Introduction to FireVoxel: Quick Start Guide

FireVoxel (FV) is a medical image analysis software package developed by Artem Mikheev and Henry Rusinek, Radiology Department, NYU School of Medicine. The main types of data analyzed by FV are:

- 3D volumes from MRI, CT, PET, SPECT or ultrasound acquisitions
- 4D datasets, typically representing a dynamic time series of 3D volumes
- 3D/4D regions of interest (ROIs) linked to above data

This document is a step-by-step walk through the basic user interface using a sample brain MRI DICOM

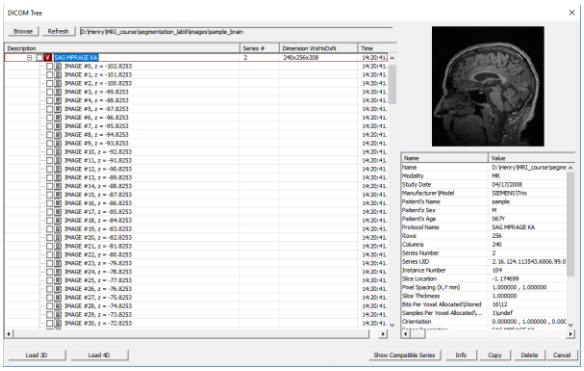
wp.nyu.edu/FireVoxel is the web page where you can download the software, tutorials, and sample data. Follow instructions listed in the file *installation.txt* to install the program.

Step 1 - MENU, TOOLBAR and DOCUMENT AREA

At the start you will see the main window, the toolbar on the right and only few menu items. The gray document area is initially empty. Make sure that the vertical resolution of your screen is fine enough to view the entire toolbar (17 icons).

Step 2 – DICOM TREE

Let's load a sample sagittal T1-weighted brain MRI dataset *sample_brain* provided as a compressed (zipped) file on the *QuickStart page wp.nyu.edu/firevoxel/*. You will need to unzip individual DICOM files into a folder. After unzipping, click on *File* item of the main menu and select the *Open DICOM Single* submenu. *Browse for Folder* dialog box will now appear in order to navigate to a folder that contains your sample DICOM dataset.



Step 3 – LOAD 3D VOLUME

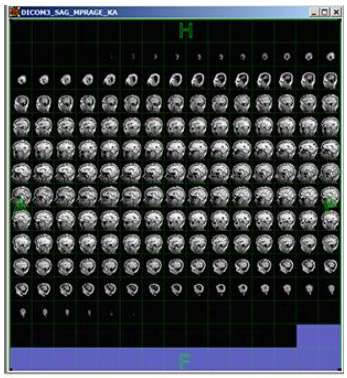
The *DICOM Tree* dialog box will next appear to help you select the desired volume. The sample data contains only one volume, but in general you will need to deal with a more complex structure of PATIENTS, STUDIES, and SERIES. Individual 3D volumes are marked with a **V**. (You may also see lists of volumes VL, slice S, and lists of slices SL.) To help your selection, representative slices will appear on the upper right corner as you click on different parts of the DICOM tree. The corresponding DICOM information is tabulated on the lower right.

Click on series description **SAG_MPRAGE_KA** to highlight our volume, then press *Load 3D* button to load it.

Note: when loading from DICOM tree we **ignore square boxes** that prefix each line! Use description instead.

DICOM Tree dialog box will now close. If you need to load multiple documents, it is easier to start with *File -> Open DICOM Multiple* submenu

Step 4 – IMAGE DISPLAY



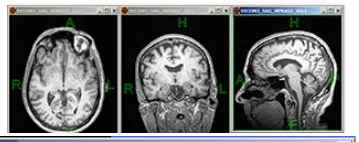
The Document window is created inside the main window. New menu items (*Volume, ROI, etc*) will now appear. The document window will show the film (square grid of slices) view of all 208 sagittal slices. Position the mouse cursor on the desired slice and **right double-click** to switch to a *Single Slice* view. Repeating right double-click brings you back to the *Film View*. In **Single Slice** view, use the mouse scroll wheel or the keyboard up/down arrow keys to view different slices

Press *Orthogonal Projections* icon (the one that shows xyz axes) on the toolbar to generate two additional windows with orthogonal view of the volume.

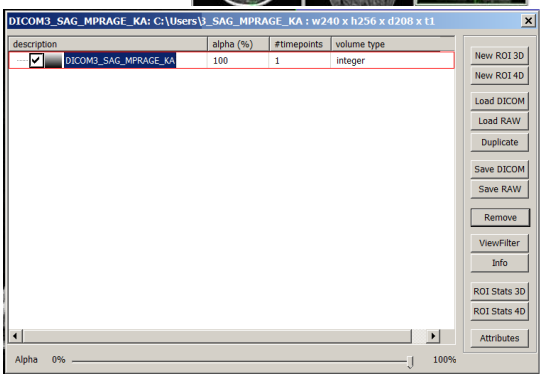
You can control the green letters that show Right, Left, Anterior, Posterior, Head, Foot by clicking *File -> User Interface Options -> Show orientation*.

Step 5 – SIZE ICONS

You can load multiple volumes in separate resizable windows. Independently image can be resized using the four zooming icons shown on the left. 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, close the axial and coronal view windows.



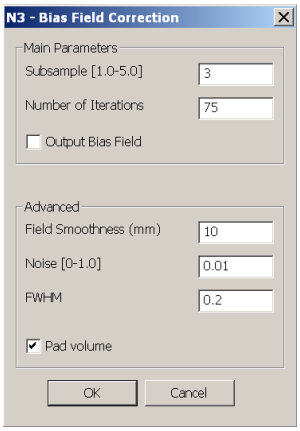
Step 6 – LAYER CONTROL



Using the mouse, left double-click anywhere over the volume to pop up the very important *Layer Control* box. Layers enable you to handle in a single document multiple 3D and 4D images of identical resolution and voxel size. Images on different layers can be saved and loaded from files. Layers are moved within and across documents using drag-and-drop.

FV combines layer opacities or "alpha" values. Our MRI is on a single layer that is 100% opaque. Opacity of selected layers is controlled with the horizontal slide bar at the bottom. *Info* button displays information about the volume. *View Filter* button reveal color map box used for mapping voxel intensities to screen colors.

Step 7 – REDUCE NON-UNIFORMITIES

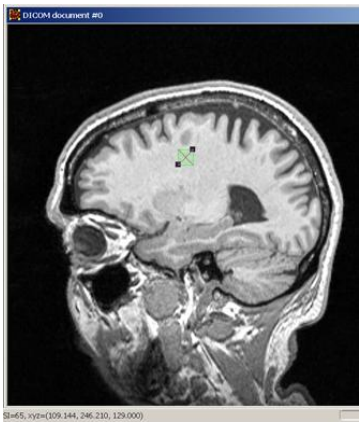


Our MRI shows non-uniformities that interfere with segmentation step that follows. To reduce non-uniformities we will apply N3 method a histogram deconvolution technique (*Sled J et al. IEEETransMedImag 17(1), 1998*) from menu: *Nonuniformity -> N3*. Press OK to compute and apply field correction.

In the *Layer Control* dialog box we now see two layers. The result of *N3* operation is placed as the next layer. The becomes Active -- highlighted. The buttons on the right side of *Layer Control* box apply to the Active layer. The active layer can be changed with a mouse click.

Now remove the original MRI layer: uncheck the square box, press *Remove* button on the right, confirm with YES. We are left with the image corrected for field non-uniformities.

Step 8 – VECTOR ROIS



Select from menu: *Applications -> Brain-MR -> Find White Matter Seed SAGITTAL*. This tool finds and displays a 1 cm^3 green box in the white matter. This is a Vector ROI (VROI), useful for image cropping, annotating and measuring sizes. Double-click on the box to explore its properties. There is a menu group *Vector* devoted to VROIs. This VROI will now be used as a seed for brain segmentation algorithm.

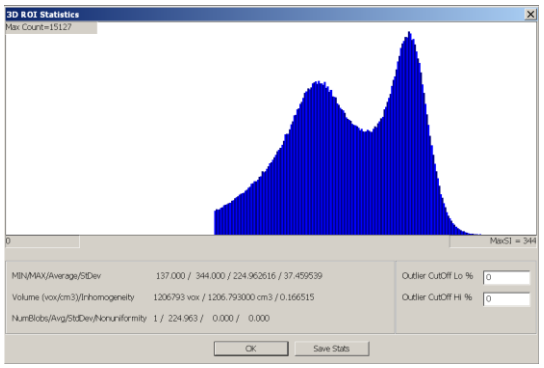
Step 9 – EDGEWAVE SEGMENTATIONS

Select *Segment > EdgeWave basic* from the menu. (Equivalently you can click on the red brain icon on the bottom right of the FireVoxel window.) In the *EdgeWave* 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 after N3 processing. The next, 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*. Note how *View Filter* button works differently for gray-scale image and the binary mask.

Step 10 – ROI STATISTICS

Clicking on *ROI Stats 3D* in the *Layer Control* box. This will display statistics for the MRI signal in the brain mask. ROI signal and histogram stats can be analyzed automatically in batch mode. Click OK to close this box.

Step 11– ROI EDITING



An active ROI can be edited (on multiple views) 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 mouse scroll wheel or the crayon *Paintbrush* icon from the toolbar is used to adjust the size of the *Paintbrush/Eraser*.

Under ROI menu there are many tools to manipulate ROIs, including interior filling in 2D (also using F7 key) and across-slice ROI interpolation tools like: *ROI> Morph>Fill2D and Morph.*

Note: FV does not deal with slice ROIs. You need two distinct ROIs to separately analyze different slices.

Basic keyboard shortcuts

Film / slice view: double-right mouse	Bring up Layer Control: double-left mouse
Paint: Ctrl-left mouse	Erase: Ctrl-right mouse
ROI Stats: F3 (F4 for 4D data)	Scroll wheel, UP/DOWN arrow keys: next slice
Fill the ROI interior on one slice: F7	Move vector ROI: Shift-right mouse
Full view of selected data: space bar	Press ESC to exit gray level windowing
Drag-and-drop: move layer	LEFT/RIGHT arrow keys: advance frames