A Novel MRI Visualization Tool for White Matter Pathology in Multiple Sclerosis

Mei Xiao[1], Thao Do[1], Carl Helmick[2], Jung Soh[1], Oscar Meruvia-Pastor[1], Jordan A. Fisk[2], John D. Fisk[2], George Robertson[3], Christoph W. Sensen[1]

[1]Department of Biochemistry and Molecular Biology, University of Calgary, Calgary, Alberta, Canada

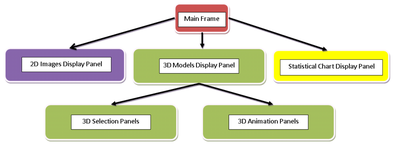
[2]Department of Psychiatry / [3]Department of Pharmacology, Dalhousie University, Halifax, Nova Scotia, Canada

208.15

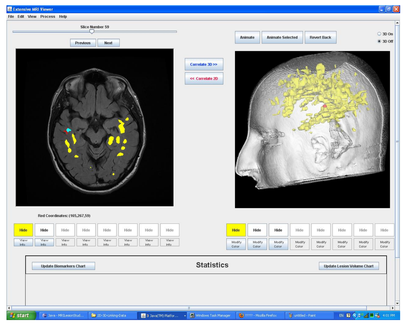
We have developed a new software tool that integrates 2D MRI images with reconstructed 3D images and other measures of interest. This tool enables users to look at standard 2D views of MS lesions and their 3D surface models side by side, and allows them to see changes over time in various ways.

The software includes features such as the ability to map a 2D data point to a surface point on the displayed 3D surface model, and vice versa. Specific 3D volumes can be selected from the 3D model for zooming or animation or a point on the 3D model can be selected to highlight all of the lesions that are connected to it. Changes in MS lesions over time can also be shown as an animation to demonstrate differences across scanning sessions while the total volume of MS lesions can be calculated, displayed as a chart, and exported for statistical analyses. This visualization tool has been used to examine MRI scans from MS patients who were scanned once a month, for six months.

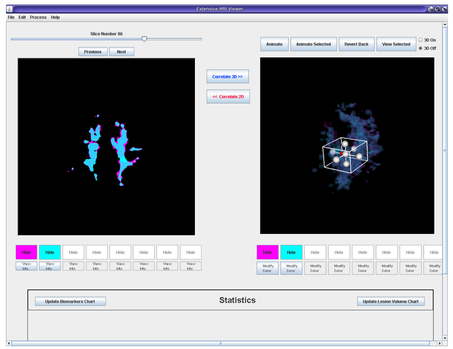
Conventional clinical MRI scans allow us to see damage to the white matter structures, tissue deep in the brains of people with MS. This damage is seen as extremely bright areas on the standard structural MRI images which show the regions of inflammation and loss of the myelin surrounding nerve fibers that is characteristic of MS. Studies seeking to understand how MS progresses over time have used MRI images to calculate the volumes of these bright areas to create a measure of MS “lesion burden”. This measure has then been used to evaluate the effectiveness of new MS treatments. While there are many neuroimaging tools that can be used to visualize combinations of MRI images, none had been developed to visualize small and large scale changes in MS white matter lesions over time, in combination with 2D/3D modes. Accordingly, researchers and clinicians will benefit from new and easily applied methods for visualizing MS lesions that allow for quantifying their volumes, and that allow for viewing changes in lesion size, shape and location over time.



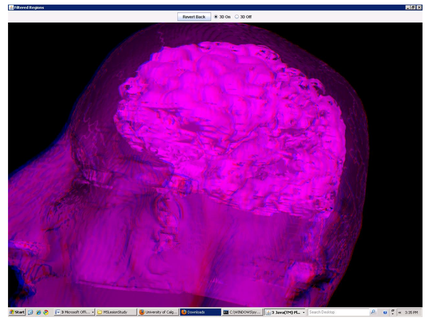
Visualization architecture. The main frame consists of a 2D display panel, a 3D display panel, and a statistical chart panel. More details of 3D models can be seen by selecting a 3D sub-volume or initiating animation.



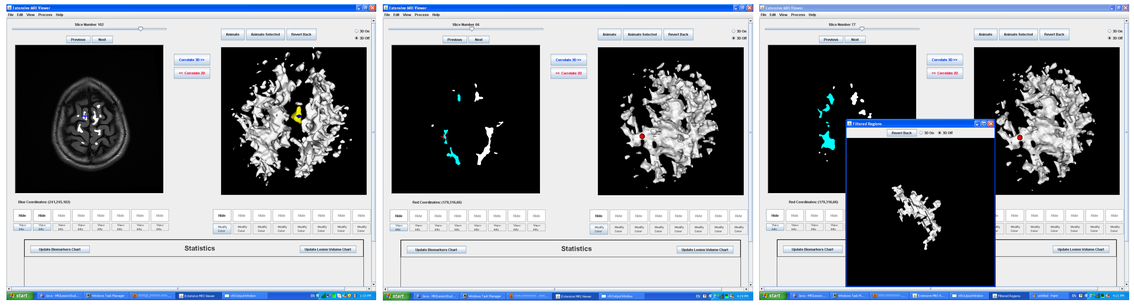
Concurrent visualization of 2D and 3D images. A stack of FLAIR images and segmented lesion masks (left) and the 3D models of the head and the lesions (right) are linked by using the same color.



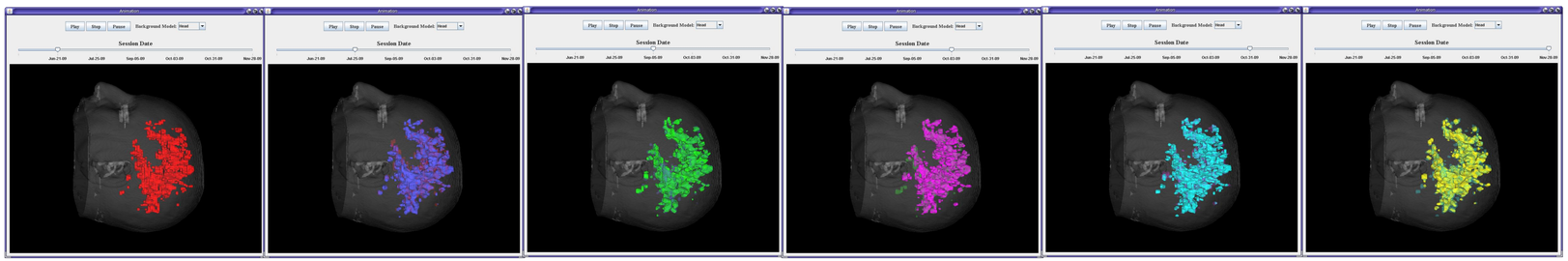
Selecting 3D volumes of interest. A point on the 3D model is selected to bring up a box around it, which can be adjusted to set the volume of interest. Upon typing *b* key on the keyboard a new window will be opened to display the selected 3D volume in much more detail.



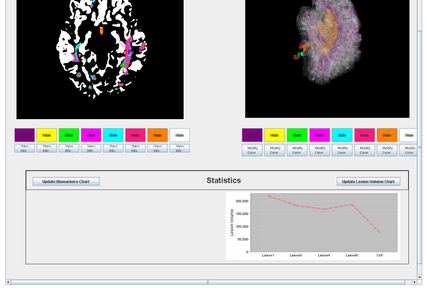
Viewing selected portions of a 3D model. A new window has been opened to show a zoomed-in view of a volume of interest. Selecting *3D On* will change the display to an anaglyph image for stereoscopic viewing with red/blue 3D glasses.



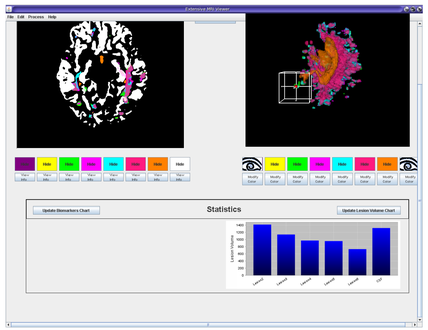
2D-3D mapping. A 2D point on a slice of a stack (blue crosshair) is mapped to a nearest surface point (blue sphere) on the 3D model (left). A 3D point (red sphere) is mapped to the corresponding lesion (highlighted in cyan) and the exact matched 2D point (red crosshair) in the 2D image stack (middle). The selected 3D lesion is displayed in a new panel (right).



Animating changes in lesions over time. Six lesion models reconstructed from six scans acquired over time are shown. The slider bar shows the actual date of the scan. Different colors represent different time points, such that temporal changes between successive scans are elucidated.



Measuring total lesion volumes. The volumes of the loaded 3D lesion models are calculated and plotted to facilitate the observation of the changes in the total lesion burden.



Measuring local lesion volumes. The volumes of selected portions of 3D lesion models are calculated and plotted to facilitate the observation of the changes in the lesion burden in a localized portion of the model.