to switch to a *Single Slice* view. Repeating right double-click brings you back to the **FilmView**.

In *Single Slice* view, use the mouse scroll wheel or the keyboard up/down arrow keys to view different slices

Press Orthogonal Projections icon (lowest on the toolbar) to generate additional windows with orthogonal view of the volume.
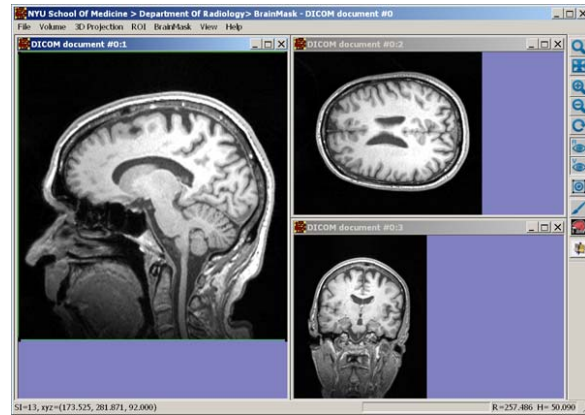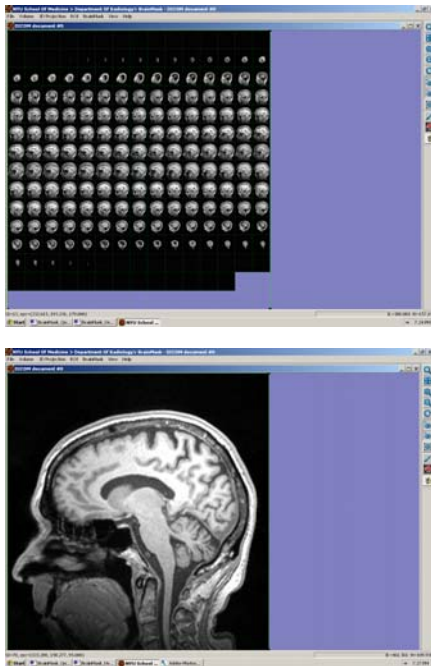
Three orthogonal views

Film view and Single Slice view

You can load multiple volumes in separate resizable windows. Independently you can resize the volume relative to the document window using the four zooming icons.


Before performing an operation, the relevant object needs to be selected with a mouse click. If a volume is selected, a green rectangular frame appears around its border.

Before we continue, if you activated orthogonal views, close the axial and coronal view windows.

Step 5

Using the mouse, left double-click anywhere over the volume to bring up the *Layer Control* dialog box. Layers enable you to view and manipulate multiple volumes in unison. All layers have identical resolution so that they could be superimposed in the same document. You will soon learn more about overlays.
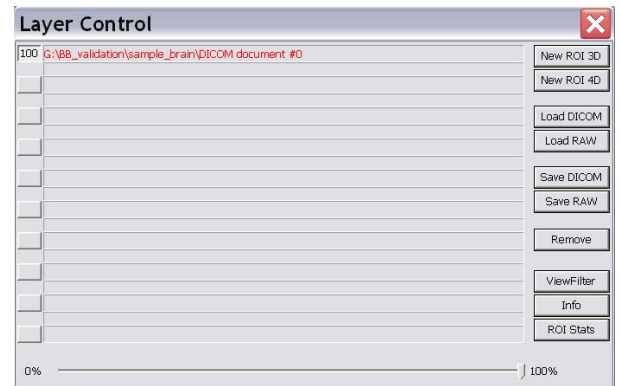
Our sample data is loaded as a single base layer which is 100% opaque (non-transparent). The transparency of the layer is controlled with the horizontal slide bar at the bottom of the *Layer Control* box. Press the *Info* button to display information about the volume. Press the *ViewFilter* button to change the way voxel intensities are mapped to screen colors: gray level window and color maps. Before continuing, close *Layer Control*.

Step 6

Our sample brain MRI is distorted by non-uniformities that are undesirable for the segmentation step that follows. To reduce non-uniformities we will apply a histogram deconvolution technique of Sled et al [2]. First make sure that the volume is selected (see Step 5), then select the *BridgeBurner>Bias Field Correcton (N3)* submenu item.

N3 dialog box lets you modify operation parameters. Let's change *subsample* parameter from 3 to 4 for this tutorial. Press OK to run the field correction.
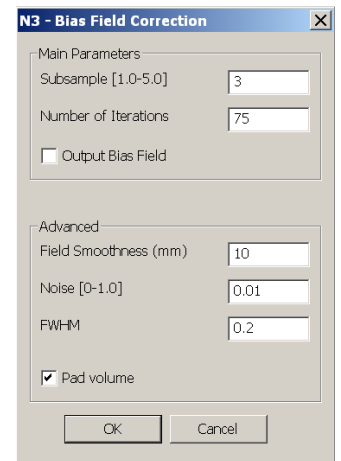
[2] Sled JG et al. A Nonparametric Method for Automatic Correction of Intensity Nonuniformity in MRI Data IEEE Trans Med Imag 17(1), 1998.

Step 7

Bring up again the *Layer Control* dialog box using left double-click. We now see two layers. The result of *N3* operation is placed over the original layer, becoming the Active layer, shown in red. Most of the buttons on the right side of *Layer Control* apply to the Active layer.

Active layer can be changed by clicking on that layer's name. Click with left mouse on the original, base layer, the one labeled document #0 to make it Active and highlighted in red. Press *Remove* button on the right to get rid of this

volume. We are left with the image corrected for field non-uniformities. Close the *Layer Control*.

Step 8

Select the *BridgeBurner>Find White Matter Seed – SAGITTAL* from the main menu. This tool finds and displays a 1 cm^3 box in the white matter that will be used as a seed for the segmentation algorithm that follows.
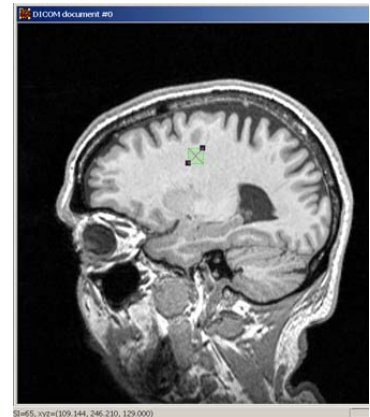
Step 9

Select *BridgeBurner>Run BridgeBurner* from the Main Menu. In the *BridgeBurner* dialog box keep the default settings and press OK. After a brief calculation the brain mask will appear as an overlay over the original volume.

We now have two layers. The base layer is the MRI with reduced non-uniformities. The top, active, layer is the brain mask. Try to change the transparency and the color of the brain mask by left double-clicking on the image to go to *Layer Control* (Refer to Step 6).
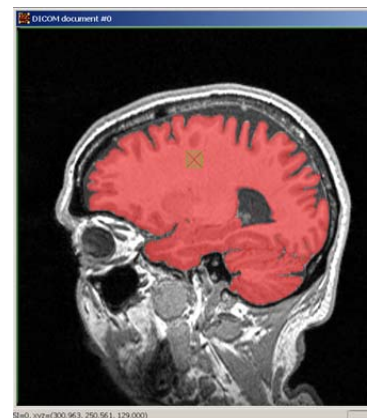
Step 10

Press the F4 button, which is equivalent to clicking on *ROI Stats* from the *Layer Control* box. This will display useful statistics for the base image voxels that belong to the brain mask layer. Click OK to close this box.
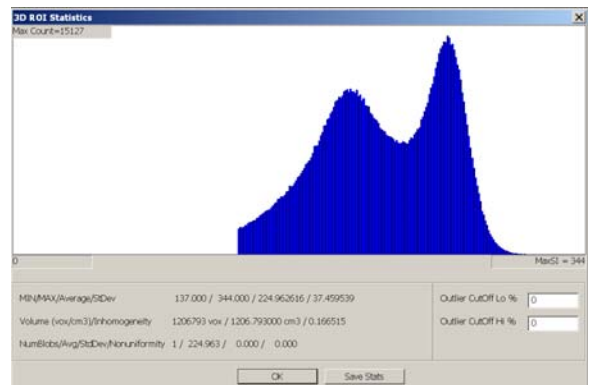
Step 11

An active layer can be manually edited and corrected with the *Paintbrush/Eraser* tool. This tool becomes active when you simultaneously hold down the *Ctrl* key and the left mouse button, and move the mouse over the volume. Holding down *Ctrl* key and the right mouse button will erase the region. Painting can be applied to any active layer. The *Paintbrush* icon from the toolbar is used to adjust the properties of the *Paintbrush/Eraser*, including its radius.