Analyze 10.0

Process

Exercise 23 : Image Calculator Image Manipulation

This exercise will demonstrate how to use the Image Calculator module for rudimentary image processing and manipulation.

1. Load both the **MRI_3D_Head.avw** and **MRI_3D_Brain_Bin.avw** data sets from the **$:\BIR\images\TutorialData** directory.
2. With the **MRI_3D_Head** data set selected in the Analyze workspace, open the Image Calculator module (**Process > Image Calculator**).
3. In the **Image Calculator** module, the MRI_3D_Head data set icon should appear in the white space above the calculator (figure 1).

4. Click the **Multiply** button [**A**] on the calculator.
5. Drag-and-drop the **MRI_3D_Brain_Bin** data set from the Analyze workspace into the Image Calculator module (white space).
6. This first manipulation demonstrates how to multiply a grayscale data set with a binary data set. The binary brain will act as a mask, all voxels in the grayscale data set that fall within the binary mask will be kept, while the voxels that fall outside will be removed.

7. Click the **Equals** button [**B**] on the calculator. A dialog box will be returned stating that the action modifies the loaded volume, click **Change a Copy of the Loaded Volume**.
8. The masked grayscale data will appear in the Image Calculator module; a copy will be automatically be saved to the Analyze workspace.

9. Click the **Multiply** button again.

10. Click the **Matrix** button [**C**] on the calculator.
11. The Matrix Tool will open (figure 2); set to **Rotate** around the **Z-axis 45 degrees** and click **Apply**. Click **Done** to close the Matrix Tool.

12. Click the **Equals** button on the calculator. A Transformation window will be returned; use the default settings and click **Transform**.
13. The transformed data will appear in the Image Calculator module and the copy in the Analyze workspace will be updated.

note In order to be able to drag-and-drop data sets from the Analyze workspace into the module, make sure that the Analyze window is not maximized to full window display.

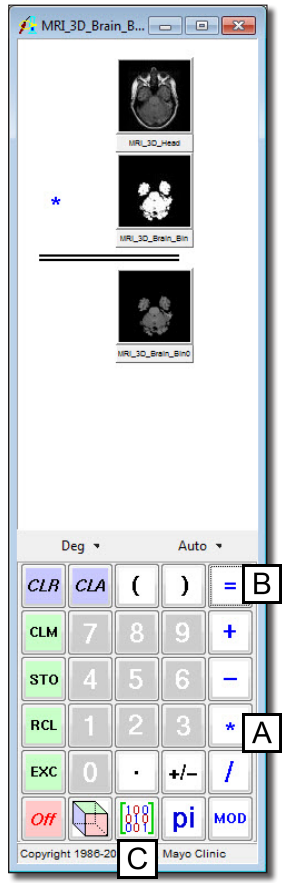

Figure 1

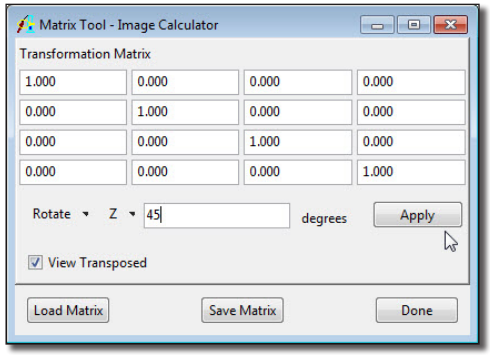

Figure 2

14. Right-click on the calculator and choose **Buttons**; the Button Tool will open (figure 3).
15. The Button Tool includes a ‘Palette’ and ‘Key Pad’ (figure 3). To add a button to the main calculator, drag-and-drop it from the ‘Palette’ to the ‘Key Pad’ area of the Button Tool.
16. Click the **Flip** button [**D**] that now appears on the calculator (figure 4).
17. In the Function Options window returned, check the **Flip X** option and click **Apply** (figure 5).
18. View the results by clicking the **Volume Tool** button [**E**] on the calculator.
19. A copy of the data set (as specified earlier) with the manipulations performed has automatically been saved to the Analyze workspace.
20. Close the Image Calculator module before proceeding to the next exercise.

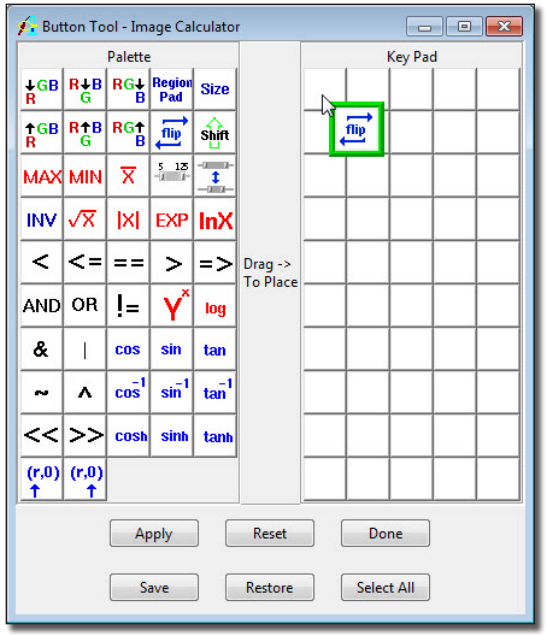

Figure 3

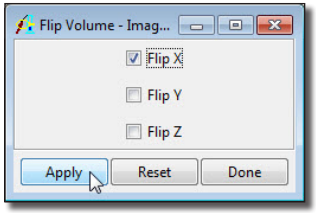

Figure 5

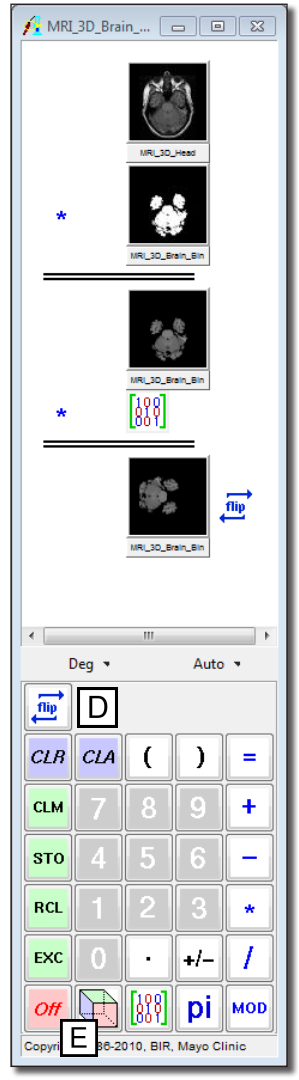

Figure 4

Exercise 24 : Image Calculator SubRegion Data

The Image Calculator module performs mathematical operations on volumes, matrices and constant numerical values. The module also contains a number of processing functions including: subregioning (crop), flipping, resizing, shifting etc. This exercise will demonstrate how to use some of these additional processing tools to manipulate your data.

1. Load the **MRI_3D_Head.avw** data set from the **$:\BIR\images\TutorialData** directory.
2. Open the **Image Calculator** module (**Process > Image Calculator**).
3. In the Image Calculator module, right click on the white space and select **Buttons** from the menu options (figure 1).
4. In the **Button Tool**, select the **Region Pad** button [**A**] from the palette on the left, and drag and drop it onto the Key Pad [**B**] on the right.
5. After the Region Pad button has been moved to the Key Pad, hit **Apply**. The main Image Calculator key pad will be updated with the additional button option. Close the Button Tool.
6. Now drag and drop your data set from the Analyze workspace onto the Image Calculator process canvas, (the white space. This will load the data set into the module and the volume will appear on the canvas.

7. Hit the **Region Pad** button [**C**], the Region Pad buttons **Function Option** window will be returned (figure 4).
8. In this window you can subregion the data by entering Low and High values for the X, Y and Z options.
   - **X Low** - Specifies the first column of pixels from each slice to be loaded.
   - **X High** - Specifies the column end point
   - **Y Low** - Specifies the first row of pixels from each image to be loaded
   - **Y High** - Specifies the row end point
   - **Z Low** - Specifies the first slice from the selected volume to be loaded
   - **Z High** - Specifies the slice endpoint

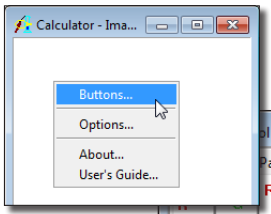

Figure 1

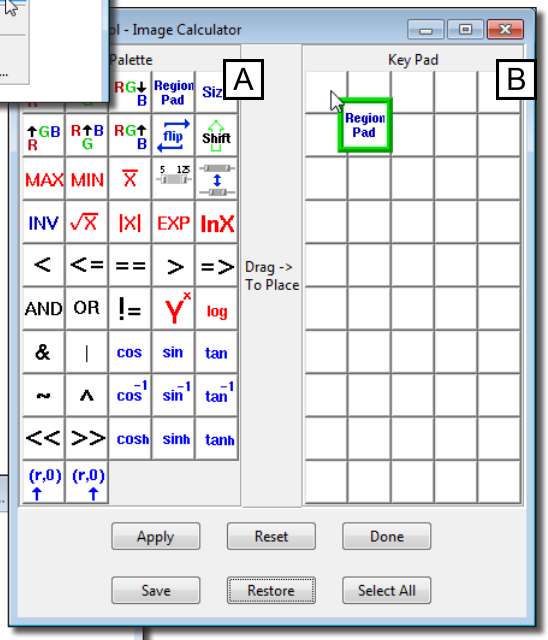

Figure 2

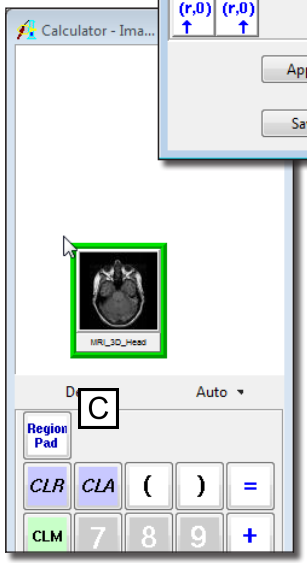

Figure 3

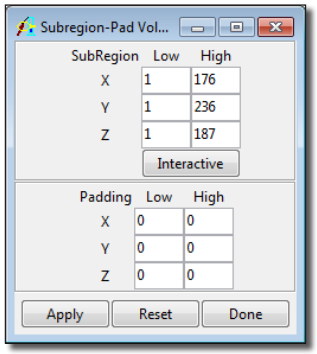

Figure 4

9. Click on the Interactive button in the Subregion window.

Example 1: Subregioning 50 slices in the X.

i. Set the **X Low** value to **25**

ii. Set the **X High** value to **151**

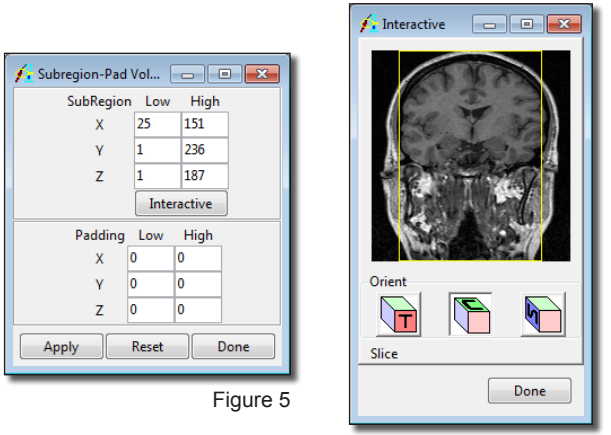

Figure 5

Example 2: Subregioning 50 slices in the Y.

i. Set the **Y Low** value to **25**

ii. Set the **Y High** value to **211**

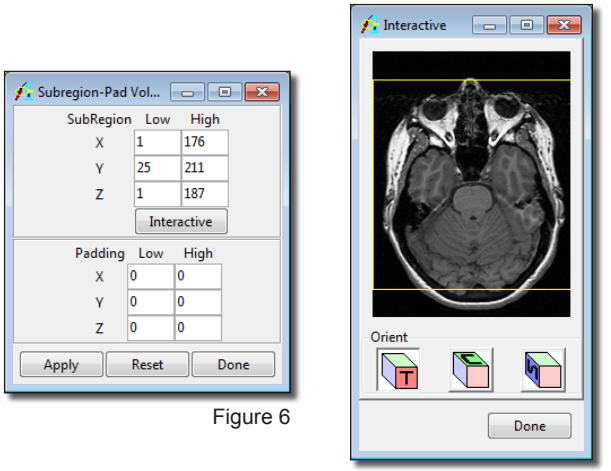

Figure 6

Example 3: Subregioning 50 slices in the Z

i. Set the **Z Low** value to **25**

ii. Set the **Z High** value to **162**

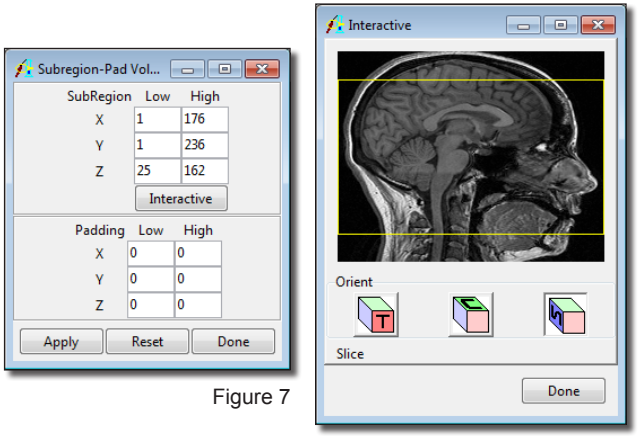

Figure 7

10. Now use the interactive tool to subregion. Use the tool to trace a bounding box around the area you wish to subregion.
    - To define the box, simply click and drag the box on the image display [**A**].
    - You can review and adjust the box in all three orthogonal orientations, by using the T, C, or S cube icons to change orientations.
    - You can review your subregion on all slices prior to applying the subregion, use the slice slider bar to navigate through the volume [**B**].

11. A subregion defined in the Interactive tool automatically updates in the X,Y and Z high/low values in the Region Pad Function Option window. To apply a subregion to a data set, hit **Apply** in the Region Pad Function Option window.

12. When you Apply a subregion you will be asked if you would like to apply the changes to the Loaded or if you would like to Change a Copy of the Loaded Volume. Select **Change a Copy of the Loaded Volume**. The changes made to the copy of the data set will automatically be saved to the Analyze workspace.

13. Close all windows associated with Image Calculator before proceeding to the next exercise.

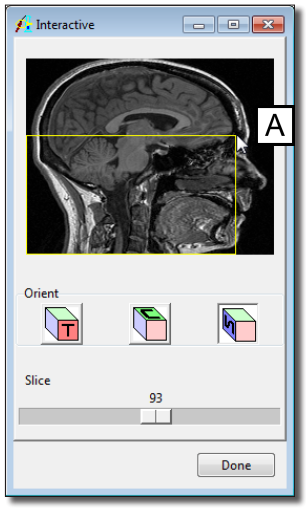

Figure 8

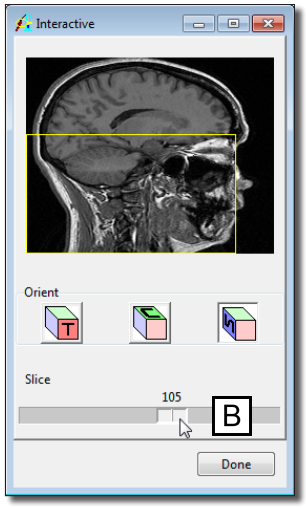

Figure 9

Exercise 25 : Image Algebra Formula for Image Manipulation

The Image Algebra module provides an algebraic formula parser, allowing both simple and complex algebraic operations (containing up to 1000 variables and 1000 constants) to be performed on image data. This exercise will demonstrate the use of common algebraic processing and other manipulations with the Image Algebra module.

1. Load the **Cubic_CT_Head.avw** data set from the **$:\BIR\images\TutorialData** directory.
2. Deselect the Cubic_CT_Head data set in the Analyze workspace, and then open the **Image Algebra** module (**Process > Image Algebra**).

note The Image Algebra module remembers parameters from previous Image Algebra sessions. If the module detects parameters from a past session, it will prompt the user to remember or forget these settings.

Thresholding Data

3. You may remember from previous exercises (Volume Render 12 and 13), that the Cubic_CT_Head data set can be thresholded to 145 to show bone.
4. [**A**] Enter the formula: **Output = (a > 145) * a**. Press <**Enter**> (figure 1)
5. [**B**] Drag-and-drop the **Cubic_CT_Head** data set from the Analyze workspace into the Image Algebra module under variable '**a**'.
6. Click the **Output** button [**C**]; in the **Parameters** window returned, set **Name** to **Bone**. Click **Done** to dismiss the window.
7. Click **Go** [**D**] in the main Image Algebra window to begin processing.
8. Once processing is complete, right-click on the **Output** icon and select **Display** to examine the data with all voxels less than 145 removed (figure 2). Close the Display tool once the data has been reviewed.

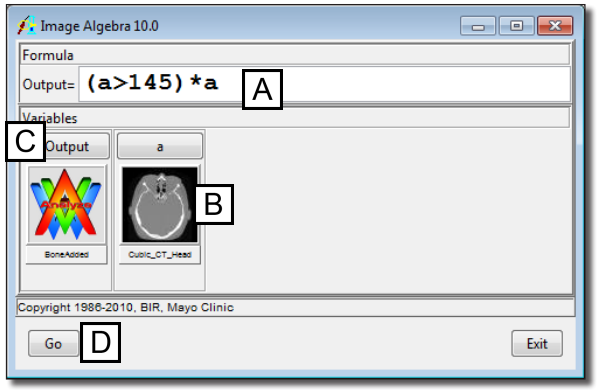

Figure 1

Figure 2

Manipulating Data

9. In the Image Algebra module edit the formula: **Output = (a < 145) * a**. Press <**Enter**>. All voxels greater than 145 will now be removed from the data set.

10. Click the '**a**' button to view the parameters for variable 'a' (figure 3). Click **Done** to dismiss the Parameters window.
11. Click the **Output** button and change **Name** to **NoBone**. Click **Done** to dismiss the window.
12. Click **Go** in the main Image Algebra window to begin processing.
13. Once processing is complete, right-click on the **Output** icon and select **Display** to examine the data with bone removed.
14. Now, try adding the bone back in with the new formula: **Output = (b >= 1) * b + (b < 1) * a**. Press <**Enter**> (figure 4).
15. Since we have reused the 'a' variable, the Image Algebra module will remember the data associated with it from the previous example. However, this is the first time the '**b**' variable has been specified, so drag-and-drop **NoBone** (from Output or the Analyze workspace) to the area under variable '**b**'.
16. Click the **Output** button and change **Name** to **BoneAdded**. Click **Done** to dismiss the window.
17. Click **Go** to process the new formula (figure 4).
18. Once processing is complete, right-click on the **Output** icon and select **Display** to examine the data with the bone added back.
19. Right-click in the formula field and explore some of the example formulas provided.
20. Close the Image Algebra module before proceeding to the next exercise.

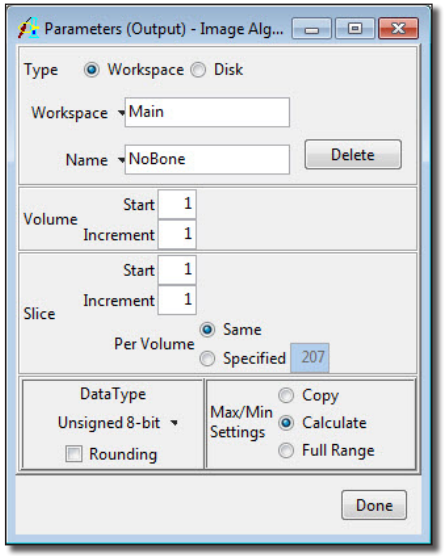

Figure 3

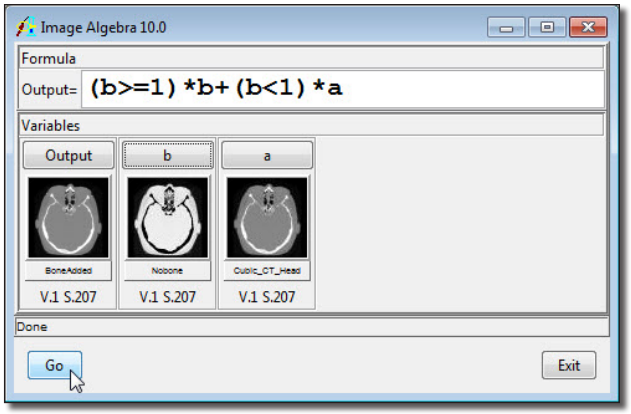

Figure 4

Exercise 26 : Histogram Operations Histogram Normalization

The Histogram Operations module provides the ability to do histogram processing, such as histogram matching, flattening, and equalization (normalization). The goal of this exercise is to demonstrate how to normalize the histograms of SPECT images taken under different conditions.

1. Load both the **SISCOM_Ictal_SPECT.avw** and **SISCOM_Interictal_SPECT.avw** data sets from the **$:\BIR\images\TutorialData** directory.
2. With only the **SISCOM_Ictal_SPECT** data set selected in the Analyze workspace, open the **Histogram Operations** module (**Process > Histogram Ops**).
3. Open the **Function** window (**Generate > Function**).
4. In the Function window select **Histogram Normalize** and set the following parameters (figure 1):
   - **Use Histogram: Median**
   - **Target Value: 150**
   - **Image Display: Original and Filtered**
   - **Histogram Display: On**
5. Click **Filter**. An **Input** and **Output Histogram** will automatically be returned. The filtered result will be displayed in the main Histogram Operations window.
6. In the Function window change **Action** to **Memory** and click **Filter** again. A dialog box will be returned stating that the action modifies the loaded volume, click **Change a Copy of the Loaded Volume**.
7. Drag-and-drop the **SISCOM_Interictal_SPECT** data set from the Analyze workspace into the main Histogram Operations window.
8. Press the **Filter** PowerBar button. In the dialog box returned, click **Change a Copy of the Loaded Volume**.
9. The two new volumes you have created have been normalized to the same value, so equivalent numbers in the images now indicate levels of metabolic activity (figure 2). Additionally, both normalized volumes have automatically been saved to the Analyze workspace.
10. Close the Histogram Operations module before proceeding to the next exercise.

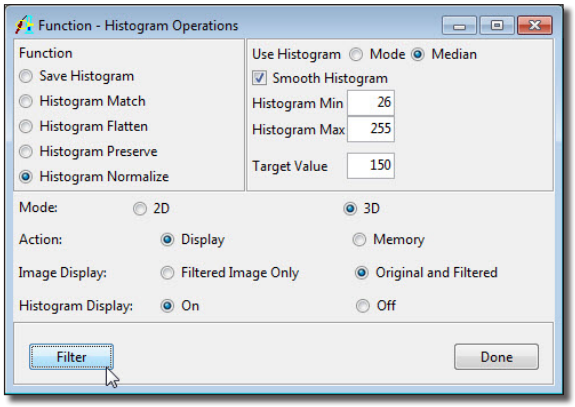

Figure 1

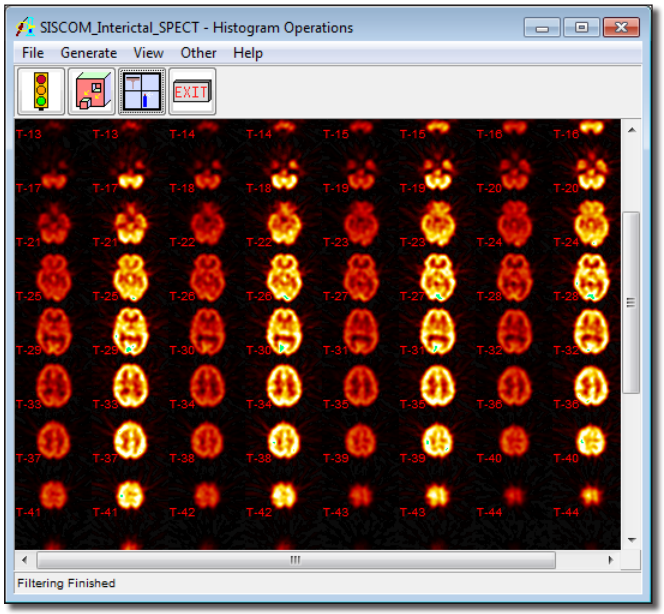

Figure 2

Exercise 27 : Spatial Filters

The Spatial Filters module enables the application of two-dimensional and three-dimensional filters to image data. This exercise will demonstrate how to apply a filter in the Spatial Filters module to your data.

1. Load the **MRI_3D_Head.avw** data set from the **$:\BIR\images\TutorialData** directory.
2. Open the **Spatial Filters** module (**Process > Spatial Filters**).
3. Open the **Preview Options** window (**Generate > Preview Options**).
4. Select the **Loaded and Preview Volumes** option (figure 1).
   This will preview the original data set and a copy of the data set with any filter applied, side-by-side.
5. Open the **Filters** window (**Generate > Filters**).
6. In the Filters window, select the **Low Pass** filter by clicking the radio button next to the option (figure 2).
7. Now, click **Preview** [**A**]. The original data set and the filtered data set will be displayed side-by-side in the main Spatial Filters window (figure 3), the filtered data set appears on the right.
8. Preview several other filters, noting the effect of each.
9. To apply a filter to the data set, click **Filter** [**B**] in the Filters window. A dialog box will be returned stating that the action modifies the loaded volume, click **Change a Copy of the Loaded Volume**.
10. A filtered copy of your volume will be saved to the Analyze workspace.
11. Close the Spatial Filters module before proceeding to the next exercise.

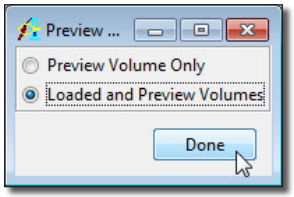

Figure 1

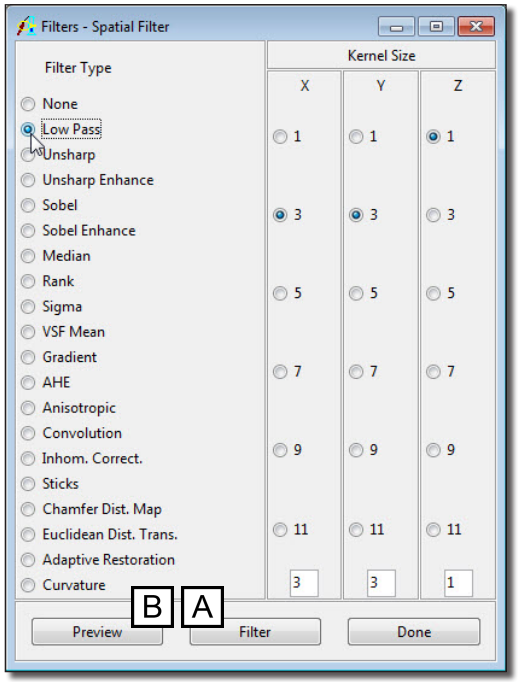

Figure 2

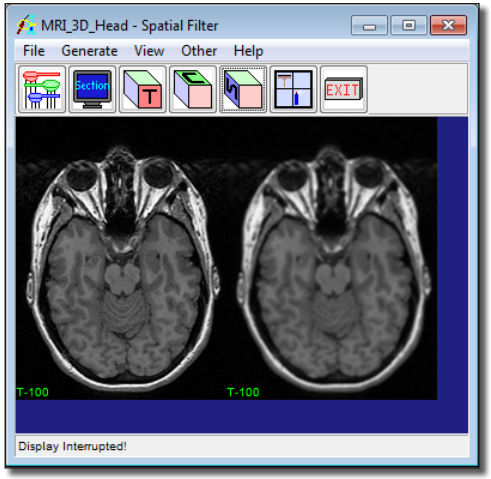

Figure 3