

3DView – Installation and Operation

The following notes are intended as a guide to the installation and operation of the 3DView Volume Rendering Application. As this software is still under development, some of the features and screenshots may differ from those described.

NOTE – BEFORE USING 3DVIEW, PLEASE REFER TO THE LICENSE AND COPYRIGHT NOTICES INSTALLED IN THE APPLICATION FOLDER AND REPRODUCED AT THE END OF THIS DOCUMENT.

Acknowledgements

3DView has been developed as a joint initiative between RMR Systems Limited, represented by Roger Rowland, and Dr. Rudy Lapeer from the School of Computing Sciences at the University of East Anglia.

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Installation

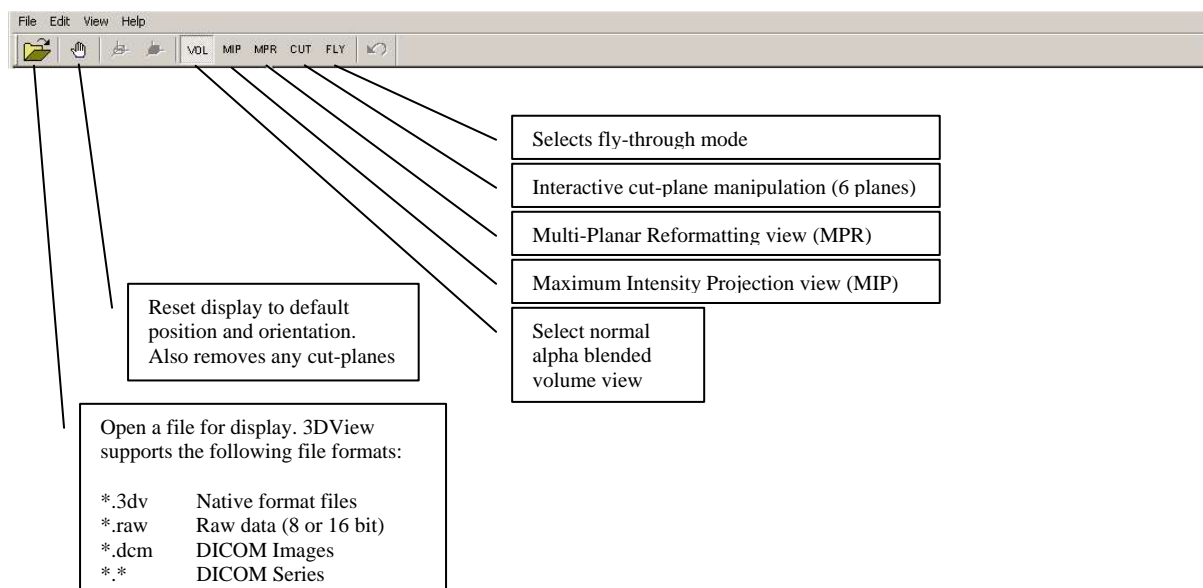
To install the 3DView executable and sample data, run the SETUP.EXE program contained in the CD or downloaded distribution. Follow the instructions on screen. Although this application will run on most modern PC hardware, the following configuration is recommended for best performance:

Windows 2000 or Windows XP
Pentium IV Processor 2.0GHz or faster
512Mb RAM
ATI Radeon 9000 or above, or Nvidia GeForce 4 with 128Mb RAM

Getting Started

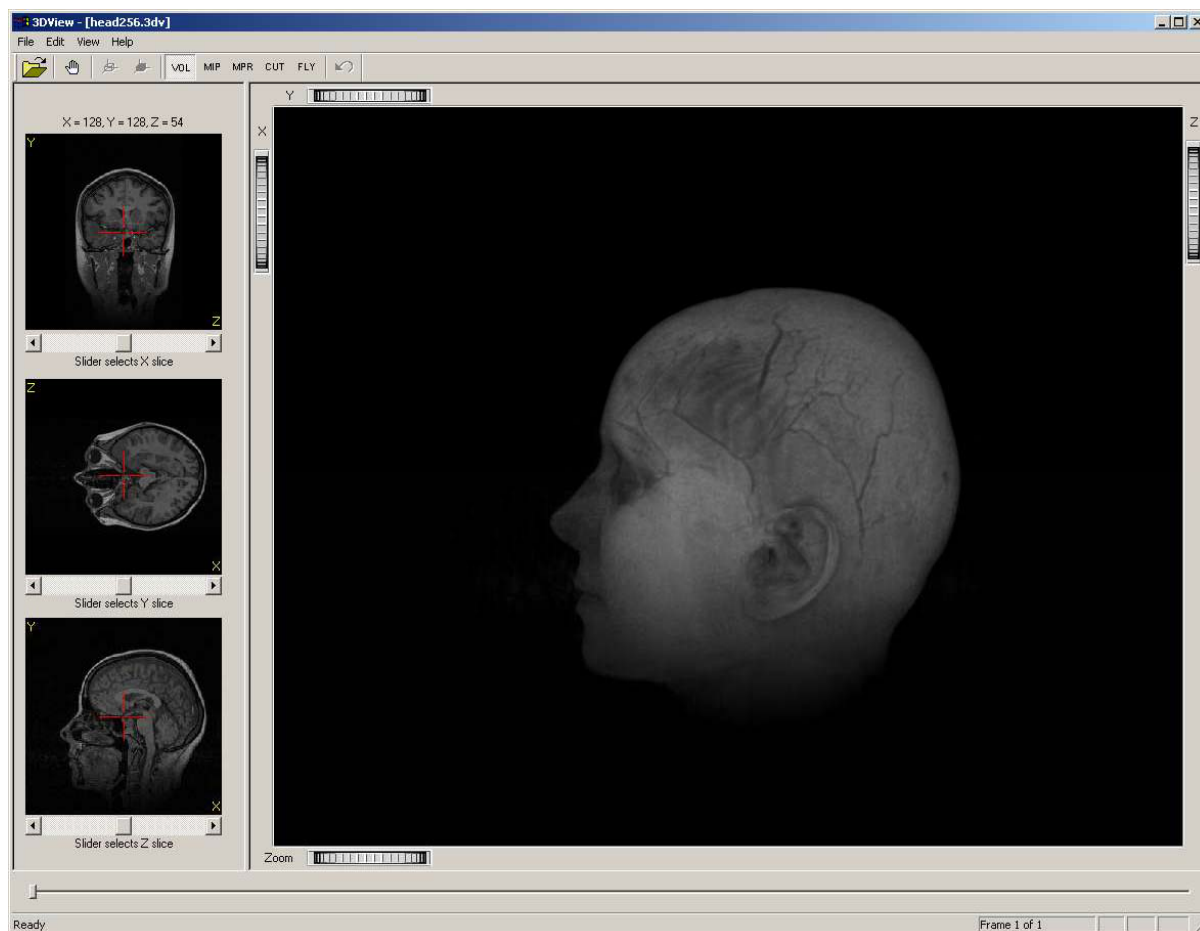
After installation, a shortcut to 3DView will be present on the Start/Programs menu. Use this to launch the application.

Most of the applications features are driven from the menu or toolbar or by using the mouse over the working area of the display. The toolbar allows easy selection of the following options:



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Launch the application and use the toolbar button or menu option (File/Open) to open the sample data file HEAD256.3DV. A screen similar to the following should be shown:



The panel on the left shows three planar views of the volume in preview mode. A red cross shows the point of interest in MPR view or the camera position/orientation in fly-through mode. In all views, the point of interest may be selected by left-clicking and/or dragging with the mouse over any of the three planar images. The individual slider bars may also be used to scroll through the slices. The three views will remain synchronised.

The main window shows the default volume view. The image may be rotated by left-clicking and dragging on the image itself. By dragging and releasing the mouse, it is possible to initiate a spinning of the displayed object. A single click with the left mouse button will stop the spin. The Reset button on the toolbar may also be used.

There are four thumbwheel controls in the border of the main window. Left-click and drag over these controls to rotate the view about the X, Y or Z axis, or to zoom in or out as required. Again, the Reset option on the toolbar will return to the default view as shown above.

Maximum Intensity Projection (MIP)

Clicking this button on the toolbar will switch the display to MIP mode. In this view, the blending function is altered so that the voxels with the maximum intensity through the line of view are mapped to the display. This results in the characteristic semi-transparent view, used primarily with MR images that have a well defined internal structure. For an example of this display, refer to the Stereo View section later in this document.

Click again on the VOL button on the toolbar to return to the default view.

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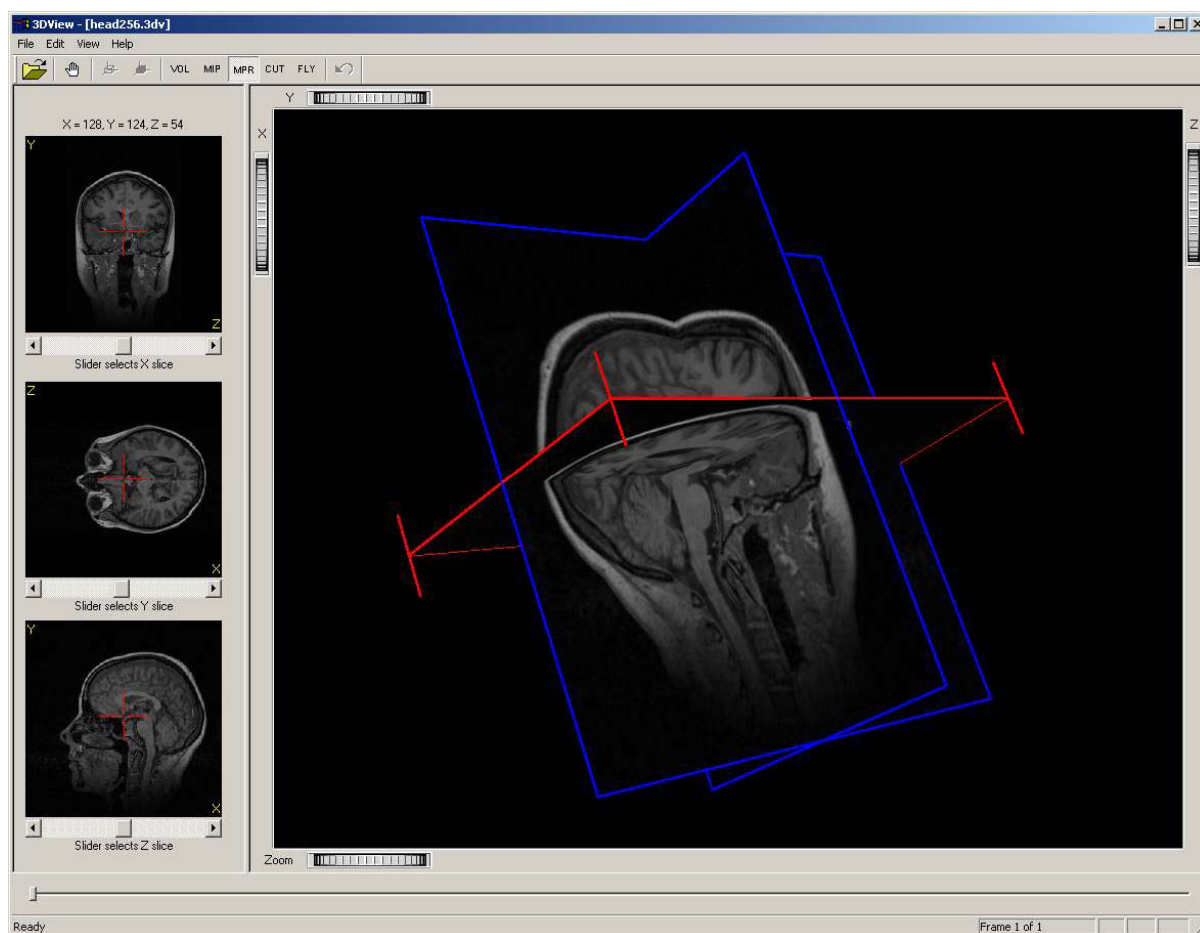
Multi-Planar Reformatting (MPR)

The MPR features available in 3DView are at present fairly basic. To demonstrate how this works, load the sample data as described above, then click on the MPR button in the toolbar.

A display similar to that below will be shown.

The volume data is displayed as an intersection of three planes (in the x, y and z orientations). The relevant slice for each plane is projected onto the front and back of each plane.

The planes may be moved either by clicking and dragging with the left mouse button over any of the three planar preview images in the left hand panel of the display, or by clicking and dragging with the **right** mouse button over the image in the main display:



The above screenshot shows the latter method. Simply right-click on the surface of the plane you wish to move (use left-click/drag to rotate the view first if necessary). With the right mouse button held down, the selected plane will be highlighted in red as shown. Drag in the direction of the corner indicators to adjust the position of the selected plane. The planar preview images will be automatically synchronised with this view.

In MPR view, the rotation and zoom thumbwheels operate as normal.

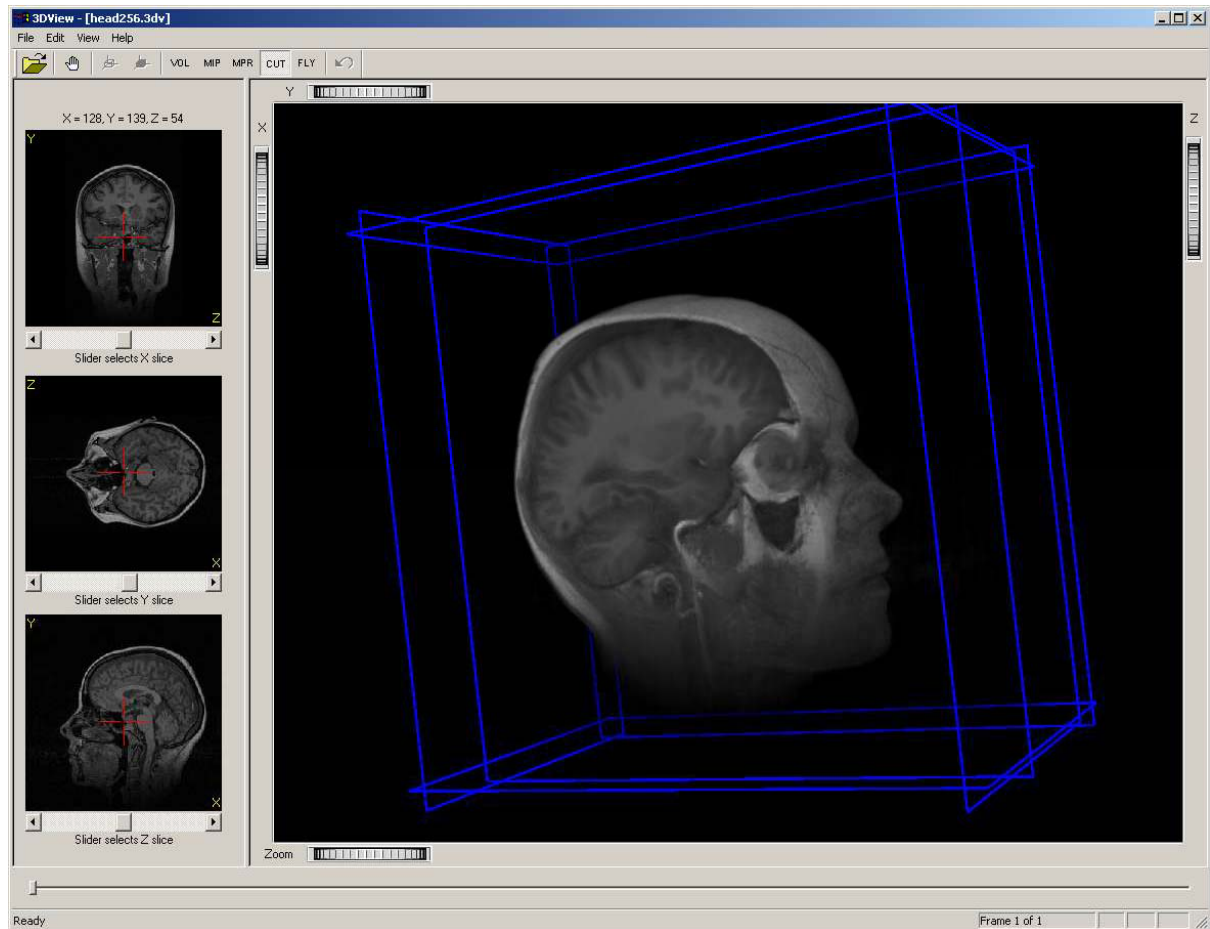
Interactive Cut-Planes

At the moment, six fixed-orientation cut planes are available to allow a sub-volume to be isolated from the loaded data.

With the sample data loaded, click on the CUT button on the toolbar. The current positions of the six cut planes will be shown outlined in blue (see overleaf).

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In a similar way to the MPR view, the cut planes are manipulated by using the right mouse button to click and drag over a particular plane. Again, it may be necessary to rotate the volume in order to gain access to the plane you wish to move.



The above screenshot shows the sample volume with just one of the cut planes active.

To remove the blue borders around the cut planes, click the VOL button on the toolbar to return to the normal view. The cut planes will remain in place until the Reset button is selected.

Fly Through

The fly-through view places the “camera” inside the volume, and allows it to be moved so that you can travel inside the data. The display is still rendered as a volume, rather than as a surface mesh, and so the quality of the image will be dependent on the characteristics of the data and the settings of the transfer function (see later).

Navigation in fly-through mode is achieved in various ways:

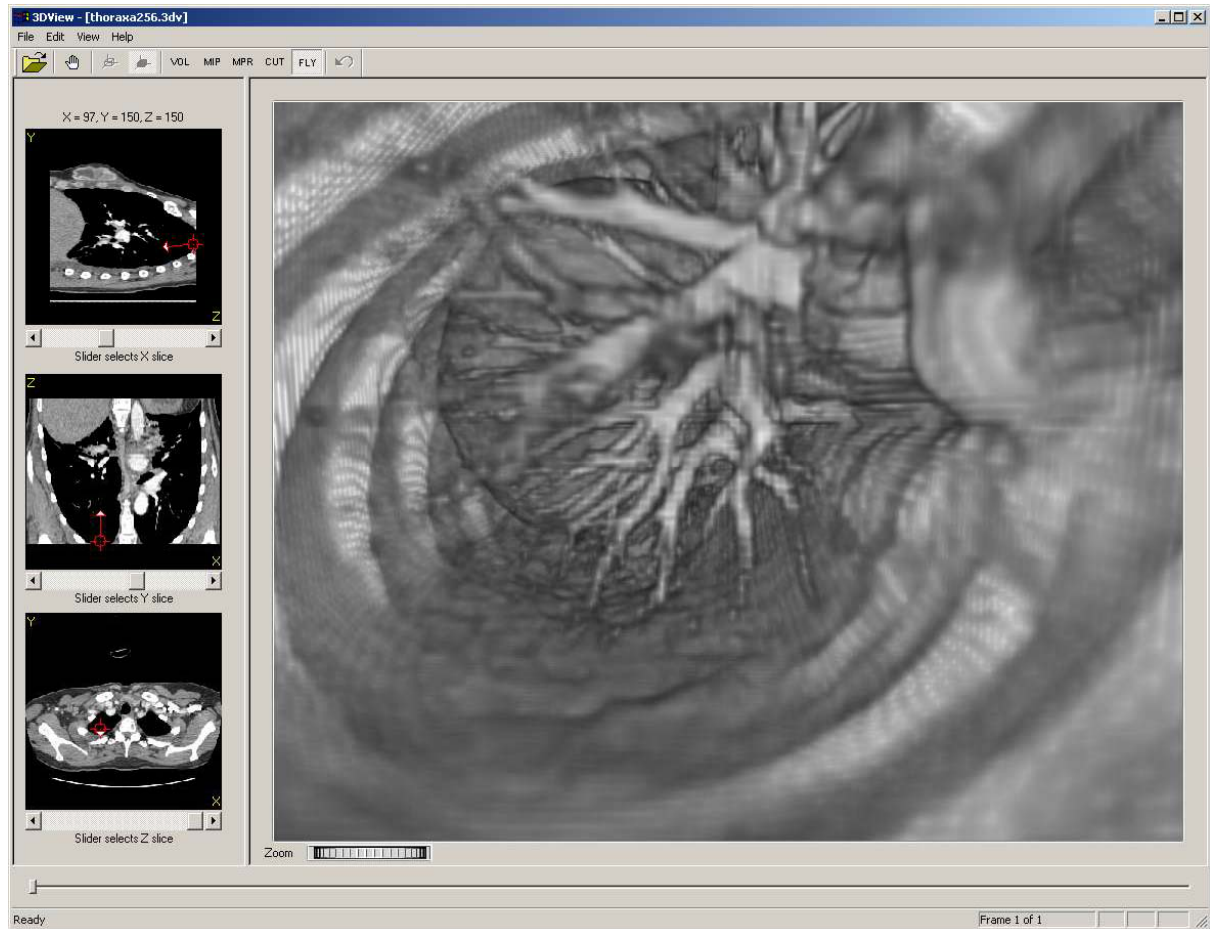
The location of the camera may be set by clicking on any of the three planar views in the left hand panel of the display. An arrow will indicate the current view direction of the camera.

The camera may also be moved by clicking the mouse over the main display. In this view, the normal rotate/spin operation of the mouse is disabled. Clicking and holding the left mouse over the image will move the camera forward. Clicking and holding the right mouse button will move the camera backward.

The camera’s view direction may be changed by using the left/right/up/down cursor keys. Note that with large display sizes and/or lower-spec hardware, there may be a delay between pressing a key and the display being updated. This is an area that we are currently developing further and will be improved in subsequent releases.

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It is advisable to use the Zoom thumbwheel when in fly through mode to produce an acceptable image. By zooming out, a more wide-angle view is obtained, which can aid navigation.



The above screenshot shows a view from inside the lung and chest cavity, using data from a CT scan of the thorax.

Stereo View

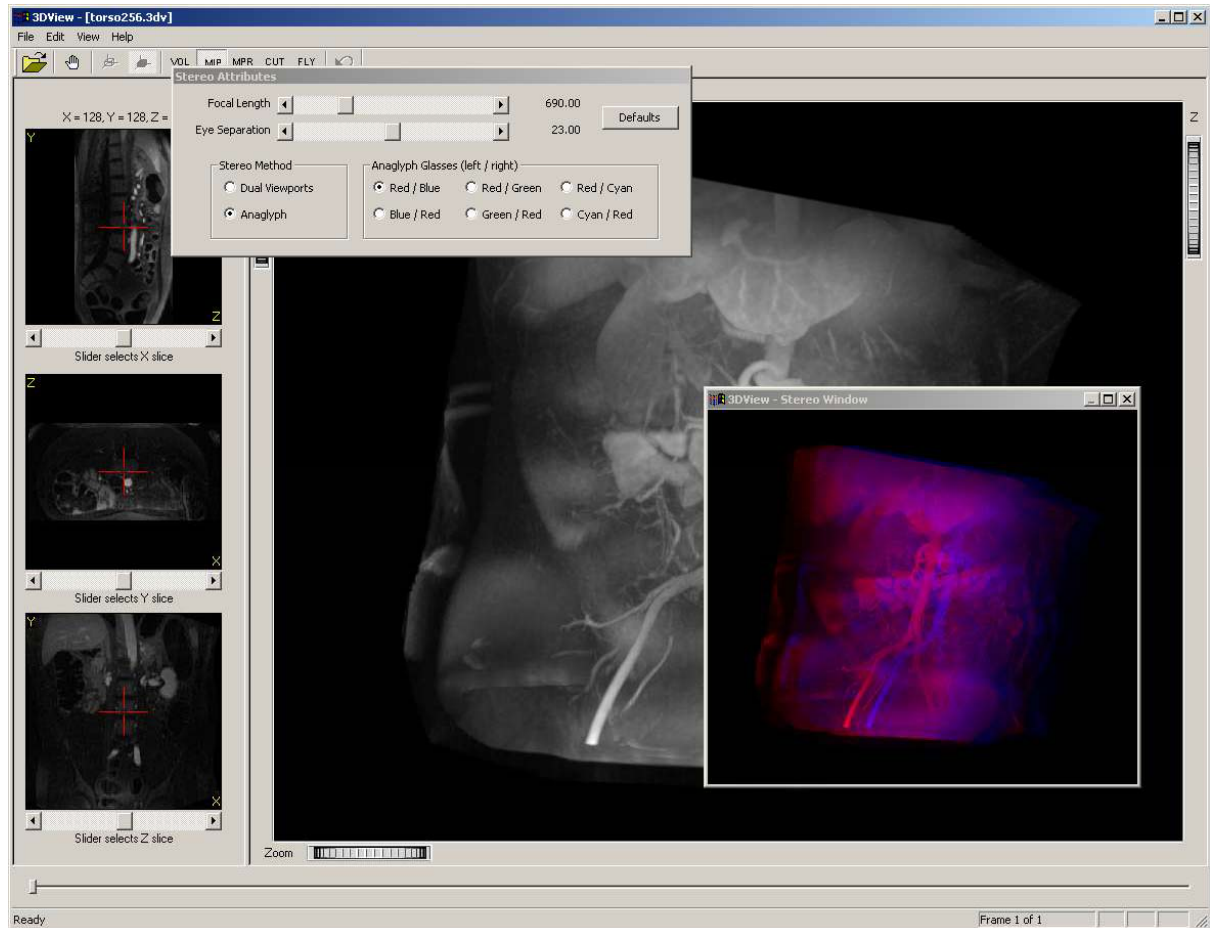
3DView also offers a stereoscopic view. In this view, which is in a separate window, two images of the volume are rendered – each from a slightly different position. The stereo view may be shown in anaglyph mode, in which case it is necessary to wear, for example, red/blue anaglyph glasses, or for commercial stereo displays (we use <http://www.dti3d.com>), the left and right images may be shown in dual viewports.

As with many areas of 3DView, the stereo display is currently under development. At present, it is possible to achieve effective stereo effects by manipulating the focal length and eye separation controls. The screen shot overleaf shows this in action, with a stereo window over a MIP view of an MRI data set.

In this view, we use multiple displays for best effect. The stereo window may be dragged to a secondary display (whether a stereo screen or not) and maximised. The volume may be manipulated as normal (spin, zoom etc.) from the main display.

In anaglyph mode, it is possible to select the colours used to match the 3D glasses available.

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Interactive Transfer Function

On many modern systems, particularly those using the recommended hardware, it is possible to interactively adjust the transfer function that maps voxel intensities to displayed colours.

The transfer function may be amended by selecting (Edit/Transfer function) from the main menu.

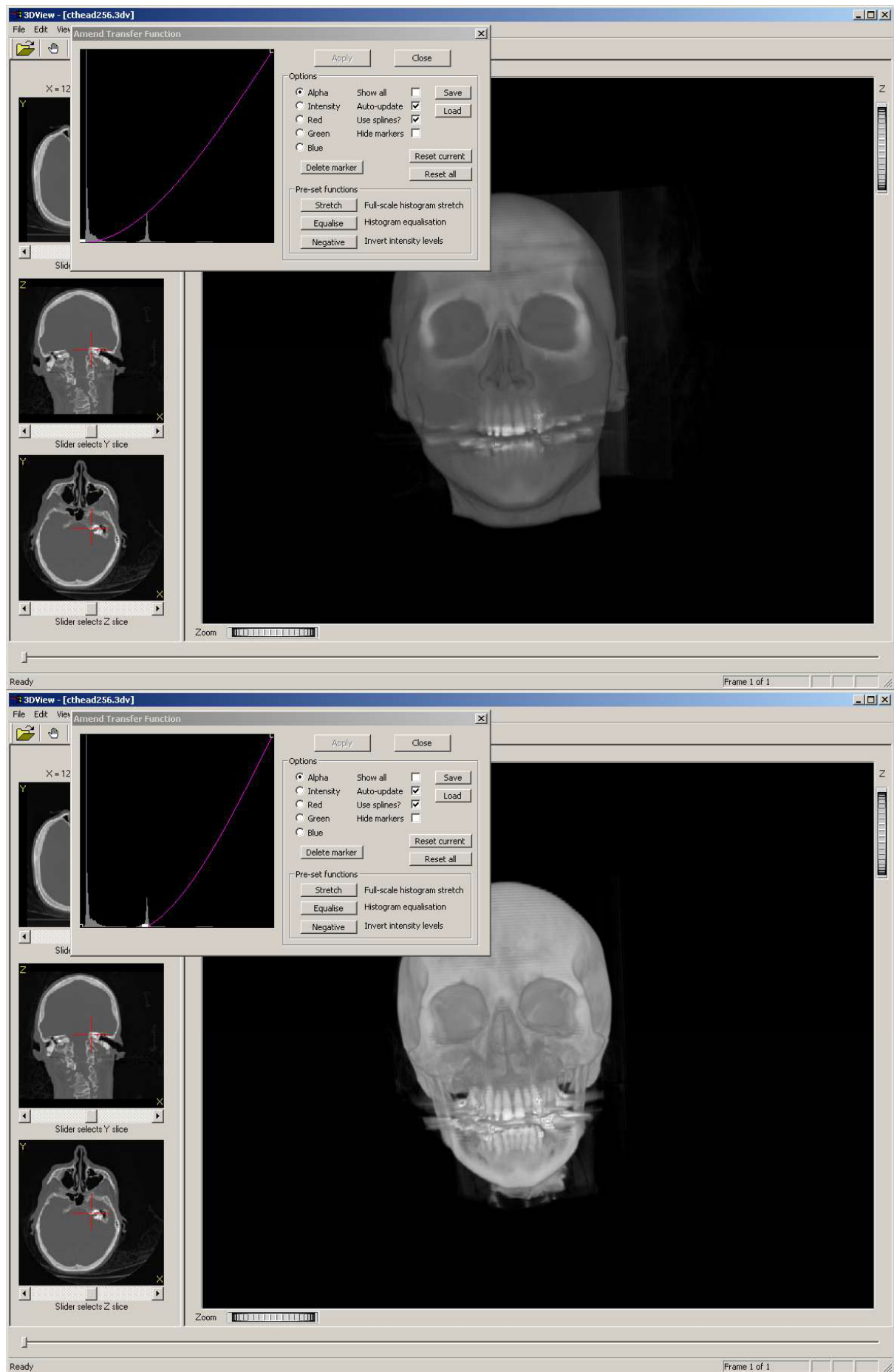
A histogram display of the intensities present in the volume data will be shown, along with the response curve of each of the available colour channels (red, green, blue, alpha). While it is possible to “colourise” the data by individual manipulation of the RGB curves, it is more useful to use the alpha channel to vary the transparency of the voxels, and/or the Intensity option (which varies RG & B together).

The transfer function is by default implemented as a spline curve although a piecewise linear mapping is possible by selecting the relevant check-box.

To add a control point on the graph, simply click with the left mouse at the place where you want the new point. Any existing control points may be selected by left-clicking (the select point will be shown highlighted in white), and then dragging to a new position or deleted by clicking the Delete Marker button on the dialog.

The two screenshots overleaf show how the alpha response (transparency) may be varied to produce different views of the same data. In this case, the data set (not supplied) is a CT scan of a skull.

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Generating a Surface Mesh

3DView uses the Marching Cubes algorithm to produce a 3D mesh representation of an iso-surface from the volume data.

To perform surface generation, select (Edit/Generate iso-surface) from the main menu. A dialog will be displayed, allowing you to review the volume data in order to select a value for the iso-surface.



The X, Y or Z plane may be selected using the option buttons shown above, and the slices displayed using the scroll bar.

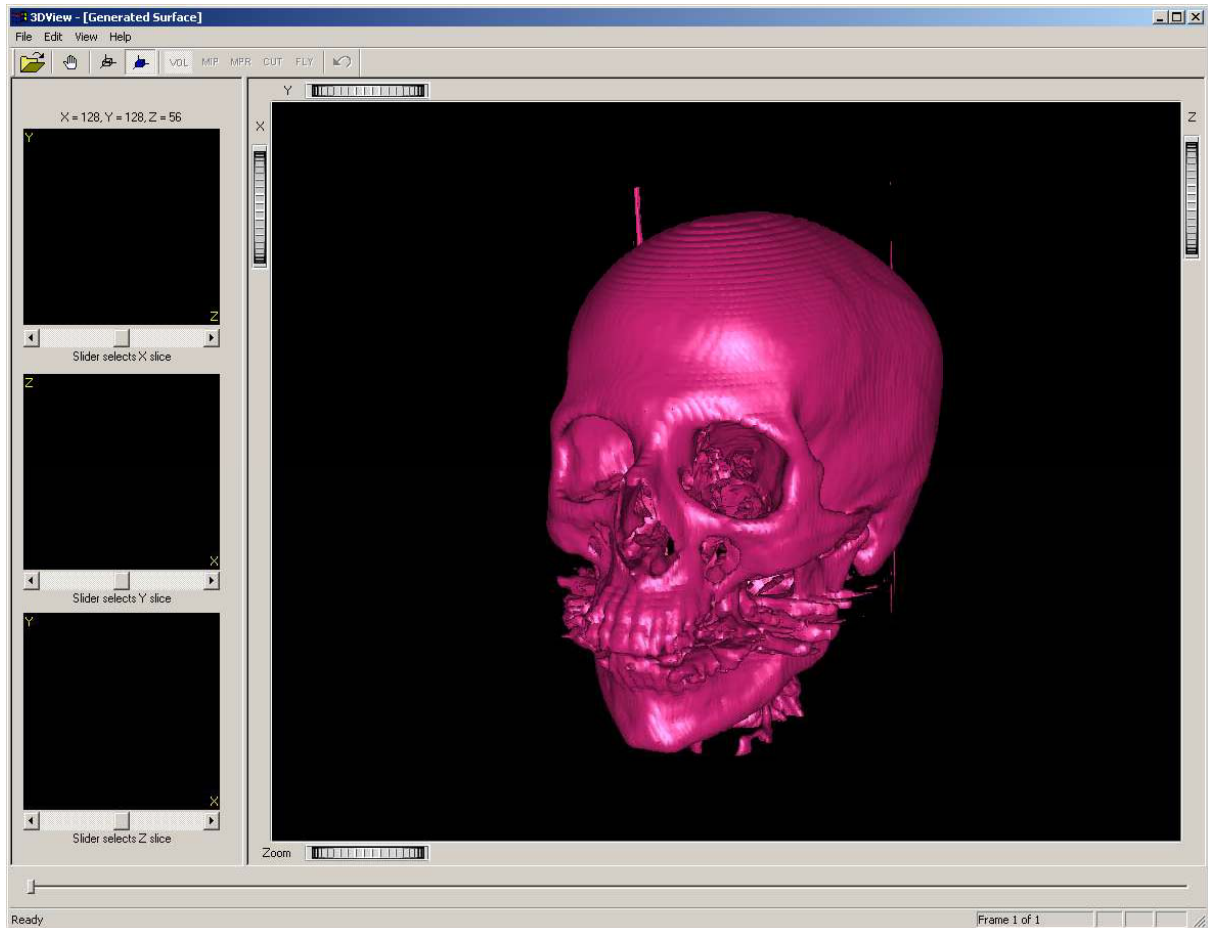
Moving the mouse over the image will display the value of the voxel at that position, and left-clicking with the mouse will enter that value in the text box as shown above.

At present, this option is only available for 8-bit data sets.

Once you have selected a value for the iso-surface, click Process and a mesh of the required surface will be generated. When complete (depending on hardware!), the original volume display will be replaced with a rendering of a 3D mesh (see overleaf).

Note that this can produce a very high number of polygons (>600,000 in the above case), and may not operate correctly on lower spec hardware.

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Note – when a surface mesh is displayed, additional toolbar buttons allow selection of solid or wireframe views.

Segmentation

Segmentation is implemented using a marker-based 3D Watershed algorithm. This allows structures within the data to be isolated from the remainder of the volume. Note – this is only available for 8-bit data sets.

To perform segmentation, select (Edit/Perform segmentation) from the main menu. A dialog will be displayed, allowing you to review the volume data in order to place markers to control the segmentation.

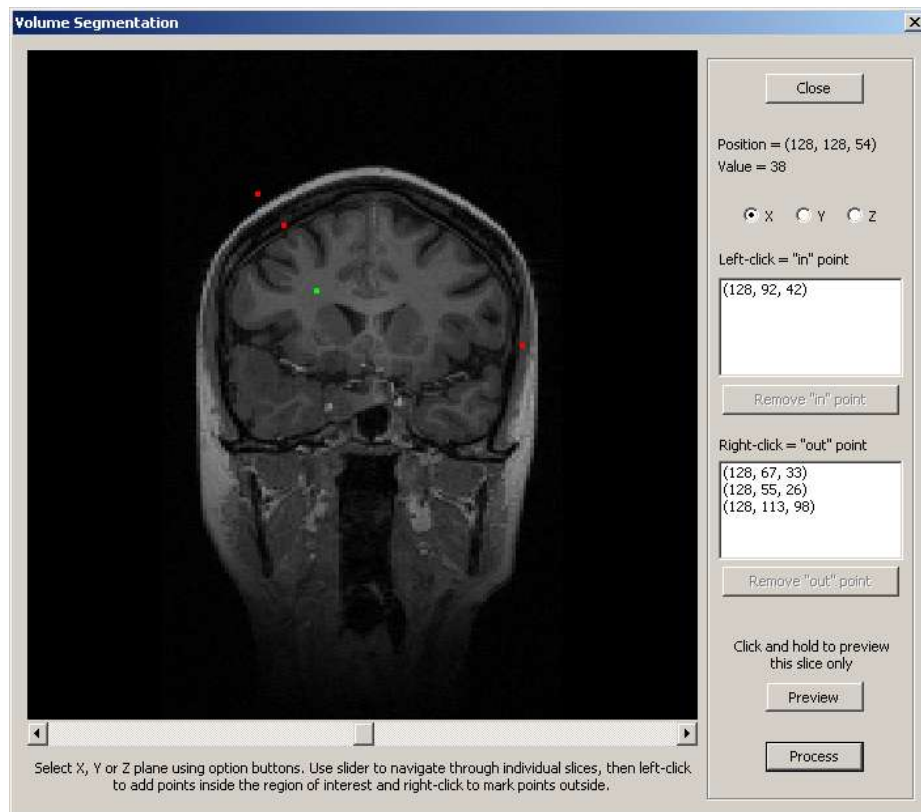
The segmentation dialog is similar to that used for iso-surface generation. It is possible to view the volume as slices through each of the three major axes and to place markers by clicking with the mouse.

Click once with the **left** mouse button on the image to create a marker that is “inside” the region you wish to segment. The marker will be displayed in **green** on the image and will also be entered in the topmost of the two list boxes on the dialog. If you place a marker in error, click on the coordinates of the marker in the list box and remove the marker by clicking the delete button.

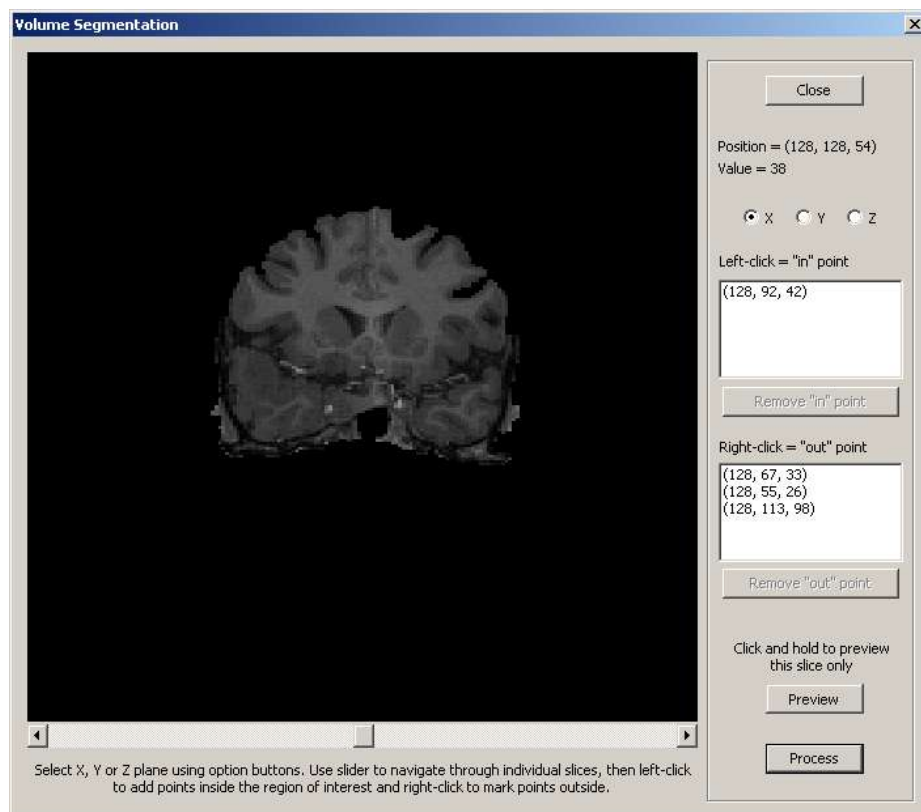
Click once with the **right** mouse button on the image to create a marker that is “outside” the region you wish to segment. The marker will be displayed in **red** on the image and will also be entered in the lower of the two list boxes on the dialog. If you place a marker in error, click on the coordinates of the marker in the list box and remove the marker by clicking the delete button.

If, on any particular slice, you have placed both an “inside” and an “outside” marker, you may preview the effect of the segmentation in two dimensions by clicking and holding the preview button. If the segmentation “leaks” in two dimensions, it will probably leak in three dimensions so this can be a useful check.

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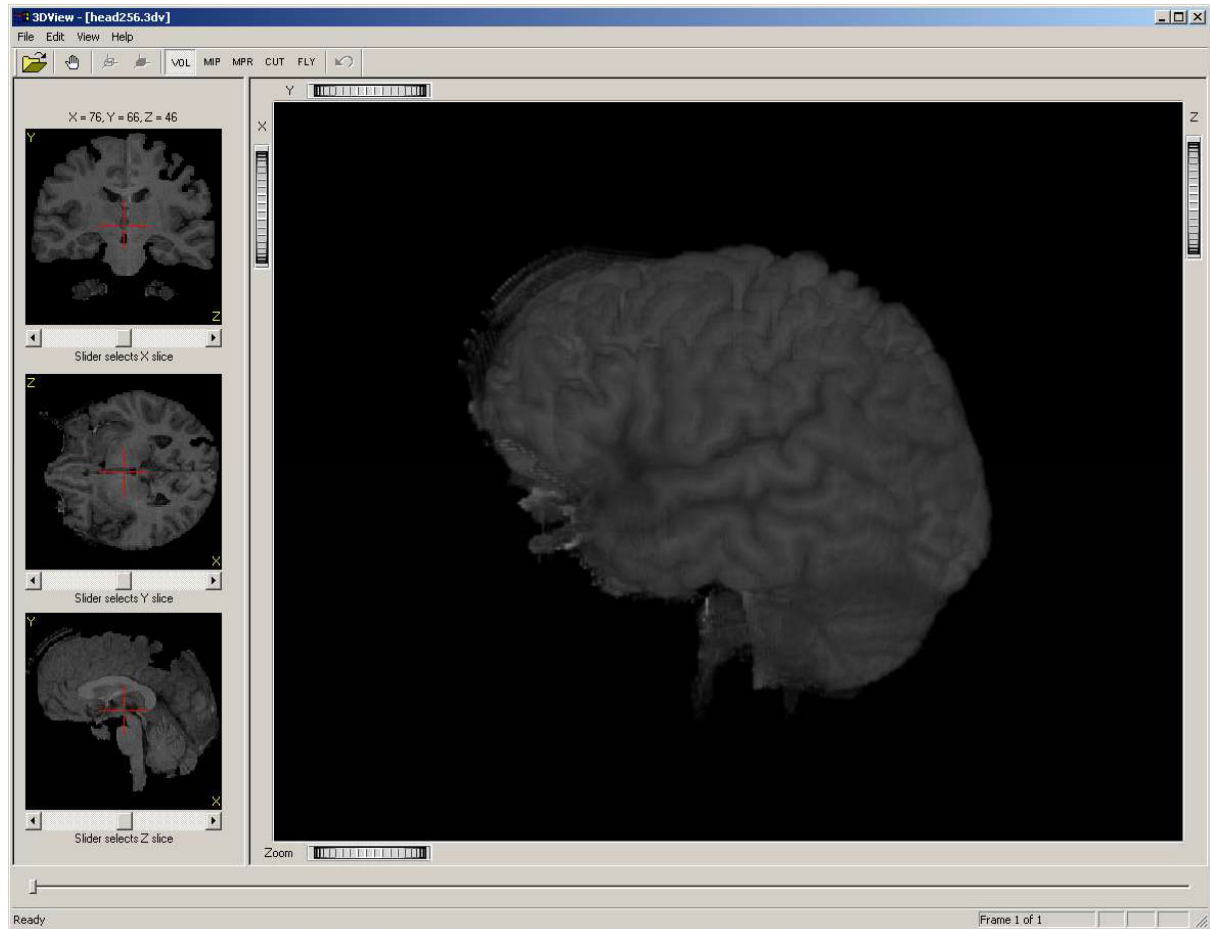


The above screenshot shows the supplied sample data undergoing segmentation. Four markers have been placed on this one slice, one “inside” the region (the brain) and three “outside”. Clicking and holding the Preview button shows the segmentation applied to this slice:



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When you have finished adding markers, click the Process button to perform the segmentation over the whole data set. For the above example, using just four markers, this is the result:



The segmented data has been “trimmed” to remove the “blank” voxels and reduce the size of the volume. This can be done using the option (Edit/Trim redundant voxels) from the main menu. The new volume may be saved to a separate file by selecting (File/Save as..) or (File/Export raw data).

Loading Raw Data

Among the file formats used by 3DView is a “raw” data import. By selecting a file with the extension .raw, the following dialog will be displayed, allowing entry of the relevant details:

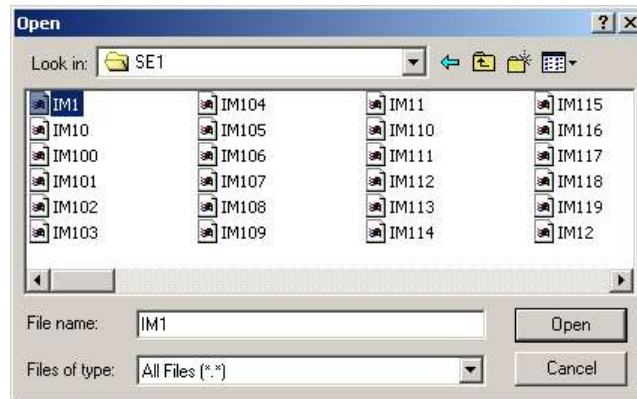
The dialog box is titled "Raw volume data import". It contains several input fields and checkboxes. The fields are: Width (X) with a value of 256, Height (Y) with a value of 256, Slices (Z) with a value of 109, Bits per voxel with a value of 8, X-Scale with a value of 1, Y-Scale with a value of 1, Z-Scale with a value of 1.4, and Offset (bytes) with a value of 0. There are also checkboxes for "Little-endian data?" which is checked. At the bottom, it shows "Actual file size: 7143424" and "Expected file size: 7143424". There are "OK" and "Cancel" buttons at the top right.

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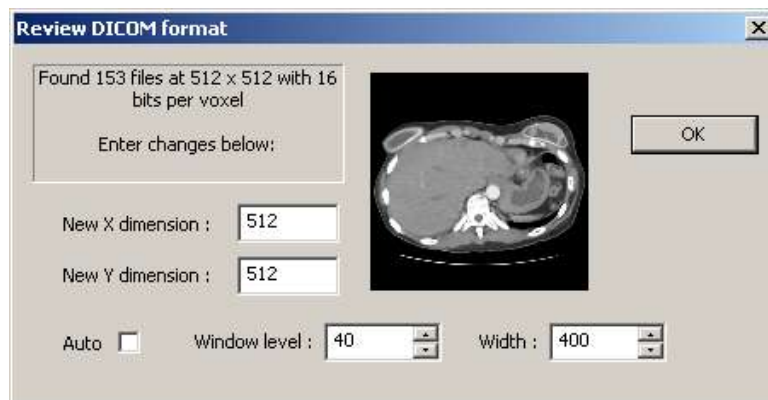
At present, only 8 and 16 bit data is supported. As you adjust the dimensions of the data in the above dialog, the expected file size will be displayed alongside the actual size of the file you have selected. If these are not in agreement when you click the OK button, the results may differ from what you expect!

Loading DICOM Data Sets

The usual method for loading data from DICOM format files is to select the “All Files” option from the File/Open dialog. Then just select any one file from the DICOM series:



3DView will examine all other files in the same folder as the selected file, and will determine if these relate to the same series. When it has completed examining the files, a second dialog will be displayed:



In this dialog, you will see how many slices have been found and at what size. Also the window and level will be set according to the default set in the DICOM data. These may be adjusted by using the above controls and the preview window will show the effect. When you click OK, these values will be used to build the voxels for display.

You may also change the size of the slices. If, as shown above, the resulting volume may be too large, you may safely reduce the dimensions (say to 256 x 256) with acceptable results. The ability of the application to handle larger data sets will depend on your own hardware configuration.

If you receive unexpected displays, or the application stops responding, try using a smaller value for the X and Y dimensions.

Saving Data

Any displayed data may be saved in 3DView's native format by selecting (File/Save As) from the main menu. In the case of 16 bit data (e.g. DICOM data), you will be given the chance to resample this data to 8-bits during saving. This can be useful if you want to perform segmentation or iso-surface generation on DICOM data as these functions only support 8-bit data sets at present.

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