second step is to render the polygon mesh using the computer's GPU. The algorithms used for this rendering technique are fast so the 3D image appears almost instantaneously, but only one or two surfaces are computed and rendered so you can see the entire volume (compared to volume rendering).

You can then choose a color and an opacity for the surface using the Surface Setting tool in the SR Viewer toolbar (Figure 7.55).

Finally, 3D surfaces can be exported as vectorial files that can be further manipulated in 3D modeling software such as Blender or Strata 3D.

The SR Viewer window is divided into a toolbar on top and an Image View on the bottom. The toolbar (Figure 7.55) contains buttons you use to access the most useful functions. The SR toolbar can be customized to fit your needs using Format > Custom Toolbar. The 3D rendered image is found in the image view window.

Toolbar

The SR Viewer toolbar (Figure 7.55) displays a variety of tools. Additional tools can be added, and other removed, using the Format > Custom Toolbar from the Format menu.
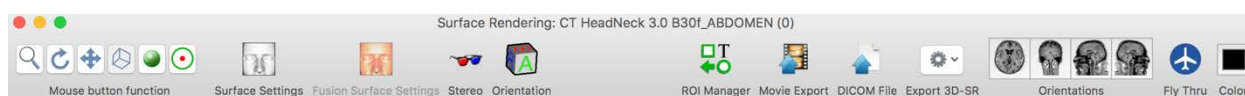

Figure 7.55. The SR Viewer Window Toolbar

Each tool is described below beginning with the default tools from left to right, followed by the additional custom tools in alphabetical order (Figure 7.56).
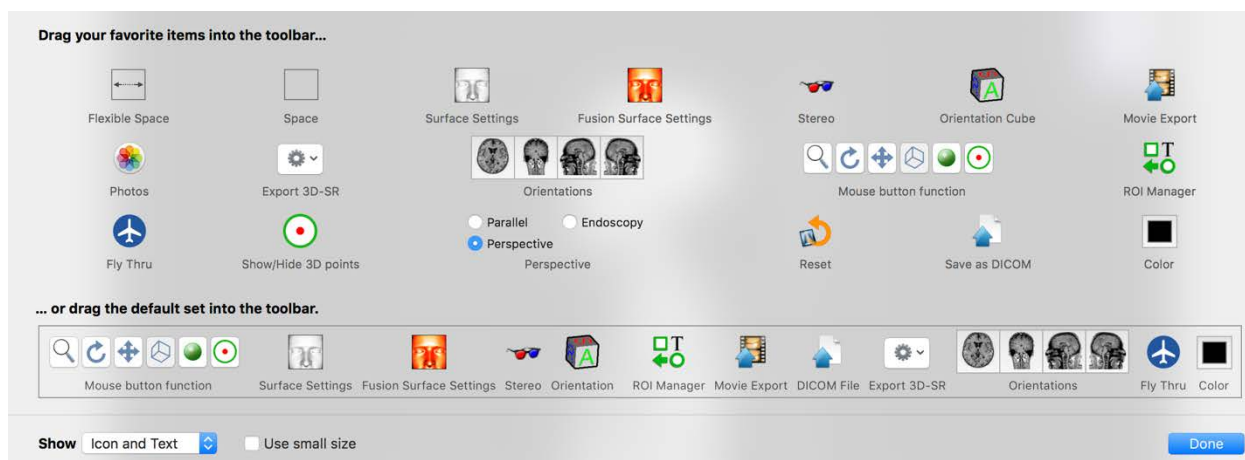

Figure 7.56. The custom tools available in the SR Viewer.

Mouse button function

The mouse button function tools allow you to choose a tool that activates when you click the left mouse button. You can choose Zoom, Rotate, Pan, Volume rotate [default], Plane rotate, and 3D Point tools. These tools have been described previously.

Surface Settings

The Surface Settings tool allows you to set rendering parameters for the primary 3D surface and an optional secondary (Figure 7.57). You can set the quality of the render using the slider to choose from low to high quality. The Decimate – Resolution can be set between 0.0 and 1.0. The decimate modifier is a way of reducing the polygon count in a mesh. The Smooth –Iteration function can be set between 1 and 100.

Two surfaces can be rendered. You can choose to enable or disable the primary and secondary surfaces using the checkbox to the left. For each surface, you can enter a pixel threshold value or choose from three pre-defined values for CT scans: Skin (−500), Bones (500), and Metal (2000). You can also set the transparency and color for the 3D surface rendering. Clicking on the Color square brings up the Mac OS X Color Picker.
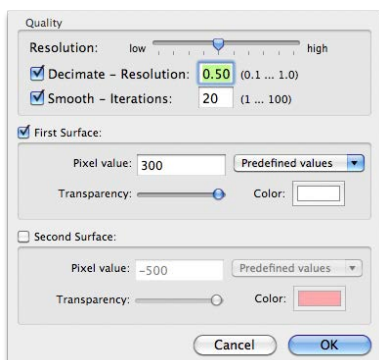

Figure 7.57. The Surface Settings used to compute the isosurface.

Fusion Surface Settings

If you are viewing a fused dataset, the Fusion Surface Settings icon will be active. It works like the Surface Setting tool, but with fused series.

Stereo

You can create an anaglyph image of your 3D volume using the Stereo tool. An anaglyph is a 3D stereoscopic effect achieved by creating two colored images one for each eye. The 3D effect is achieved by wearing red/blue glasses.

Orientation Cube

You can hide or display the orientation cube and labels using this tool. When displayed, there is a small orientation cube in the upper right corner and 4 small labels on each side of the image. The cube is displayed in the same orientation as the image. The labels include left (L), right (R), posterior (P), anterior (A), superior (S), and inferior (I).

ROI Manager

If you have created 3D ROIs in the 2D viewer already, the SR Viewer window can display some of these ROIs (you cannot create 3D ROIs in the SR Viewer). With your 3D volume render open, select the ROI Manager tool from the toolbar or via the ROI menu tab. This opens a dialog box with information about the ROIs for this series.

If multiple ROIs are available, you can display or hide each one using the checkbox to the left of the ROI's name. You can also modify the ROI color and opacity using the sliders in the ROI Manager dialog box.

Point ROIs can be added directly onto the surface rendered image in the SR Viewer window. Select the Point tool from the Mouse Button list and click on the image where you want the point to go. This point will also be displayed in the 2D Viewer window. Alternatively, you can drop a point ROI onto the 2D image in the 2D Viewer window. The color and size of the point can be edited using the Point Info dialog box.

Movie Export

You can create a movie of the 3D volume using the Movie Export tool. A popup window (Figure 7.34) allows you to choose the following options:

> *The number of frames to be generated – up to a maximum of 360 frames*
> *The rotation amplitude (180º or 360º) and direction (horizontal or vertical)*
> *The rendering quality (Current or Best)*
> *The size of the movie (current, 512x512, 768x768)*

DICOM File

This tool allows you to take DICOM snapshots of currently displayed 3D surface renders. The snapshots are added to the database. You can name the new series and set the size of the images (Current, 512x512, 768x768). You can also choose to save only the current image. However, if you choose to save a series of images from the rotating surface rendering, you have the option to set the number of frames (1-360), the amplitude of rotation (180º to 360º), and whether you want vertical or horizontal rotation. The new DICOM images can be marked as key images and sent to a DICOM node.

Export 3D-SR

This tool allows you to export the 3D Surface as vectorial data in five formats:

> • *Renderman (.rib)*
> • *VRML (.vrml)*
> • *Inventor (.iv)*
> • *Wavefront (.obj)*
> • *STL (.stl)*

Orientations

The Orientations tool allows you to switch between axial, coronal, left sagittal, or right sagittal camera positions for viewing the volume.

Fly Through

You can create movies of 3D scenes by choosing several points along a camera path. To begin, open a 3D surface volume and click on the Fly Thru icon in the toolbar or select the 3D Viewer menu from the top menu bar and select Add FlyThru Point option (or use the keyboard shortcut ⌘ **F1)**.

The Fly Through popup window appears (Figure 7.37) with a thumbnail of the 3D surface volume rendered image in index 1. Move or rotate the surface volume to a new position and click on the + symbol at the bottom left of the Fly Trough popup window. This adds a new index for that position. You can continue to add (plus sign) or delete (minus sign) index steps to the Fly Through window (Figure 7.37). When you are finished, you will have a series of steps that comprise the movie's path (think of them as scenes). You can now create and export the movie using the Export button at the bottom of the Fly Through window. Horos will interpolate the missing frames between the steps (indexed frames) to generate a smooth sequence of frames for your movie.

Choosing the Movie button at the top right of the Fly Through window will display a new popup window that allows you to choose how many frames between indexed steps, the method for interpolation (spline or linear), and an option to loop the movie. The Spline method generates smoother transitions between steps. Clicking on the Compute button generates the interpolated movie.

You can play the newly created movie using the Play button in the middle of the Movie popup window. Finally, you can export the movie as a DICOM series or as a Quicktime (.mov) file in three size options (using the Size dropdown choices).

Color

This tool allows you to change the background color of the 3D Surface view using the standard Mac OS X color picker.

Custom Tools

Perspective

You can choose the three perspective parameters for the rendering: Parallel, Perspective, or Endoscopy.

Photo

This tool opens Apple's iPhoto software and adds a JPEG image of the currently rendered image.

Reset

This resets the viewer to the default viewing settings.

Show/Hide 3D Points

This tool allows you to show or hide 3D points ROIs.

THE ENDOSCOPY VIEWER

The Endoscopy Viewer window is divided into three parts: a toolbar, three MPR views, and a 3D volume rendering. The toolbar (Figure 7.58) contains icons for useful tools. It can be customized from the Format > Custom Toolbar menu. The image view windows are divided into 3 orthogonal views and the 3D view (Figure 7.59).

Note that the Endoscopy Viewer is not compatible with image fusion or 4D data series.

Toolbar

This section describes each of these tools in the default Endoscopy toolbar from left to right. The tools on the left modify the MPR View and those on the right modify the 3D views.
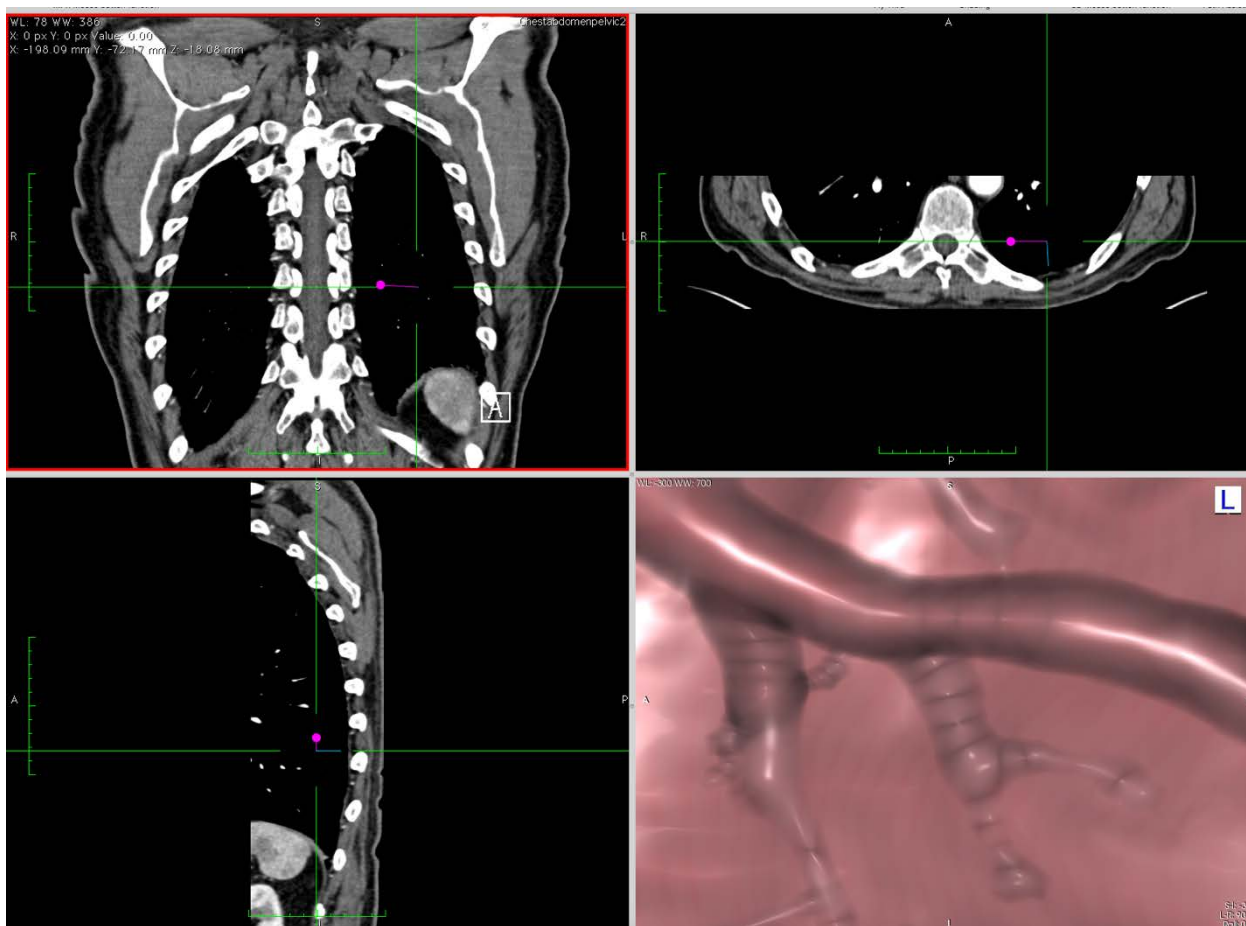

Figure 7.58. The Endoscopy Window Toolbar

Figure 7.59. The three MPR views and the 3D endoscopy view (lower right).

MPR Mouse button function (MPR Views)

You can use these mouse button tools to manipulate the 3 MPR views. These tools has been described in the 2D Viewer chapter (Chapter 6), so only those tools that a new to the Endoscopy Viewer will be described in detail. The MPR mouse tools include:

- *WL/WW [default]*
- *Pan*
- *Zoom*
- *Rotate*
- *Scroll*
- *MPR plane move – This tool allows you to move through the series by clicking and dragging the mouse on one of the MPR windows. The other two MPR windows change to reflect the moves you made in your window.*
- *Length ROI*
- *Oval ROI*
- *Angle*

Fly Through (3D View)

You can create movies of 3D scenes by choosing several points along a camera path. To begin, open an Endoscopy volume and click on the Fly Thru icon in the toolbar or select the 3D Viewer menu from the top menu bar and click on Add FlyThru Point option (or use the keyboard shortcut ⌘ **F1)**.

The Fly Through popup window appears (Figure 7.37). Move or rotate the 3D volume to a new position and click on the + symbol at the bottom left of the Fly Trough popup window. This adds a new index for that position. You can continue to add (plus sign) or delete (minus sign) index steps to the Fly Through window (Figure 7.37). When you are finished, you will have a series of steps that comprise the movie's path (think of them as scenes). You can now create and export the movie using the Export button at the bottom of the Fly Through window. Horos will interpolate the missing frames between the steps (indexed frames) to generate a smooth sequence of frames for your movie.

Choosing the Movie button at the top right of the Fly Through window will display a new popup window that allows you to choose how many frames between indexed steps, the method for interpolation (spline or linear), and an option to loop the movie (Figure 7.37). The Spline method generates smoother transitions between steps. Clicking on the Compute button generates the interpolated movie.

You can play the newly created movie using the Play button in the middle of the Movie popup window. Finally, you can export the movie as a DICOM series or as a Quicktime (.mov) file in three size options (using the Size dropdown choices).

Note that in addition to rotating or moving the image between steps, you can also change image transparency, thresholding, color settings or other parameters between indexed images. Horos allows you to save a script file of the indexed images in XML format to disk for later retrieval.

Shadings (3D View)

You can modify the shading parameters of the 3D view by clicking on the Edit button in the toolbar. Shading parameters do not modify the three MPR views.

3D Mouse button function (3D View)

You also have access to seven mouse button functions for manipulating the 3D view. You can choose from:

> • *WL/WW - This changes the WL/WW settings for the 3D view.*
> • *Pan*
> • *Zoom*
> • *Rotate*
> • *Volume rotate*

> • *Plane rotate [default]*
> • *3D Point*

Path Assistant (3D View / MPR Views)

The Path Assistant allows you to compute the centerline of an airway or vessel automatically. This can be helpful as a guide for moving the camera path in the 3D viewer. Clicking on the Path Assistant brings up a popup window (Figure 7.60) where you can choose from two modes and several settings parameters.
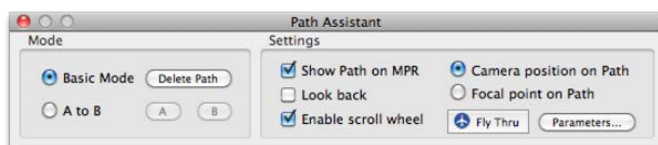

Figure 7.60. The Path Assistant panel

The **Basic** mode computes the centerline on the fly as you move the camera position. Click on the Lock path button next to Basic mode to activate it and then use the mouse scroll wheel to move the camera along the computed centerline (up and down arrow keys on the key board may also be used).

The **A to B** mode allows you to define a starting point (A) and an ending point (B). The Path Assistant then computes the centerline from A to B. Now you can use the scroll wheel on the mouse (or up and down arrow keys) to move along the computed centerline.

You can click on the Fly Thu button to create a movie sequence along the computed bath.

ENDOSCOPY VIEWER MPR FUNCTIONS

The Endoscopy MPR views use the same engine as the 2D Orthogonal MPR Viewer. The Endoscopy Volume Rendering view uses the same engine as the 3D Viewer. The basic tools and shortcuts in the three MPR views is similar to those of the 2D Viewer. If you double-click one of the views, it will display in full screen. A second double-click will switch it back to the 4-panel view.

Focal Point and Camera Position

In the Endoscopy Viewer, the orthogonal MRP views display the focal point and a camera position are denoted by a purple pin at the center of green cross reference lines (Figure 7.61). If the length of the focal point vector (pin length) is large, then the vector is parallel to the plane. However, if it is small, then the vector is perpendicular to the plane. Clicking on the focal point pin and dragging it changes the vector length.
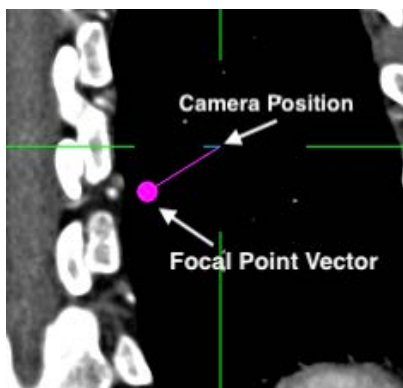
Figure 7.61. The Camera Position and Focal Point vector.

Cross reference lines

The green cross reference lines are displayed on all three orthogonal MPR views allowing you to see where a position is on each view. You can hide or show the green cross-reference lines by pressing the space bar.

ROIs

Temporary ROIs and point ROIs can be displayed on the MPR views in the Endoscopy Viewer. However, only point ROIs are displayed in the volume render view. The Endoscopy Viewer cannot display 3D ROIs. You can add Lines, Ovals, and Angle ROIs to the MPR views but they are temporary and will disappear when you move the position of the view.

To add a point ROI to the volume render view, select the Point ROI tool from the 3D Mouse button functions in the toolbar and click on the 3D render image where you want the point located. Horos uses the current WL/WW settings and computes a ray-casting to drop the point on a completely opaque structure. A point ROI added in the 3D volume will also be visible in the 2D Viewer window. Double-clicking on a point ROI allows you to change its size and color.

In the Endoscopy Viewer, you can export images of the MPR views and the Volume Rendering view in JPEG or DICOM format using the File > Export from the main menu. Exported images will be saved to the database and appear in the database window where they can be displayed or exported to a PACS workstation. Fly Thru sequences are exported via the Fly Thru export tool.

Chapter 8

Movies and Fly-Thrus

 Movie Export

You can create and export a movie file for a series displayed in the Viewer by either selecting File > Export > Export to Movie from the main menu, or by clicking on the Export Movie icon in the toolbar (shown above). A pop-up window appears with options for exporting the movie file (Figure 8.1). Depending on the type of series displayed at the time, you can choose to export a movie of fused images (PET-CT), 4D data movies (i.e. including a time dimension), only key images from a 2D series, or a 2D series. You can choose the interval and a sub-section of frames by using the sliders or entering numbers in the text boxes to the left of the sliders.
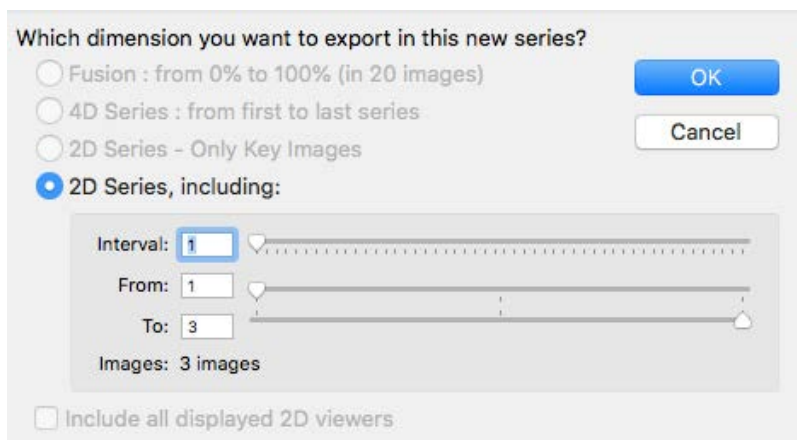

Figure 8.1. Movie Export options

If you have multiple 2D Viewers displayed on the screen (Figure 8.2), you can also select the Include all displayed 2D viewers option at the bottom. This will capture the images of all open viewers, combining them into a single movie image file. That is to say, you will have a single movie file displaying all viewers simultaneously. You can remove annotations from the exported movie using the tab key.