Analyze 10.0

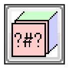
Segmentation

Exercise 28 : Image Edit Manual Segmentation of Grayscale Data

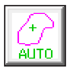
The Image Edit module provides a number of manual segmentation tools. This exercise will demonstrate how to segment grayscale data using the auto trace tool. For a full overview of all the segmentation tools in the module, please review the Image Edit tutorial available from the Help menu in the Analyze window.

1. Load the **MRI_3D_Head.avw** data set from the **$:\BIR\images\TutorialData** directory.

2. Open the **Image Edit** module (**Segment > Image Edit**).



3. Open the **Slice** window (**Generate > Slice**), and use the slider bar to move to **Slice 122**.



4. In the main Image Edit window, select the **Auto Trace** tool [**A**]. Position the cursor near the center of the brain and click to set a seed point. The Image Edit window will automatically update to display Auto Trace parameters (figure 1).

5. Use the double-ended slider bar at the bottom of the window [**B**] to adjust the threshold range until a reasonable trace of the brain is obtained. A **threshold minimum** of **34** and **maximum** of **129** works well for this data set.

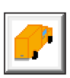
6. Select the **Delayed Flood Fill** tool and place a fill point outside the auto-traced region (click on the background).

7. Select the **Auto Trace** tool again and click **Apply & Advance** [**C**].

8. A dialog box will be returned stating that the action modifies the loaded volume, click **Change a Copy of the Loaded Volume**. The area outside the trace will be highlighted in red, and then the next slice will appear in the image display (the slice number can be seen in the lower left corner of the image display [**D**]).

> *note* An edited version of the data set will be automatically saved to the Analyze workspace.

9. Review the edited slice by opening the **Edit Review Tool** (**Tools > Edit Review**) (figure 2).



10. In the main Image Edit window, you will notice that when the module advanced to slice 123 (step 8) the seed point and auto trace parameters set in step 5 were copied forward. The trace should have automatically adjusted to the brain on this slice. If not, the seed point may have been copied forward to an area outside the brain or to a voxel with a different grayscale value. Use the **Move** button and adjust the seed point.

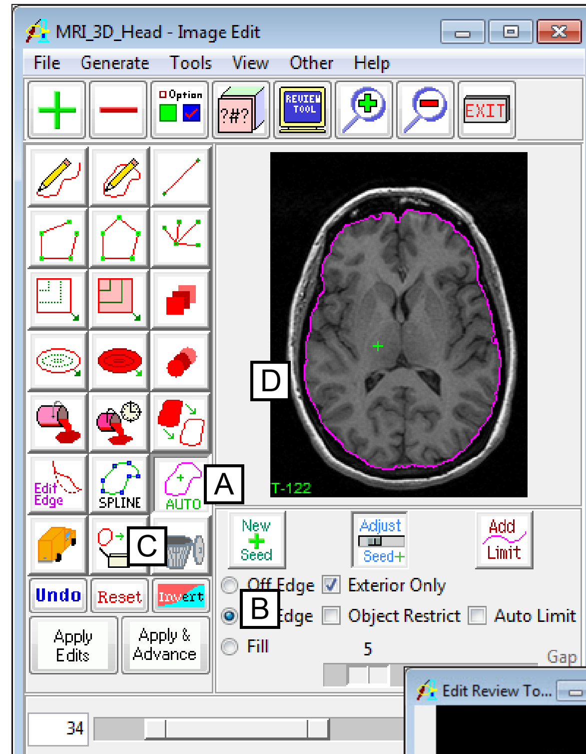


Figure 1

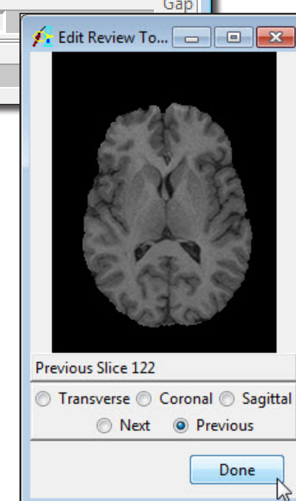


Figure 2

11. If the trace needs no further adjustment and the Delayed Flood Fill point is still positioned outside the trace, click **Apply & Advance** and edit 19 more slices, finishing on **slice 142**.
12. In the Edit Review tool, change the orientation to **Coronal** and then **Sagittal**, note the slice edits in these orientations (figure 3).
13. To create a rendering of the edited data complete the Additional Task.

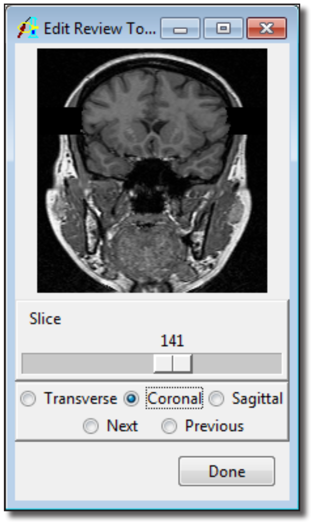


Figure 3

Additional Task

28.1 Rendering Segmented Data

1. Continue to segment the data set until approximately **slice 181** to remove the entire top of the head.
2. Close the Image Edit module.

3. Select the **MRI_3D_Head0** data set in the Analyze workspace and then open the **Volume Render** module (**Display > Volume Render**).

4. Open the **Thresholds** window (**Display > Thresholds**).
5. Set the **Minimum threshold** level to **50**, then click **Render**. The rendering will be displayed in the main Volume Render window (figure 4).
6. Close the Volume Render module before proceeding to the next exercise.

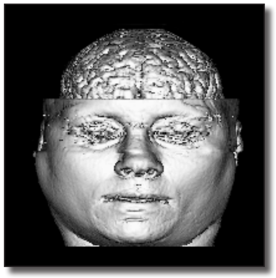


Figure 4

Exercise 29 : Image Edit Manual Segmentation and Object Map Creation

As discussed in Exercise 13: Volume Render Advanced Controls, object maps are special image files that are used in Analyze to partition and identify structures as belonging to a particular segmented object. This exercise will demonstrate how to create an object map containing manually segmented objects.

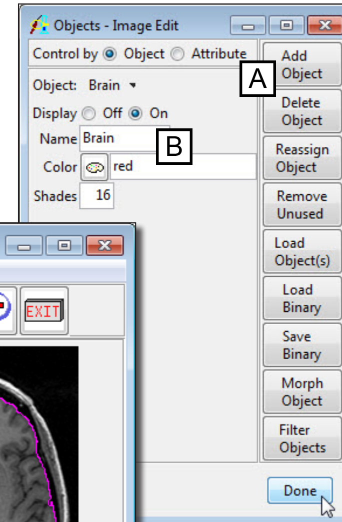


Figure 1

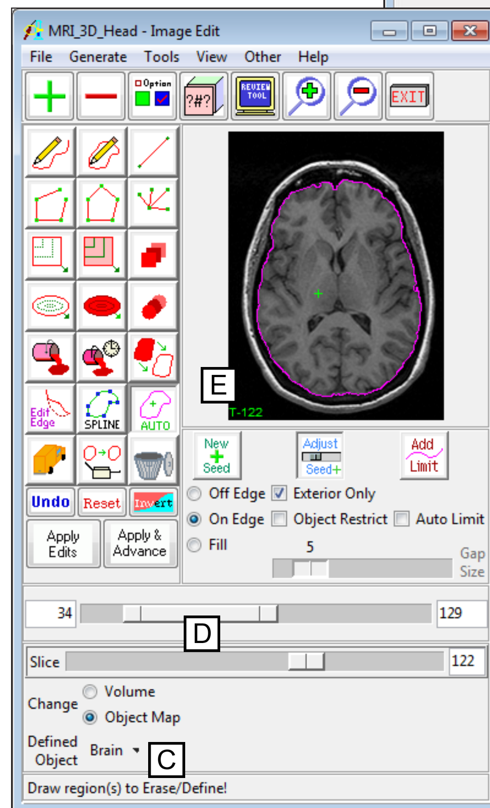
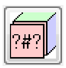
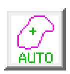


Figure 2

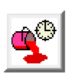
1. Load the **MRI_3D_Head.avw** data set from the **$:\BIR\images\TutorialData** directory.
2. Open the **Image Edit** module (**Segment > Image Edit**).
3. Choose **File > Create Object Map**. The **Objects** window (**View > Objects**) will automatically be returned (figure 1).
4. Click **Add Object** [**A**] to create a new empty object (Object_2).
5. Change **Name** from Object_2 to **Brain** [**B**]. Click **Done** to dismiss the Objects window.



6. Open the **Slice** window (**Generate > Slice**), and use the slider bar to move to **Slice 122**.
7. At the bottom of the main Image Edit window, set **Change** to **Object Map** and choose **Brain** from the **Defined Object** drop-down menu [**C**].



8. Select the **Auto Trace** tool, the Image Edit window will automatically update to display Auto Trace parameters (figure 2).
9. Position the cursor near the center of the brain and click to set a seed point. Use the double-ended slider bar [**D**] at the bottom of the window to adjust the threshold range until a reasonable trace of the brain is obtained. A **threshold minimum** of **34** and **maximum** of **129** works well for this data set.



10. Select the **Delayed Flood Fill** tool and place a fill point inside the auto-traced region (click inside the region).
11. Select the **Auto Trace** tool again.
12. Click **Apply & Advance**. The next slice will appear in the image display (the slice number is displayed in the lower left corner [**E**]).

> *note* | If you did not set the 'Change' option to Object Map (step 7) the defined region will appear black in the Edit Review tool.

13. View the edited object map by opening the **Edit Review Tool** (**Tools > Edit Review**).

14. Select the **Previous** option in the Edit Review tool. The change can also be viewed by selecting the **Sagittal** option.

15. With the **Auto Trace** tool selected, continue to segment slices by clicking **Apply & Advance** in the main Image Edit window. Segment the brain on **20 slices** (to slice 142).

> tip | If the auto trace does not apply to a slice, or leaks to unwanted structures, try the following: 1) adjust the threshold range, 2) draw a limit after selecting the 'Add Limit' button, or 3) turn on the 'Auto Limit' option and adjust the 'Gap Size'. Additionally, the auto trace can be adjusted on a slice by moving the seed point with the 'Move' button selected.

16. To save the created object map for use in other Analyze modules, choose **File > Save Object Map**. Save the object map as **xxx_mybrain.obj** (where 'xxx' are your initials).

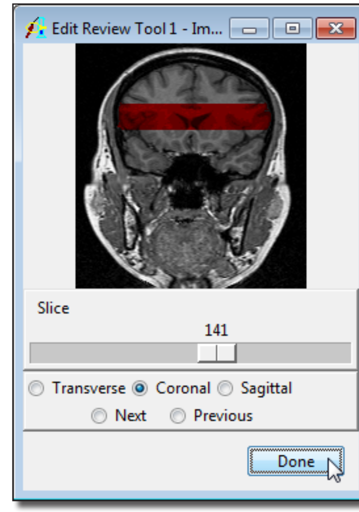
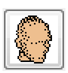


Figure 3

Additional Task

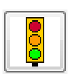
29.1 Viewing the Object Map in Volume Render



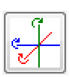
1. In the Analyze workspace, select the **MRI_3D_Head** data set and open the **Volume Render** module (**Display > Volume Render**).

2. Choose **File > Load Object Map** and load the **xxx_mybrain.obj** object map (saved earlier in step 16).

3. Open the **Objects** window (**View > Objects**). Set **Control by** to **Attribute** and set the **Display** attribute to **Off** for the **Original** object.



4. Click **Render**. You should see a rendering of the object you created in the Image Edit module.



5. Use the **Rotation** window (**Generate > Rotation**) to generate different views of the object (figure 2).

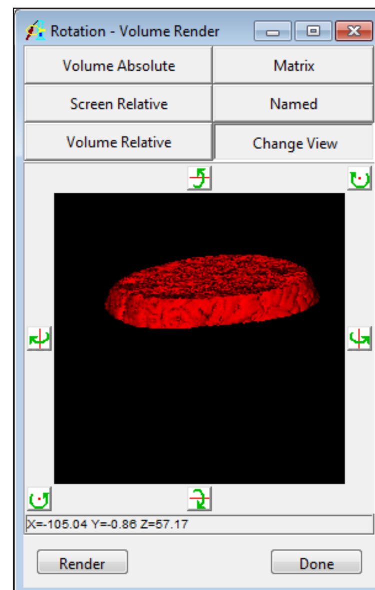


Figure 1

Exercise 30 : Morphology Morphological-Based Segmentation

The Morphology module applies 1-D, 2-D, or 3-D mathematical morphological transformations and object topology operations to a data set. This exercise will demonstrate the morphological segmentation tools available in the module by showing how to segment the brain from an MRI data set.

1. Load the **MRI_3D_Head.avw** data set from the **$:\BIR\images\TutorialData** directory.
2. Open the **Morphology** module (**Segment > Morphology**).
3. From the **Generate** menu, open the **Slice** tool. Move the slice slider to **slice 130**.

4. Open the **Step Editor** window (**Generate > Step Editor**) (figure 1).
5. Click the **Threshold** button [**A**]. In the **Step 1: Threshold** window returned, set the **Threshold Min** to **65**. Click **Threshold Volume**. In the window returned, select **Change a Copy of the Loaded Volume**.
6. Select **Generate > Display Section(s) > Current** to review that data.
7. Select **File > Save Volume**. Save the volume as **MRI_3D_Head_bin**.
8. Click the **Erode** button [**B**]. In the **Step 2: Erode** window, change the **Element Depth** to **3** and change the value **Iterations** to **2**. Click **Erode Volume** (figure 2).
9. In the Step Editor window, click **Transform Volume**. A dialogue box will be returned, select **Yes**.
10. Click **Connect** [**C**]. Change **Max. No. of Components** to **1**. Click **Connect Volume**.
11. In the Step Editor window, click **Conditional Dilate** [**D**]. In the Conditional window, change **Element Depth** to **3** and change **Iteration** to **1**. Next load the conditional volume by clicking the **Volume** button. Use the window returned to select the **MRI_3D_Head_bin.avw** data set saved in step 7. Press the **Cond. Dilate Volume** button.
12. To view your segmentation, select **Generate > Display Section(s) > Current** (figure 3).
13. The binary segmentation is available in the Analyze workspace. To obtain a suitable volume for further analysis multiply the binary volume by the input grayscale volume using the Image Calculator or Image Algebra modules.
14. When you are finished reviewing, close all windows related to the Morphology module before proceeding to the next module.

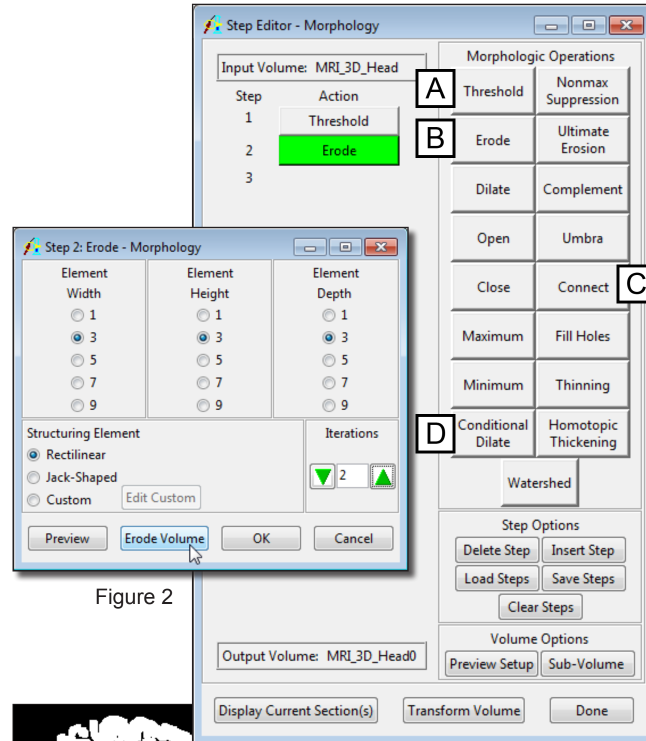


Figure 2

Figure 1

Figure 3

note Notice the left side of the Step Editor window; as operations are selected from below the Morph Operations, the sequence of steps is maintained on the left.

Exercise 31 : Watershed Automated Segmentation

The goal of this exercise is to demonstrate how to automatically strip the skull from in a T1- or T2-weighted MRI scan.

1. Load the **MRI_3D_Head.avw** data set from the **$:\BIR\images\TutorialData** directory.
2. Open the **Watershed** module (**Segment > Watershed**).
3. The Watershed module default parameters usually allow for a successful segmentation of the brain. Check the **Always Display** option and view the red pixels that define the 'Pre-Fill' level on different slices and orientations. Do not change the Pre-Fill Value (49).
4. Click **Watershed Segment Volume** to initialize the automatic segmentation.
5. After the automatic segmentation process has completed, the **Results** tab is automatically selected (figure 1). Each segmented object will appear as a different random color in the image display.
6. With the **Render Selected Object** option selected, click on the object that represents the brain in the image display.
7. The Render Tool will automatically be returned (figure 2), allowing you to review the segmented objects from difference orthogonal orientations. You can also click and drag the rendering to a new view in the Render Tool image display.
8. Select the **Create Masked Volume from Selected Object** option from the Results tab. Then, click again on the object that represents the brain. The Compare window that appears allows you to review the original and segmented volume side-by-side, slice-by-slice in different orthogonal views.
9. The **File** menu provides options to save the segmented object, the masked volume, and an object map of the segmented object.
10. Choose **File > Save Masked Volume**. In the window returned, set Destination to Analyze Workspace and then click **Save Volume**. The object clicked on in step 8 after selecting 'Create Masked Volume from Selected Object' will be saved to the Analyze workspace. Click **Done** to dismiss the Save Masked Volume window.
11. Close all windows before proceeding to the next exercise.

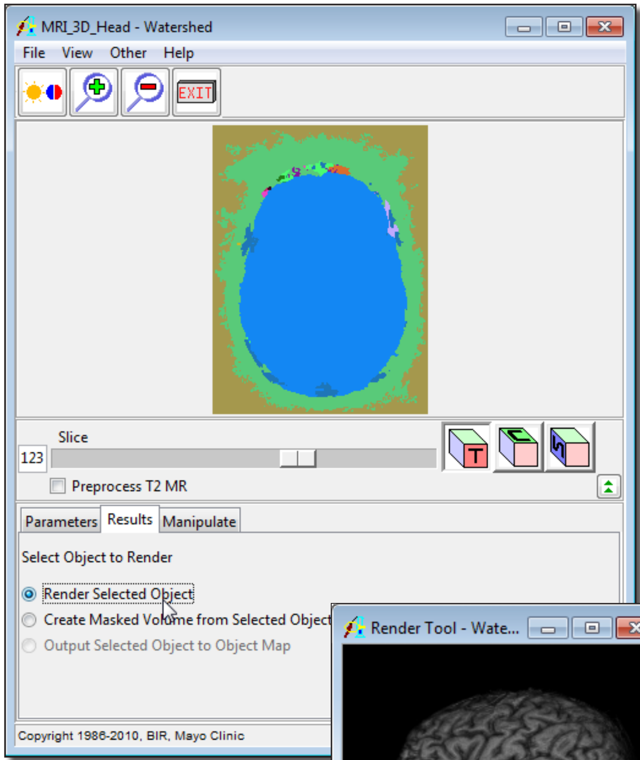


Figure 1

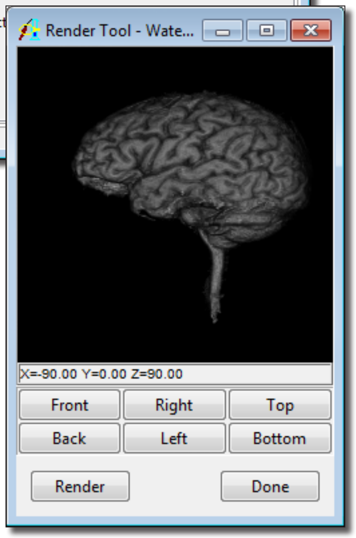


Figure 2

Exercise 32 : Multispectral Classification

The goal of this exercise is to demonstrate the use of the Scattergram tool in the Multispectral Classification module to illustrate the various supervised classifiers in the multispectral measurement space.

1. Load the **MRI_multi.avw** data set from the **$:\BIR\images\TutorialData\MultiSpectralTutorial** directory. This file contains a spatially co-registered MRI T1 and T2 volume of the same patient.

   > *note* | If you use the Load As module to load the data set into Analyze, select 'Single Multivolume' when prompted.

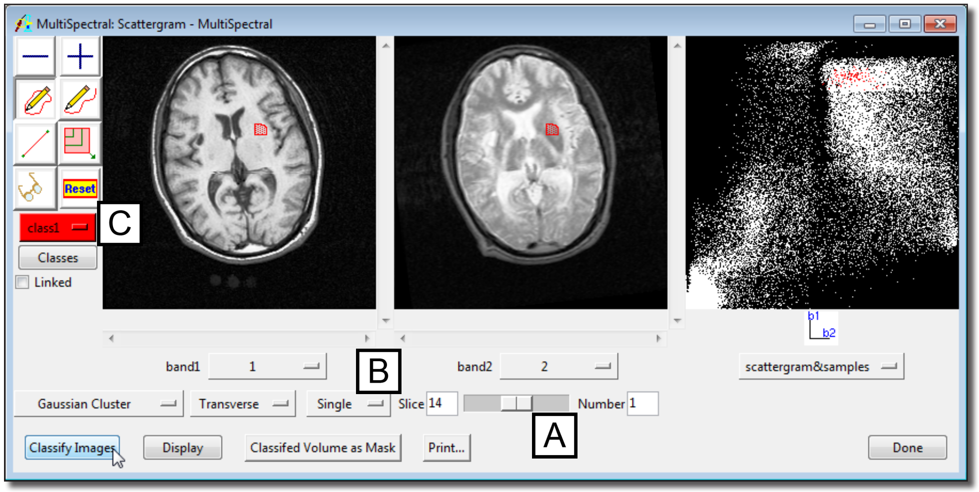
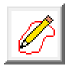


Figure 1

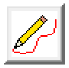
2. Open the **Multispectral Classification** module (**Segment > Multispectral Classification**).

3. Open the **Scattergram** window (**Samples > Scattergrams**).

4. In the Scattergram window (figure 1), move the **Slice** slider bar [**A**] to **slice 14**. The T1 and T2 sections are displayed side-by-side along with the scattergram of the pixels. To increase the image display size, change Single to **Double** in the drop-down menu [**B**] next to the 'Slice' slider bar.



5. Select the **Closed Trace** tool and define a small region of white matter (central brain tissue) as **class 1** by drawing on the image display. The paired values found in this region are colored red in the scattergram display and on the image displayed in the main Multispectral Classification window (figure 2).



6. Select the **Curved Line** tool and define a small region of grey matter (peripheral brain tissue) as **class 2**. Make sure to choose 'class 2' from the **Classes** drop-down menu [**C**] before starting the trace. The paired values will show as green in the scattergram and in the image display.

   > *tip* | To move a defined region hold <Shift> then click and drag the region to the desired location.

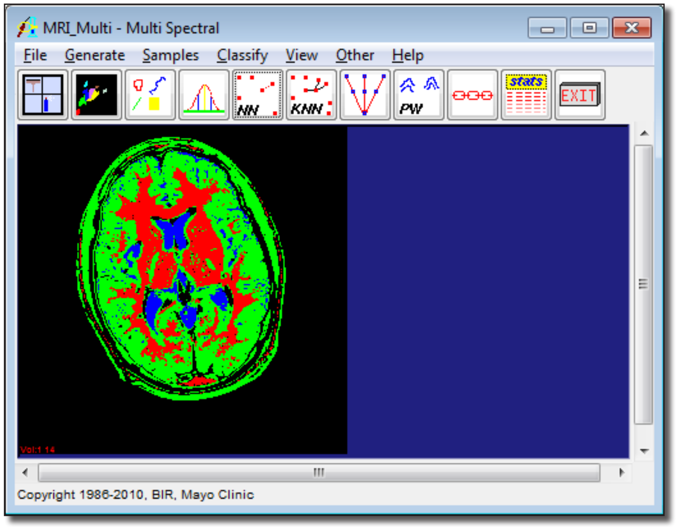


Figure 2

7. Select the **Closed Trace** tool and define a small region of cerebrospinal fluid (in the central ventricles) as **class 3**.
8. Click **Classify Images**. The Gaussian Scattergram Classifier window will automatically be returned (figure 3), click **Classify**. Click **Done** to dismiss the window.
9. Choose **Scattergram & Classified** from the drop-down menu below the far right pane of the Scattergram window to view the Gaussian class boundaries derived from the samples (figure 4).
10. By selecting classifiers other than 'Gaussian Cluster' in the Scattergram window before clicking Classify Images, other supervised classifiers can be demonstrated on the same samples.
11. Close the Multispectral Classification module before proceeding to the next exercise.

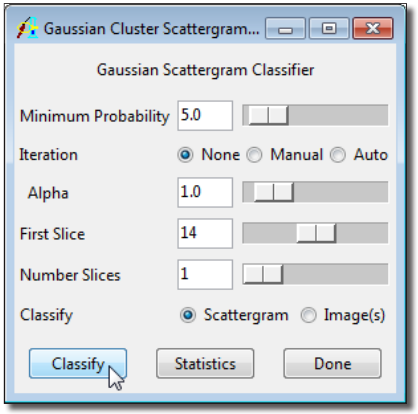


Figure 3

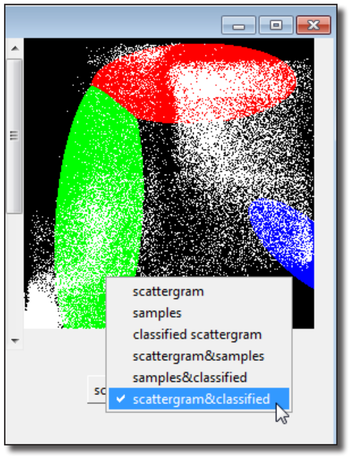
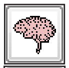


Figure 4

Exercise 33 : Object Extractor Automated Brain Segmentation

The Object Extractor module applies thresholding, morphology erosion and dilation, and region growing steps in an attempt to automatically segment an object within a volume. This exercise will demonstrate how to use this module.



1. Load the **MRI_3D_Head.avw** data set from the **$:\BIR\images\TutorialData** directory.
2. Open the **Object Extractor** module (**Segment > Object Extractor**).
3. Open the **Define Region** window (**Generate > Define Region**) to begin the segmentation process.
4. To define an auto trace on any slice of the volume, first specify a starting slice using the ‘Slice’ slider bar. **Slice 141** is an excellent starting point for this data set. Note that the orientation can be changed using the **Extract Options** directly below the slider bar.
5. In order to define a threshold range for the auto trace, a seed point must be set. Position the cursor near the center of the brain and click to set a seed point.
6. The Define Region window will automatically update (figure 1) to display auto trace parameters. Use the double-ended slider bar [A] now available to set the **Threshold Minimum** to **49** and the **Maximum** to **140**.
7. Click **Extract Object** to start the object extraction process. The grayscale copy of the extracted object will automatically be saved to the Analyze workspace.

note | Click the Clear Regs button [B] at any time to remove all traces and limit ranges. A new starting slice may also be defined if required by clicking the Target Slice button [C].

8. Once the process is complete, a rendering of the extracted object will be displayed in the main Object Extractor window. The **Render Tool** will also automatically be returned, allowing you to view the object from different orientations (figure 2).
9. The resulting extraction can be further examined in the Compare window (**Generate > Compare**). The Compare window will allow the user to compare the original and segmented volume slice-by-slice.
10. If the extraction is not satisfactory, the data may be re-segmented by clearing the regions in the Define Region window (**Generate > Define Region**) and selecting a new seed point and threshold range.
11. Close the Object Extractor module before proceeding to the Additional Tasks.

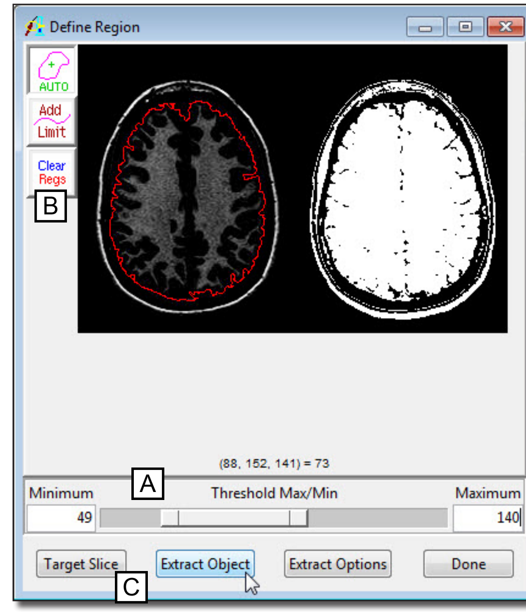


Figure 1

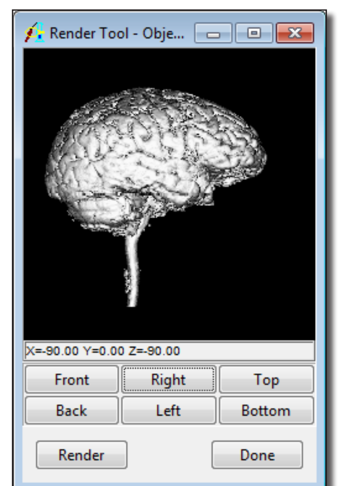
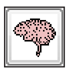


Figure 2

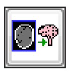
Additional Task

33.1 Extract Options - Creating an Object Map

As introduced in earlier exercises, an object map is a special image file used by Analyze to partition and identify structures as belonging to a particular segmented object. Voxels in the image volume correspond directly, on a one-to-one basis, with a voxel in the object map, whose value assigns the voxel to a particular segmented object. Since object map files can also be loaded into other Analyze modules, the same objects within an image volume can be referenced for a variety of purposes (see Exercise 47: Region of Interest Measuring Objects in Object Maps). This will demonstrate how to create an object map in Object Extractor.



1. Select the **MRI_3D_Head.avw** data set loaded in the Analyze workspace and open the **Object Extractor** module (**Segment > Object Extractor**).



2. Open the **Define Region** window (**Generate > Define Region**) and set the **Target Slice** to **141**.
3. Click inside the brain to set a seed point. Set the **Threshold Minimum** to **49** and the **Maximum** to **140**.
4. Click **Extract Options** and set the **Result** to **Object** (figure 1). A dialog box will be returned asking if you would like to create an object map, click **Yes** (figure 2). Click **Done** to dismiss the Extract Options window.
5. In the **Define Region** window, click **Extract Object** to start the object extraction process.
6. Once the extraction process is complete the object will be displayed overlaid on the original image data in the main **Object Extractor** window (figure 3). The Render Tool will also automatically be returned, allowing you to view the object from different orientations.
7. The object map will not be automatically saved, if you wish to save the object map choose **File > Save Object Map**.
8. Close the Object Extractor module. To learn how to create a binary object with the Object Extractor proceed to the next Additional Task.

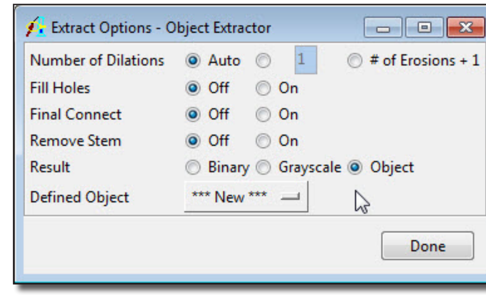


Figure 1

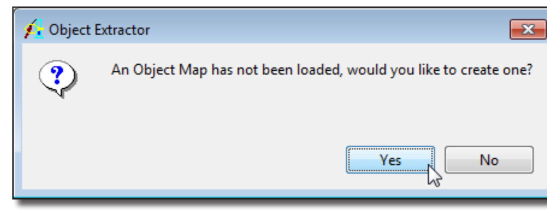


Figure 2

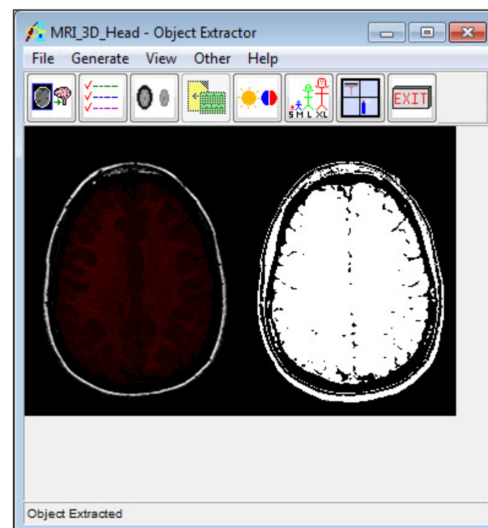
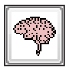


Figure 3

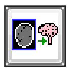
Additional Task

33.2 Extract Options - Creating a Binary Object

Occasionally it is necessary to save the segmented object as a binary object, as opposed to a grayscale object like in the first part of this exercise. This additional task will demonstrate how to achieve this.



1. Select the **MRI_3D_Head.avw** data set in the Analyze workspace and then open the Object Extractor module (**Segment > Object Extractor**).



2. Open the **Define Region** window (**Generate > Define Region**) and set the **Target Slice** to **141**.
3. Click inside the brain to set a seed point. Set the **Threshold Minimum** to **49** and the **Maximum** to **140**.
4. Click **Extract Options** and set the **Result** to **Binary** (figure 1). Click **Done** to dismiss the Extract Options window.
5. In the Define Region window, click **Extract Object** to start the object extraction process.
6. Once the process is complete, a rendering of the extracted object will be displayed in the main Object Extractor window. The Render Tool will automatically be returned again, allowing you to view the object from different orientations. The segmented binary brain will be automatically saved to the Analyze workspace and can now be used with any other Analyze module.
7. Close the Object Extractor module before proceeding to the next Additional Task.

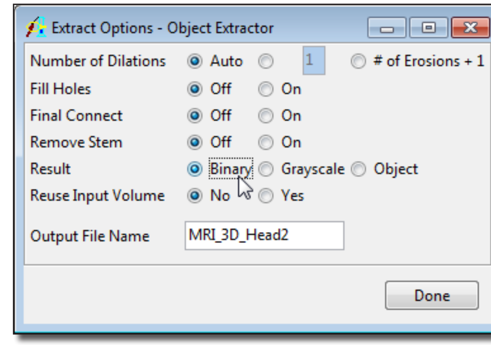


Figure 1

Additional Task

33.3 Extract Options - Automatic Brain Stem Removal

The Object Extractor module now provides the option to automatically remove the brain stem from your segmented brain. This task will demonstrate how to segment and remove the brain stem.

1. Select the **MRI_3D_Head.avw** data set in the Analyze workspace and then open the **Object Extractor** module (**Segment > Object Extractor**).

2. Open the **Define Region** window (**Generate > Define Region**) and set the **Target Slice** to **141**.

3. Click inside the brain to set a seed point. Set the **Threshold Minimum** to **49** and the **Maximum** to **140**.

4. Click **Extract Options** and set the **Remove Stem** option to **On** (figure 1). Click **Done** to dismiss the Extract Options window.

5. In the Define Region window, click **Extract Object** to start the object extraction process.

6. Once the process is complete, a rendering of the extracted brain with the brain stem removed will be displayed in the main Object Extractor window. The **Render Tool** will also automatically be returned (figure 2), allowing you to view the object from different orientations. The segmented grayscale brain will be automatically saved to the Analyze workspace and can now be used with any other Analyze module.

7. Close the Object Extractor module before proceeding to the next exercise.

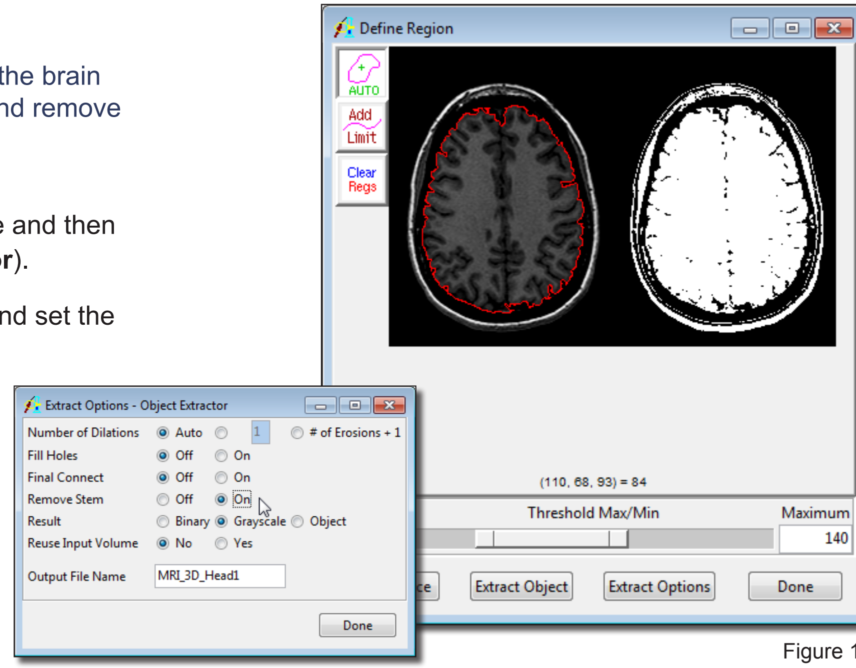


Figure 1

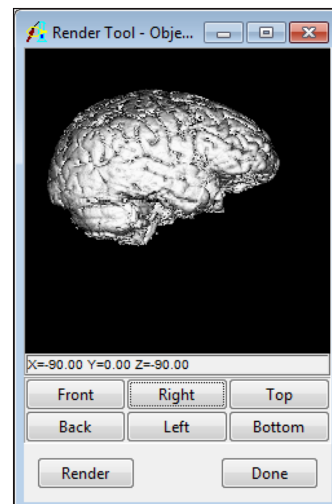


Figure 2

Exercise 34 : Object Extractor Extracting Multiple Objects

The Object Extractor module supports the creation of multi-object object maps. This exercise will demonstrate how to achieve this.

1. Load the **CT_Lungs.avw** data set from the **$:\BIR\images\TutorialData** directory.
2. Open the **Object Extractor** module (**Segment > Object Extractor**).
3. Open the **Define Region** window (**Generate > Define Region**) to begin the segmentation process.
4. To define an auto trace on any slice of the volume, first specify a starting slice using the 'Slice' slider bar. **Slice 104** is the default slice, and it is an good starting point for this data set.
5. Position the cursor near the center of the left lung and click to set a seed point.
6. The Define Region window will automatically update (figure 1) to display auto trace parameters. Use the double-ended slider bar [**A**] now available to set the **Threshold Minimum** to **18** and the **Maximum** to **99**.
7. Click the **Extract Options** button, and set the **Result** to **Object** (figure 2), select **Yes** in the window returned.
8. In the Define Regions window, click **Extract Object** to start the object extraction process. The left lung will be extracted and saved as the object called '**Extracted**'. The object will appear red.
9. Open the Define Regions window again, when opened click the **Clear Regions** button [**B**]. Next, click in the right lung to set a seed point, set the **Threshold Minimum** to **18** and the **Maximum** to **104**.
10. Click **Extract Object** again. The right lung will be extracted and saved as the object called **Extracted (2)**, the object will appear green. In the main Object Extractor module you will see both lungs (figure 3).

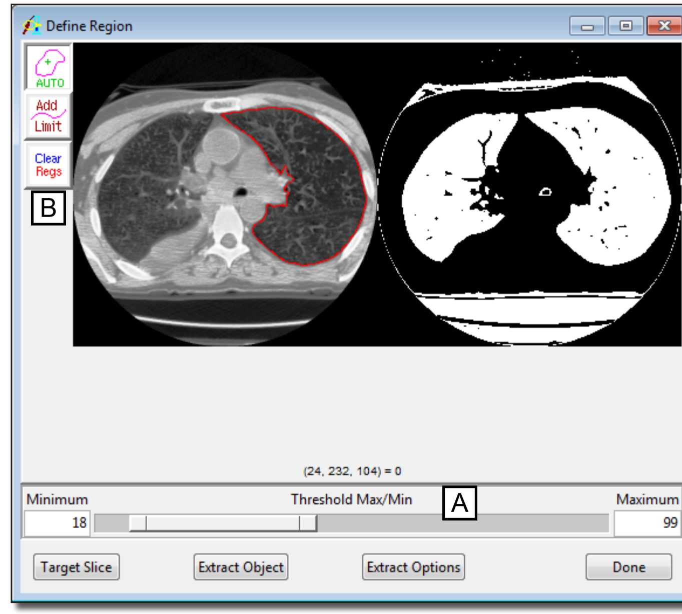


Figure 1

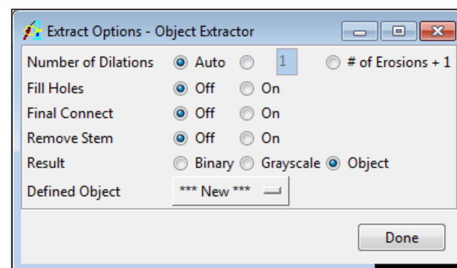


Figure 2

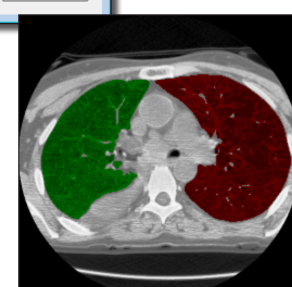


Figure 3

11. The render window will now display both lungs in 3D (figure 4).
12. To change the name and color of each object, go to the **Objects** window (**View > Objects**). Set **Control By** to **Attribute**, and from the drop down menu select the **Name** and **Color** attribute options (figure 5).
13. To save the object map for use in other modules, select **File > Save Object Map**.
14. Close all windows related to the Object Extractor module before proceeding to the next exercise.

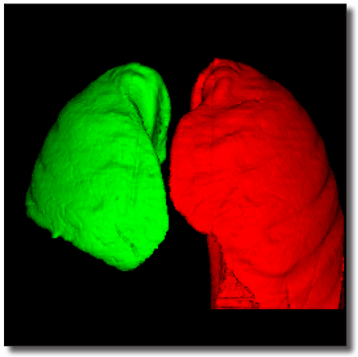


Figure 4

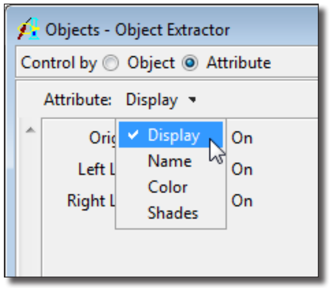
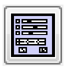


Figure 5

Exercise 35 : Surface Extractor Polygonal Surface Extraction

Polygonal surface extraction is the process of converting an object in the voxel-based volume to a representation of the surface of the object, expressed as sets of vertices and polygons. This conversion must optimally extract a representative surface, with as much detail as possible, but do so with as few vertices and polygons as possible. This exercise will use the Adapt/Deform algorithm to perform such an optimal surface extraction. Often this surface extraction is a precursor to using the surface with other applications, such as CAD/CAM modeling, rapid prototyping (model building), and finite element analysis.

1. Load the **MRI_3D_Head.avw** data set from the **$:\BIR\images\TutorialData** directory.
2. Open the **Surface Extractor** module (**Segment > Surface Extractor**).
3. Choose **File > Load Object Map** and load the **MRI_3D_Head.obj** object map.



4. Open the **Extraction Parameters** window (**Generate > Extraction**).
5. Click **Objects** [**A**] at the top of the Extraction Parameters window (figure 1). In the window returned, leave the **Brain** set to **On** and set all other objects to Off. Click **Done** to dismiss the window.
6. Create a polygonal surface of the 'Brain' object using the Adapt/Deform algorithm with the default parameters. With the **AdaptDeform** tab selected click **Extract** [**B**].
7. A dialog box will be returned stating the number of polygons generated. Note the number of polygons (approximately 37,258), then click **Done**.
8. To create a rendering of the surface model, choose **Generate > Render**. A surface map will automatically be created for the 'Brain' surface, and the **Surfaces** window returned. The rendering will be displayed in the main Surface Extractor window (figure 2).
9. In the Extraction Parameters window change the **Cube Edge Size** [**C**] to **5** and rebuild the surface by clicking **Extract**. Note, the number of polygons generated (approximately 12,261), then click **Done**.
10. Choose **Generate > Render** to view the extracted surface with the new parameters (figure 3). Increasing the 'Cube Edge Size' will smooth the surface, reducing the number of voxels considered when generating the initial surface estimate, which reduces the polygon count.

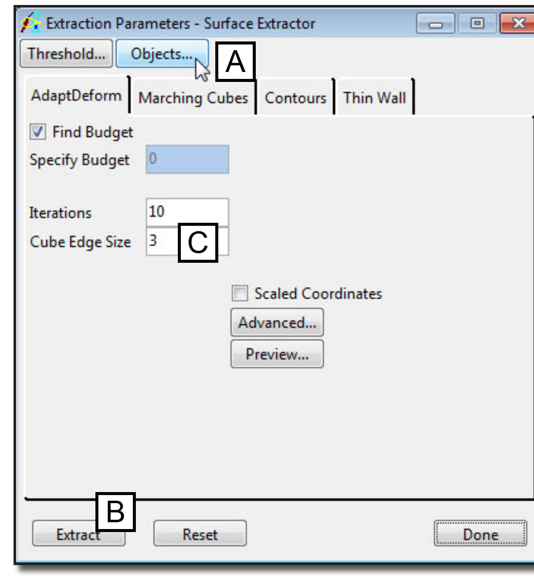


Figure 1

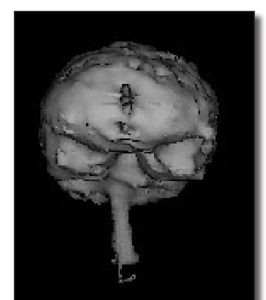


Figure 2

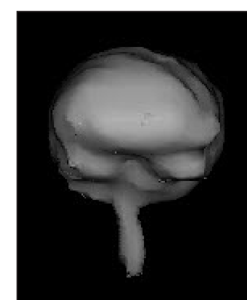
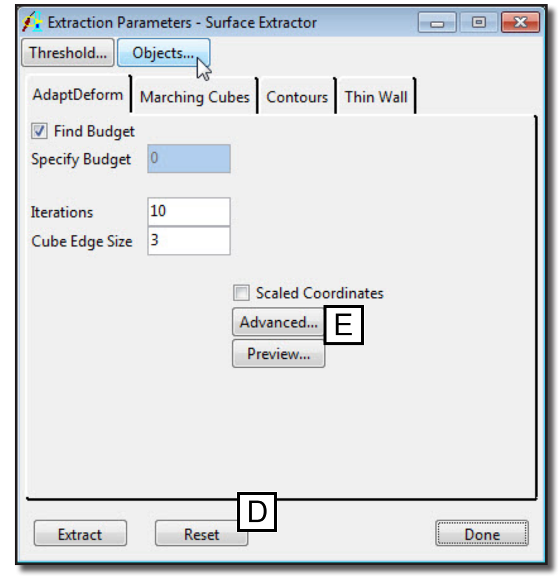


Figure 3



11. Click **Reset** [**D**] in the Extraction Parameters window to restore the default parameters (‘Cube Edge Size’ of 3).

12. Click **Advanced** [**E**] and change the **Time Step** to **0.5**. Click **Done** to dismiss the window.

13. Rebuild the surface by clicking **Extract** in the **Extraction Parameters** window. Note the number of polygons generated (approximately 37,258), then click **Done**.

14. Choose **Generate > Render** to view the extracted surface with the new parameters. Increasing the ‘Time Step’ causes the surface extraction to reach equilibrium faster, producing a smoother surface without altering the polygon count. When the opposite changes are made, the surface will conform to the voxel surface better, resulting in a rougher, more “voxelated” surface.

> *note* | Increasing the resolution increases the processing time, this is demonstrated by setting the ‘Cube Edge Size’ to ‘1’. In cases where a high resolution (Cube Edge Size of 1) is required, use the Marching Cubes algorithm.

15. **Decreasing** the **Surface Force** and increasing the **Spring Constant** (also ‘Advanced’ options) smooths the surface without altering the polygonal count by forcing the polygons to bridge small variations in the voxel surface (the polygon’s attraction to the surface is reduced and they become harder to bend).

16. Press the **Save Surface** PowerBar button or choose **File > Save Surface > To File** to save the extracted surface to disk.

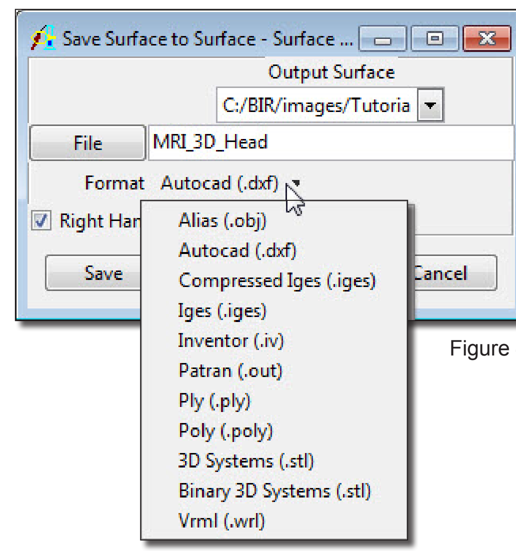


Figure 4

17. In the Save Surface window returned (figure 4) you can select from the following surface description formats in the **Format** drop-down menu: Alias (.obj), Autocad (.dxf), Compressed Iges (.iges), Iges (.iges), Inventor (.iv), Patran (.out), Poly (.poly), 3D Systems (.stl), Binary 3D Systems (.stl), Vrml (.wrl).

18. Close the Surface Extractor module. To learn about extracting the surface of a binary data set, complete the following Additional Task.

Additional Task

35.1 Extracting the Surface of a Binary Data Set

1. Load the **MRI_3D_Brain_Bin.avw** data set from the **$:\BIR\images\TutorialData** directory.
2. Open the **Surface Extractor** module (**Segment > Surface Extractor**).
3. Open the **Extraction Parameters** window (**Generate > Extraction**).
4. With the **AdaptDeform** algorithm tab selected, click **Extract**.
5. Note the number of polygons generated (approximately 37,504) and choose **Generate > Render** to view the extracted surface (figure 1).
6. Close the Surface Extractor module before proceeding to the next exercise.

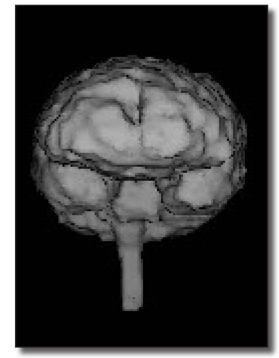


Figure 1

Supported Surface File Formats

Polygonal Formats

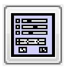
Alias Wavefront	(.obj) Read and Write
Autocad	(.dxf) Read and Write
IGES	(.iges) Write only
Compressed IGES	(.iges) Write only
Inventor	(.iv) Write only
Patran	(.out) Write only
Poly	(.poly) Read and Write
Binary 3D Systems	(.stl) Raad and Write
VRML	(.wrl) Write only

Contour Formats

HP 3D	(.hpgl) Write only
IGES	(.iges) Write only
Compressed IGES	(.iges) Write only
Pogo	(.slc) Read and Write
3D Systems Stereolithography	(.slc) Read and Write
ASCII Columns	(.txt) Read and Write

Exercise 36 : Surface Extractor Contour Surface Extraction

Contour surface extraction is the process of converting an object in the voxel-based volume to a representation of the surface of the object, expressed as a series of stacked contours. This surface extraction is a precursor to other applications, such as CAD/CAM modeling, rapid prototyping (model building), and finite element analysis. This exercise demonstrates how to use the Contours algorithm.



1. Load the **MRI_3D_Head.avw** data set from the **$:\BIR\images\TutorialData** directory.
2. Open the **Surface Extractor** module (**Segment > Surface Extractor**).
3. Choose **File > Load Object Map** and load the **MRI_3D_Head.obj** object map.
4. Open the **Extraction Parameters** window (**Generate > Extraction**).
5. Click **Objects** [**A**] at the top of the Extraction Parameters window (figure 1). In the window returned, switch the **Ventricle** to **On** and set everything else Off. Click **Done** to dismiss the window.
6. Create a contour surface of the 'Ventricle' object using the Contours algorithm with the default parameters. Select the **Contours** tab and click **Extract.**
7. A dialog box will be returned stating the number of slices for which contours were generated. Note the number of slices used (60), then click **Done**.
8. To create a rendering of the extracted contour model, choose **Generate > Render**.
9. In the Extraction Parameters window, click **Advanced** [**B**] in the 'Contours' tab. Check the **Subvolume Extraction** option and click **Done** to dismiss the window (figure 2).
10. Rebuild the contour surface by clicking **Extract** in the Extraction Parameters window. Note the number of slices used (108). This resamples and reformats the object and thus changes the number of slices.
11. Choose **Generate > Render** to create a rendering of the extracted contour model (figure 3).
12. Close the Surface Extractor module before proceeding to the next exercise.

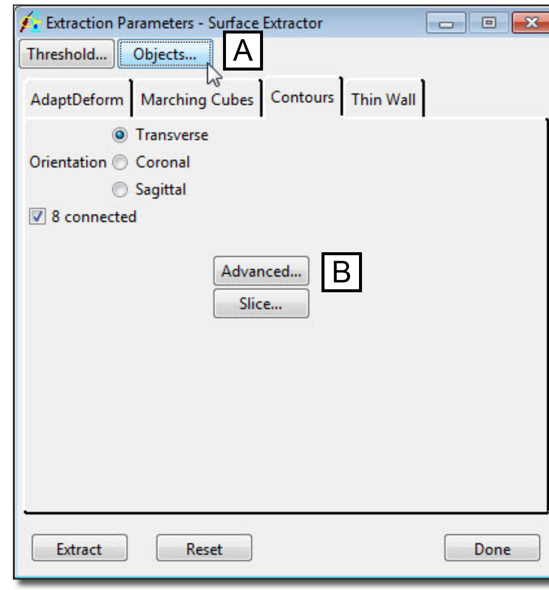


Figure 1

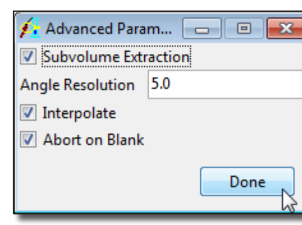


Figure 2

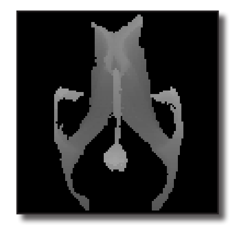


Figure 3