

CT@IMBL - Drishti Manual

[Drishti](http://anuf.anu.edu.au/anuf_staff/limaye.html) is a real-time interactive volume rendering and animation tool developed by the Ajay Limaye and the team at the ANU supercomputer facility "VizLab" (http://anuf.anu.edu.au/anuf_staff/limaye.html)

The Drishti visualisation suite is comprised of two main applications: the **Importer**, and the **Renderer**; with ancillary programs such as the **Painter**, the **Composite** utility and **Prithvi**. This guide concerns use of the Drishti Importer and Renderer only. (In versions prior to 2.1 both these applications can be invoked using the Drishti Launcher utility.)

Importing files

The Drishti renderer is very restricted in the type of volume files it accepts for processing. All volume data **must** be in a particular NetCDF format (file extension .pvl.nc.xxx) before the Renderer can work on it. To aid transformation of other image types to NetCDF, an **Importer** program is provided. In principle the Importer can accept a wide variety of standard image file types. For IMBL the ones of primary concern are TIFF. Importer is supposed to accept standard multi-file image stacks, and single file raw volume data. In the most recent version of Importer (2.6.3) even 32bit floating point TIFF files are accepted. In practice the most success importing has been using an image sequence of 16 bit TIFF files. These can be easily created from X-Tract using the Slice Processing form. The importer also works with old NetCDF files (extension.nc), and other less popular formats. It can also accept raw data. Reading raw data requires a separate text file stating the dimensions (in x,y,z) the data type, and number of header bytes.

Beware, the 'files' open facility opens single files not image sequences. The current version (version 2.6.3) will accept single multi-image 16 bit TIF files. If a subdirectory contains nothing but image sequence files you can import using 'standard image directory' menu choice. Importer does allow drag and drop operation. Once imported a tool is provided to alter the voxel value (grayscale) mapping, before saving to the NetCDF format file. A number of additional options are available at this stage including filtration and rebinning (or sub-sampling).

The .pvl.nc file is actually an .xml header file, can be drag and dropped into the rendering program. The data itself is contained in associated files called xxx.pvl.nc.001 etc.

Rendering - options

To make best use of the Drishti renderer it's best to use a machine with a graphics card having **OpenGL** capability. Once conversion of volume data to NetCDF is complete this file can then be loaded into the Renderer.

The state of the program can be saved to an .xml file called a 'project'. This procedure saves the transfer function and viewing information, along with pointers to the data files. However, don't assume that by saving the project you can then delete the data files. The project does not save the data files themselves.

An important feature to note is the swapping between coarse and fine resolution on-screen rendering (hi-res and lo-res modes). This is achieved by pressing the **F2** function key. Rotating, positioning and mapping operations will work much faster in the low resolution mode. Mouse controls within the viewport are: left click and hold=rotate, right click and hold=pan, mouse wheel=zoom.

Whilst moving the object in the viewport the view resolution is deliberately degraded. Once the movement is stopped the object will be rendered to a higher resolution. To turn this function off

toggle in the 'toggle' drop down menu, or type 'h'. The level to which the rendering is made can be changed in the *view>preferences* dialog box.

Pressing spacebar with the mouse hovering in the viewport window brings up available commands. (Version 2.0 onwards shows a handy guide to these, as well as the hotkey shortcuts.)

Creating a rendered view from the volume data makes use of the Transfer Function Editor. The transfer function maps the value of each voxel to a colour and opacity for ray tracing (rendering) purposes. The tools which control this mapping is very comprehensive and flexible. However it does take some getting used to. Making the image look like you want is a mixture of science, art, and practice.

Shadow rendering can be toggled on or off (press 'l'). Making this calculation needs serious CPU/GPU effort for large datasets so it is suggested it remains off until the final steps in producing the image/movie you require.

The light positions for rendering can be changed. Go to the menu and select Toggle 'View shader widget'

Other quality control factors are accessible via the main menu bar. These include render quality (sub-sampling factor), anti-aliasing etc.

Transfer function tools

The transfer function editor makes use of a 2-D map of the volume data differential histogram. This is a voxel value histogram, with the third axis being the magnitude of the voxel value gradient. The colour/opacity mapping is superimposed on this to provide the complete transfer function. The transfer function tool allows flexible and sophisticated mappings, but it will take some time to understand how to get what you want from it. The colour/opacity map is shown as an overlay on the pixel value/gradient map. The overlay in its simplest form is a pair of lines, with three handles on each. The Central handle moves the whole line, whereas the handles at the ends control the position and length of the line segment. Click on the line to add points to the function. Double click to modify the colour. More details can be found in the help file.

Once defined transfer functions can be saved, and several of them can be switched on or off for highlighting different aspects of the data. The transfer functions in use are shown as check boxes at the top of the Transfer Function Editor panel

Switching the pixel value/gradient map to 1-D mode just shows histogram with no gradient axis.

Note: the vertical axis on the graph is still marked as the gradient, but it only shows the gradient values in the 2-D mode.

Hover mouse over either of the two maps then press spacebar. This allows choice of several standard colour maps. (Rainbow, greyscale etc.)

Bounding boxes

In low-resolution mode (press F2 to toggle) you can alter the boundaries of the volume used for display. This is achieved by left clicking and dragging the diamond shaped grabs on the faces of the wireframe box, or using the arrow keys for finer adjustments.

Oblique clip planes can be created. Type 'c' whilst the mouse in the viewport. To delete a clip, hover over red dot and press 'delete'. Cylindrical clipping is also supported. Use spacebar and ?

In hi-res mode, to make bounding box disappear type 'b'.

Renderer Preferences

Under the **Preferences** tab you can set the quality of the render can be adjusted. There are also facilities to add axes and labels, etc.

Animation

Animations are created using a Keyframe editor tool. This is shown using the 'View' drop down menu. The idea is to set several camera and object orientations, positions, zooms, and mappings in a time line sequence. The animation creator will then interpolate between these key frames to generate intervening frames of the animation.

To start, set up the view you want as the first key frame than click 'add keyframe' in the animation tool. Individual key frames, or groups can be manipulated to alter the animation timing.

Use key frame editor ('View' toggle). In hi-res mode manoeuvre the image and 'add keyframe'. Then the play button will show the complete interpolated sequence.

'Save Movie' always choose the size to be multiples of 16(?)

Camera orientations are defined using the Brick editor. Brick 0 is the main bounding box defining the visible volume.

Paint

The Paint utility is helpful in generating/modifying the masking information for volumes.

Using Dristhi

Mouse viewing control

Use the mouse to move the camera around the object. You can respectively revolve around, zoom and translate with the three mouse buttons. Left and middle buttons pressed together rotate around the camera view direction axis Double clicks automates single click actions: A left button double click aligns the closer axis with the camera (if close enough). A middle button double click fits the zoom of the camera and the right button re-centers the scene. A left button double click while holding right button pressed defines the camera Revolve Around Point.

Button(s)	Description
Wheel	Zooms camera
Left	Rotates camera
Left double click	Aligns camera
Right	Translates camera
Right double click	Centers scene
Middle	Zooms camera
Middle double click	Shows entire scene
Left & Middle	Rotates on screen camera
Shift+Left	Adds a point
Shift+Middle	Zooms on region for camera
Right double click with Left pressed	Resets revolve around point
Left double click with Right pressed	Sets revolve around point
Left double click with Middle pressed	Zooms on pixel
Right double click with Middle pressed	Zooms to fit scene

Keyboard viewing control

Key(s)	Description
ESC	Quit
DEL	Delete currently active point, path, clip plane.
F1	Help
F2	Toggle between lowres and hires windows
Home	Increase drag image quality
End	Decrease drag image quality
PgUp	Increase still image quality
PgDown	Decrease still image quality
1	Toggle shading mode in hires window
a	Toggle axis
b	Toggle bounding box
f	Toggle the display of FPS
s	Toggle stereo display (if stereo is enabled via command line)
t	Add captions. Once the captions are added they can be edited, moved around and animated. Hover over a caption to activate it and press spacebar to edit it.
?	Toggle the display of text
!	Toggle smoothing of sub volume when loading in hires window. By default, if the selected sub volume does not fit in texture memory, it is smoothed before subsampling. Users can toggle this smoothing by pressing ! and reloading the sub volume.
Ctrl+s	Save project
Alt+s	Save a screenshot
Alt+f	Change camera mode (revolve or fly)
Alt+Return	Toggle full screen display

Creating a clip plane

A clip plane can be created using the 'clip' command. It needs three points defined prior to creation (shift + left click) and is created with those three points on the plane. The orientation of the plane can be altered using the visible direction indicators and a left click and hold with the mouse. If one indicator is lit up this is the axis for rotation. The mouse wheel will move the plane along the axis normal to the plane.

Working with bricks

Drishti has an ability to manipulate sub-volumes of a loaded volume. A 'brick' is defined as a rectilinear block within the main volume. Multiple bricks can be defined, including ones which overlap, and many aspects of these sub-volumes can be altered independently of the main volume. The classic example of the use of bricks is to rotate about an axis defined within a volume. Camera rotation using the mouse buttons may not give you the effect you want.

Dristhi Help

Dristhi - Hot keys and Mouse

Hot Keys

Numerical keys

- 0** - Set render resolution to normal - image is rendered at full resolution of the render window.
- 1** - Toggle shadows.
- 2** - Toggle Red-Cyan anaglyph mode.
(For this and the following. Use Focus Distance slider in Stereo tab within the Preferences panel under View to change the focus.)
- 3** - Toggle Red-Blue anaglyph mode.
- 4** - Toggle Crosseye stereo mode.
- 5** - Toggle Crosseye stereo mode compatible with 3D TVs - this will create a squashed image by 50% for each eye. When displayed on 3D capable TV, the images will be stretched out properly.
- 6** - N/A
- 7** - N/A
- 8** - Set render resolution to very low - image is rendered at quarter resolution of the render window.
- 9** - Set render resolution to low - image is rendered at half resolution of the render window.
- ?** - Toggle information text at the bottom in image window.
- Alt+Return** - Toggle full screen display.
- Alt+f** - Toggle between examine and fly mode for camera.
Default is examine mode.
- Alt+s** - Save single image. If any of the Red-Cyan or Red-Blue anaglyph modes are active, anaglyph image will be saved. Same goes for image sequences and movies.
- Cntrl+c** - Copy a snapshot to clipboard.
- Cntrl+h** - When keyboard focus is any of the editors under "View" menu, show help for that editor.
- Cntrl+s** - Save project.
- Cntrl+y** - Redo the last undone camera position/rotation change. Users can perform unlimited redo.
- Cntrl+z** - Undo last camera position/rotation change. Users can perform unlimited undo.
- Esc** - Quit Dristhi

Function keys

- F2** - Toggle between Hires and Lowres modes.
- Home/End/Shift+Left/Shift+Right** - Change drag image stepsize.
- PageUp/Pagedown/Shift+Up/Shift+Down** - Change still image stepsize.

Alpha keys

- Spacebar** - Bring up command input dialog.
- Tab** - Bring up dialog for GiLighting.
- a** - Toggle axis display.
- b** - Toggle bounding box.
- c** - Add a clip plane. Clip plane is always added in the center of the volume.
- d** - Depth cueing - darkening of image depending on distance to the viewer. By default depth cueing is disabled.
- e** - Toggle use of prune texture to skip rendering empty (transparent) spaces in the data.
- g** - Toggle mouse grab for widgets - trisets, networks, paths, clip planes, crop, dissect, blend, displace.
- h** - Force normal render even for mouse drags. If drag mode is not active, force to use higher resolution volume even for mouse drags.
- j** - Toggle use of drag volume for shadow render.
- l** - Toggle use of drag volume for render.

r - Reload sub-volume or toggle Carve/Paint Radius box. When mouse cursor is in a clip plane viewport or user is in paint/carve mode, pressing **r** will toggle the Carve/Paint Radius box. Users can change carve/paint region radius via this box. When mouse cursor is not in a clip plane viewport or user is not in paint mode then pressing **r** will trigger reloading the sub-volume. This is useful when the volume data file has changed and the sub-volume needs to be reloaded. Helpful in volume file is changing in real time and one wants to view the changed data.

s - Toggle stereo display in Hires mode. Operational only when activated using -stereo command line option. Users can also get stereo-like results by switching to red-cyan/blue anaglyph mode by pressing 2 or 3.

t - Add captions or toggle Tag Selector box. When mouse cursor is in a clip plane viewport or user is in paint mode, pressing **t** will toggle the Tag Selector box. Users can change current tag value via this box.

When mouse cursor is not in a clip plane viewport or user is not in paint mode then **t** will add captions. It will pop up a caption dialog to input the caption details. Once the captions are added, they can be edited, moved and animated. Hover over a caption to activate it and press spacebar to edit it.

Users can display frame number - `$#f`, time step number in volume - `$#v[0-3]` or interpolated values - `$n(value)`, within caption.

Example :

`$4f` will display frame numbers with padded 0s.

`$3v0` will display time step number for volume 0.

`$2v1` will display time step number for volume 1.

"Temperature : `$n(3.032)`" will display "Temperature : 3.03" if "floatprecision" is set to 2.

"Temperature : `$n(3.032)`" will display "Temperature : 3" if "floatprecision" is set to 0.

If one keyframe has `$n(val1)` and subsequent keyframe has `$n(val2)` then the intermediate frames will have interpolated values between val1 and val2.

v - Toggle visibility of widgets - networks, clipplanes, crop, dissect, blend, displace.

Mouse

Mouse Shift+Right click - Change rotation pivot.

Normally the rotation pivot is at the centre of the volume. To change that Shift+Right mouse click on the desired point to set that point as the new rotation pivot. Rotation pivot can be on any geometry or volume. To reset the rotation pivot, Shift+Right click on empty region on screen.

Mouse left + middle drag - Rotate object about the axis perpendicular to the screen.

Mouse left button drag - Rotate object

Mouse left double click - Align camera.

Mouse middle double click - Centre scene.

Mouse right button drag - Translate camera.

Mouse right double click - Centre object.

Mouse wheel/middle button drag - Zoom camera.

Commands

addplight

Add point/string light source.

If there is a single point then a point light source is added. When multiple points are available then string light is added. A string light is nothing but multiple light sources at the nodal points on a path. Once added the light source can be manipulated. Hover over the light source and press space bar to bring up the parameter dialog for that light source. Users can change light buffer size, light colour, shadows etc for the light source.

Press DEL while hovering over the light source to remove it. Light sources are animatable.

addrotation

addrotation x y z a

Rotate camera by a degrees about the axis defined by vector x,y,z from its current orientation. The vector x,y,z is internally normalized.

Example :

addrotation 0.1 1.0 0.5 40

addrotationanimation

addrotationanimation [x/y/z] [angle] [frames]

Simplest way to add rotation animation to keyframe editor. Two keyframes will be added to the keyframe editor. First frame with rotation angle 0 and second frame is set at frame number [frames] with rotation angle set to [angle].

Default value for axis is x-axis, angle is 360 degrees and frames is also 360.

Examples :

addrotationanimation

addrotationanimation y 90 400

addrotationx

addrotationx a

Rotate camera by a degrees about X-axis from its current orientation.

Example :

addrotationx 30

addrotationy

addrotationy a

Rotate camera by a degrees about Y-axis from its current orientation.

addrotationz

addrotationz a

Rotate camera by a degrees about Z-axis from its current orientation.

autospin

autospin [off]

When left mouse button is quickly dragged and released, model goes into auto-spin mode.

autospin off : switch off auto-spin

autospin : switch on auto-spin

backgroundrender

backgroundrender [no]

Toggle rendering to framebuffer object. Default is render to framebuffer object. By rendering to framebuffer object, the image is drawn and saved properly even when other windows overlap the render window.

When backgroundrender is switched off, regions of the render window occluded by other overlapping windows are not drawn, consequently the images may be saved with parts of overlapping windows.

When users want to save images with transparent background - set the background colour to black and switch off backgroundrender.

blend

When two points are specified a blend widget can be added. Blend allow users to blend different transfer functions within the selected region. When the blend widget is visible press spacebar while hovering on the widget to change blend parameters via a parameter dialog.

Blend can be morphed into crop/dissect/glow/displace.

caption

Opens up dialog to add caption. Once the captions are added, they can be edited, moved and animated.

Hover over a caption to activate it and press spacebar to edit text, colour and rotation.

Also when activated and press "c" to specify normalised screen position for the caption - (0,0) is top left and (1,1) is bottom right corners.

Users can display text embedded with frame number - \$#f, time step number in volume - \$#v[0-3], interpolated values - \$n(value) and dial - \$d(value), within caption.

For \$n(v) & \$d(v), the values v will be interpolated for inbetween frames. In the case of \$n, these values will be displayed as numbers, where as in the case of \$d, these values will be displayed as a pie (0-360 degrees). The values for pie can be greater than 360 or less than 0 - the pie displayed will change accordingly. Caption halocolor is used as background and color is used as foreground for the pie, but these colors flip with the number of complete turns.

Dial will always be shown at the start of the text.

Example :

\$4f will display frame numbers with padded 0s.

\$3v0 will display time step number for volume 0.

\$2v1 will display time step number for volume 1.

\$d(90) will display quarter dial with halocolor as background.

\$d(450) will also display quarter dial with halocolor as foreground.

"Temperature : \$n(3.032)" will display "Temperature : 3.03" if "floatprecision" is set to 2.

"Temperature : \$n(3.032)" will display "Temperature : 3" if "floatprecision" is set to 0.

If one keyframe has \$n(val1) and subsequent keyframe has \$n(val2) then the intermediate frames will have interpolated values between val1 and val2.

clip

When three points are specified a clip plane can be added.

Clip plane allow users to cull regions in the volume. When the clip plane widget is visible press spacebar while hovering on the widget to change clip plane parameters via a parameter dialog.

colorbar

Adds color legend / colormap to the display.

By default color legend will display colormap from set 0 transfer functions.

Multiple color legends can be added.

The color legend can be moved around using left mouse button. It can be scaled using right mouse button.

Hover over the colorbar to select and change it.

Press 0,1,.. to change transfer function set.

Press h/v to change the style - horizontal/vertical.

Press DEL to remove it.

countcells

Count the number of isolated regions, as defined by the transfer function. Only those voxels that have opacity greater than zero according to the current transfer function will be considered for locating isolated regions.

crop

When two points are specified a crop widget can be added. Crops allow users to cull regions in the volume. When the crop widget is visible press spacebar while hovering on the widget to change crop parameters via a parameter dialog.

Crop can be morphed into dissect/blend/glow/displace.

deselectall

Deselect all selected/active points.

disablegrabpoints

Disable mouse grabbing for points. Mouse grabbing for points will remain disabled till it is switched on with "enablegrabpoints".

By default mouse grabbing is enabled for points.

When there is many points, it might happen that while dragging the mouse across the screen, a point might get activated and moved around quite unintentionally. This option is to avoid that.

This option also helps in slightly increasing rendering speeds while rendering large point clouds.

When mouse grabbing is enabled, before each frame is rendered, a search is performed to find any grabbable object below the current mouse position. Reducing the number of grabbable object will reduce this search time.

disablevolumeupdates

Do not upload a new texture even when subvolume is changed.

By default, texture is updated whenever subvolume is changed.

displace - When two points are specified a displace widget can be added. Displace allow users to move parts within the selected region. When the displace widget is visible press spacebar while hovering on the widget to change displace parameters via a parameter dialog.

Displace can be morphed into crop/dissect/blend/glow.

dissect

When two points are specified a dissect widget can be added. Dissect allow users to cut open regions in the volume. When the dissect widget is visible press spacebar while hovering on the widget to change dissect parameters via a parameter dialog.

Dissect can be morphed into crop/blend/glow/displace.

enablegrabpoints

Enable mouse grabbing for points. Mouse grabbing for points will remain enabled till it is switched off with "disablegrabpoints".

By default mouse grabbing is enabled for points.

enablevolumeupdates

Enable texture updates whenever subvolume is changed.

By default subvolume updates are enabled.

floatprecision

floatprecision *value*

Sets the precision for displaying floating point numbers - i.e. maximum number of significant digits.

Default value is 2 - i.e. 2 digits after decimal point.

geosteps

geosteps <int>

The rendering of meshes becomes slower when "merge with volume" is switched on in the mesh dialog. This happens because the mesh is diced up into several slabs which results in coarse level sorting of triangles in that mesh. These mesh slabs are then rendered with the volume (if available). Higher number of slabs result in slower rendering. The parameter "geosteps" controls the number of slabs that are rendered. Higher value results in less number of slabs (coarser sorting) and faster rendering. Default value is 1.

getangle

Given three points calculate angle in degrees.

getsurfacearea

getsurfacearea [tag]

Calculate surface area by counting surface voxels (similar to getvolume). When getsurfacearea is supplied with tag, only those surface voxels that have the given tag value are counted.

getvolume

getvolume [tag]

Calculate volume by counting voxels that have non-zero opacity, i.e. count voxels that are shown. When getvolume is supplied with tag, only those voxels that have the given tag value are counted.

Glow

When two points are specified a glow widget can be added. Glow allows users to emissive glow within the selected region. When the glow widget is visible press spacebar while hovering on the widget to change glow parameters via a parameter dialog.

Glow can be morphed into crop/dissect/blend/displace.

grid

grid <columns> <rows>

Add a grid using the selected set of points in column major fashion. If none of the points is selected, the grid is created using all the available points. The order of selection of points affects the grid.

Once a grid is created, points used for creating the grid are removed. The grid can be modified after it has been created - rows or columns of points can be added and removed from the grid. Individual points on the grid can be moved.

image2volume

Save the volume rendered image seen on the screen as a 3D volume. Only the opacity part will be saved as volume.

Volumetric data is constructed by saving opacity information for each slice used to create the final rendered image. The voxel size for the generated volumetric data is decided by the stepsize (which determines the number of slices used to generate the final rendered image) and scaling of the image (ie. how close is camera to the scene).

Users can merge multiple volumes, use bricks to translate/rotate/scale parts of data. Essentially whatever you see on the screen will be saved in the 3D volume.

interpolatevolumes

Interpolatevolumes [no|color|value]

Linearly interpolates color/voxel values between two volumes in double volume. The interpolation ratio varies between 0.0 and 1.0 : $\text{color/val} = (1 - \text{frc}) * \text{volume1} + \text{frc} * \text{volume2}$. This ratio is automatically determined based on the frame number and the timestep number of the first volume. At keyframes this value is always 0.0. Default is no interpolation between the volumes.

landmarks

Add landmarks via the (selected) set of points. Once a point is converted to landmark then it can be assigned a name via landmark dialog. Landmarks are shown as points.

To toggle visibility of the landmark dialog hover over any of the landmarks and press space bar.

Landmark dialog allows users to calculate and show distances between landmarks, projections on line as well as plane. Landmark point and text colour and size can be modified.

Users can save landmarks to a text file. Landmarks can be loaded from .landmark file or a .points file or from a set of points. Landmarks can be reordered. Just reorder the rows in the table for landmarks and press "Reorder" button at the top left in the dialog to reorder the landmarks.

Enter the landmark name in the "Name" column of the landmark table. Coordinates in the table can be changed.

To calculate distance between landmarks use the Distances textbox.

Format for this is point pairs separated by comma.

Following show distances between points 1 and 2, 1 and 4, and 3 and 4.

1 2, 1 4, 3 4

To project landmark distances on a line use the Line Projection textbox.

Format for this is 2 coordinates to define line on which the distances are to be projected, followed by point pairs and text display distance in pixels from default position. The two coordinates defining the line are separated by comma. The line definition is separated from landmark points definition by semi-colon. The point pairs and distances are separated by comma. For e.g.

0 0 0, 1 0 0 ; 1 2 0, 1 4 10, 3 4 -20

Here first (0 0 0) and (1 0 0) are points on the line on which the landmark points will be projected.

(1 2 0) - 1 and 2 are landmark points and 0 is the deviation of display text.

(1 4 10) - 1 and 4 are landmark points and 10 is the deviation.

(3 4 -20) - 3 and 4 are landmark points and -20 is the deviation.

To project landmark points on a plane use the Plane Projection textbox.

Format for this is 2 coordinates to define plane on which the distances are to be projected, followed by points. The two coordinates defining the plane are separated by comma. The plane definition is separated from landmark points definition by semi-colon. The points are separated by comma. For e.g.

200 200 450, 0 0 1 ; 1, 2, 5

Here first (200 200 450) and (0 0 1) define the projection plane. (200 200 450) is a point on the

plane and (0 0 1) is the plane normal. Users can make use of clip plane to show projection plane -

turn on solid color and "grid" option to make clip plane look good. Plane center and normal for the clip plane can be obtained from the clip plane dialog.

1, 2, 5 are the landmark points that will be projected on the plane.

Landmarks can be moved around using mouse as well as via the dialog.

Individual landmarks can be deleted by hovering over relevant landmark and pressing "DEL" key.

"c" to show landmark coordinates.

"n" to show landmark number.

"t" to show landmark name.

loadbarepoints

Load points from a file. These points will be shown as tiny green dots. Bare points cannot be selected and edited. They can only be removed all at once.

User will be asked for the text file name from which the points will be loaded. This file should specify number of points on a single line followed by all point coordinates with one point (i.e. 3 values) per line.

Example :

```
4
0.5 1.0 4.0
3.5 1.0 1.0
2.5 1.0 4.0
0.5 1.5 6.0
```

****Once loaded these points cannot be edited.****

loadgrid

Load grid from a file. User will be asked for the text file name from which the points will be loaded. This file must be a text file with number of points in column and row at the top followed by one point (i.e. 3 values) per line. The file may contain multiple grids, as shown in the example below. Once created a grid can be edited.

Example :

```
2 2
34.5303 20.1612 9.31844
41.9833 21.8794 4.20507
26.2442 17.2637 21.2988
35.3462 19.1446 19.023
5 3
271.732 218.195 222.585
295.348 195.691 225.244
324.001 175.675 233.581
365.62 170.704 230.079
412.551 186.984 229.766
288.938 238.488 198.753
305.034 223.429 200.204
334.305 211.594 202.559
358.957 207.566 203.925
397.39 219.637 199.611
308.406 259.479 172.502
331.812 250.454 173.442
350.776 237.703 181.048
373.104 249.167 176.439
397.585 256.729 169.862
```

loadimage

Load background image from a file. User will be asked for the image file. This image will be drawn for the background instead of background color.

loadnetwork

Load network file.

loadpath

Load a path from a file. User will be asked for the text file name from which the points will be loaded. This file must be a text file with number of points at the top followed by one point (i.e. 3 values) per line. The file may contain multiple paths, as shown in the example below. Once created a path can be edited.

Example :

```
4
0.5 1.0 4.0
3.5 1.0 1.0
2.5 1.0 4.0
0.5 1.5 6.0
3
1.5 19.0 21.0
2.5 10.0 42.0
0.5 12.5 16.0
```

Paths can also use indexed coordinates. In this case the first line should be "#indexed". The next line specifies the number of points followed by coordinates of each point on a separate line. After all the points have been specified, list point number for the individual paths on separate line.

Example :

```
#indexed
8
75.9695 211.301 2.95066
62.4697 211.301 2.98529
82.5082 211.141 18.0185
76.5653 210.904 40.2637
75.5968 210.772 52.5721
64.0969 210.772 52.6016
74.7241 210.244 102.195
76.5653 210.904 40.2637
0 7
1 3
0 1 2
4 5 6 7 3
```

loadpathgroup

Load paths from a file. All the paths in the file are treated as a single entity. Points cannot be added or removed from a pathgroup.

Users can also load indexed paths.

More information can be found under loadpath help.

loadply

Load .ply Stanford formatted polygon file.

loadpoints

loadpoints/loadpoint

Load points from a file. User will be asked for the text file name from which the points will be loaded. This file should specify number of points on a single line followed by all point coordinates with one point (i.e. 3 values) per line.

Example :

```
4
0.5 1.0 4.0
3.5 1.0 1.0
2.5 1.0 4.0
0.5 1.5 6.0
```

Once loaded these points can be edited.

loadtriset

Load .triset file.

loadvector

Load vector field from a text file.

User will be asked for the text file name from which the points and vectors will be loaded. This file must be a text file with number of points at the top followed by point and vector per line. Each line must have atleast 4 values and upto 6 values. The first 3 values will be treated as position. The missing vector values will be filled with 0. Once loaded user can assign colour gradient based on vector length.

The vectors are treated just as a special case of pathgroups.

Example :

```
4
10.5 1.0 4.0 0.0 1.0 0.0
13.5 1.0 1.0 0.3 0.5 0.0
12.5 1.0 4.0 0.0 0.8 2.0
10.5 1.5 6.0 0.4 1.3 0.7
```

Another example (here the missing y & z vector values will be taken as 0.0)

Users can use this format for loading scatter plot data - pos and value.

```
4
10.5 1.0 4.0 0.9
13.5 1.0 1.0 0.3
12.5 1.0 4.0 1.0
10.5 1.5 6.0 0.4
```

masktf

masktf [tfset]

Used for creating the empty space skipping volume. This volume is used as a mask. The rendering is limited to within the non-zero regions of this mask.

mix - mix [0|1|2] [no|color|opacity|color opacity|tag|tag no]

During handling of multiple volumes, "mix" influences the rendering of volume specified by the volume number in the mix command.

The second parameter is volume number. If not specified volume 0 is assumed. Color and opacity for all volumes below the volume number are not affected - For example when volume number is 1, color and opacity for volume 0 is not affected.

Default style is "mix no" - volumes are composite in normal way.

When "color" is specified, affected volume is tinged with colors from transfer functions defined for volume numbers above it. The opacity/transparency is not modulated. Volume numbers above the affected volume are not rendered.

When "opacity" is specified, transparency for the affected volume is modulated with transparency from transfer functions defined for volume numbers above it. The color is not modulated. Volume numbers above the affected volume are not rendered.

When both "color" and "opacity" are specified both of these are modulated for the affected volume.

When "tag" is specified, affected volume is tinged with tag colors. Volume 1 voxel value is used as tag value to choose appropriate tag color.

Examples :

mix no - switch of the mixing.

mix color - modulate color for volume 0 by the colors from volumes 1,2,...

mix 1 color opacity - modulate color and opacity for volume 1 by color and opacity from volumes 2,... Volume 0 remains unaffected.
mix tag - modulate color for volume 0 by tag colors chosen using volume 1 values.
mix tag no - turn off tagging.

mop

mop [option] [parameters]

When only mop is specified, command dialog for mop will open up.

More information on the following options available in MOP command dialog.

Supported options :

average

average [chan1] [chan2] [dst] : $dst = (chan1 + chan2)/2$

blend

blend [off] : switch on/off blend mode.

When blend mode is switched on, the paint tags that users have painted on the data are used as reference to the transfer functions for blending. Appropriate transfer functions will be blended in place of tag colors - tag value refers to the transfer function set. If the tag value is greater than the total number of transfer function sets, then set 0 is chosen.

When multiple volumes are loaded, appropriate transfer functions from different sets are applied to the volumes with the tag value referring volume 0 transfer functions. In the case of multiple volumes, user need to take care of choosing appropriate tag values for painting, so that there is no overlap between transfer function sets.

carve

carve [off] : switch on/off carve mode.

Using carve users can modify values in channel 1. Only the mask values in a spherical region around mouse cursor and those that have non-zero channel 1 are affected. Channel 1 values are normally set for non-zero opacity voxels when mask texture gets updated with transfer function change.

When in carve mode, users can remove spherical portions of the data by using shift+left mouse drag. Normally shift+left mouse click add a point - this normal function is disabled when carving is switched on. Only mask values that have non-zero channel 1 are carved.

Shift+right (or Ctrl+left) mouse drag will restore mask buffer values in the spherical region defined by carve radius. Only mask values that have non-zero channel 1 are restored.

Shift+middle (or Alt+left) mouse drag will set mask buffer values in the spherical region defined by carve radius to 255.

Users can also employ paths and points for carving operations. Path can also be used to patchup big holes. Points can be used to fillup large empty spaces before shrinkwrap operations.

Mop functions:

carverad

carverad [radius] [decay] : Specify carve radius and decay parameters. Carving allows users to remove spherical portions of the data by setting mask buffer values to 0 in that region.

Carve radius defines the sphere of influence. The decay parameter specifies the smoothing near the edges - mask buffer values are set to 0 near the central region and are smoothstepped to original values near edge. Decay value 0 implies sharp boundary. Users can also change carve radius and decay using up/down and left/right arrows respectively.

For example

mop carverad 20 5 : influence sphere of radius 20, with 0 values within sphere of radius 15 and gradually climbing to original values near the edge.

chessboard

chessboard [sz]: Chessboard distance transform. The values start with 0 on the surface of the object and increasing inside the object. Default value for sz is 1. This operation applies the following protocol :

cityblock

cityblock [sz]: Cityblock distance transform. The values start with 0 on the surface of the object and increasing inside the object. Default value for sz is 1. This operation applies the following protocol :

close

close [sz] [chan]: Morphological closing of channel chan - dilate followed by erode dictated by size parameter. Default value for sz is 1 and chan is 0.

copy

copy [src] [dst] : Copy mask buffer channel src to mask buffer channel dst. src and dst can be either 0,1,2.

copyfromsaved

copyfromsaved [src] [dst] : Copy savedbuffer channel src to mask buffer channel dst. If specified, src and dst can be either 0,1,2. If not specified, all channels from savedbuffer are copied to mask buffer.

copytosaved

copytosaved [src] [dst] : Copy mask buffer channel src to savedbuffer channel dst. If specified, src and dst can be either 0,1,2. If not specified, all channels from mask buffer are copied to savedbuffer.

Dilate

dilate [sz] [chan] : Dilate mask buffer channel chan by sz. Default is dilate by 1 for chan 0.

Dilateedge

dilateedge [val1] [val2]: Very similar to erode - values near the edge are set to zero based on current mask values at those positions. User needs to provide two parameters to this operation which will specify range of values that can be eroded. If only one value is provided then the range of values is taken as [1, val]. For e.g.

mop dilateedge 100 : erode edge where values are between 1 and 100

mop dilateedge 230 253 : erode edge where values are between 230 and 253

edge

edge [val] [thickness] : Set edges of mask buffer to val. Parameter thickness controls how thick edge would be. By default val is 0 and thickness is 1. For e.g.

mop edge 0 2 : set 2-voxel thick edge to 0

erode

erode [sz] [chan] : Erode mask buffer channel chan by sz. Default value for sz is 1 and chan is 0.

fusepatch

fusepatch : merge patches that were added using paths with the rest of the mask. Patches are usually added to help contain the interior region during shrinkwrap process.

hatch

hatch [box | grid] [xn] [xd] [yn] [yd] [zn] [zd]

This action etched a box or grid hatching pattern on channel 0 based on "box" or "grid" option and integer values xn,xd,yn,yd,zn,zd.

Pseudo code to set channel value to 0 is as follows :

```
zeroit = true;
```

```
if (xn > 0 and xd > 0) zeroit .and. (xcoord%xn < xd);
```

```
if (yn > 0 and yd > 0) zeroit .and. (ycoord%yn < yd);
```

```
if (zn > 0 and zd > 0) zeroit .and. (zcoord%zn < zd);
```

```
if (box selected and zeroit is true) then set value to 0;
```

```
if (grid selected and zeroit is false) then set value to 0;
```

histogram

histogram [chan] : Calculate frequency histogram for channel chan. Default value for chan is 2.

invert

invert : Inverts the mask buffer : 255-current mask value.

itk : Apply ITK (Insight Tool Kit) filters. Several filter are implemented. Channel 1 (which usually stores opacity information) is passed on to the filter. The results are passed back in channel 2. The filter is performed over the opacity information - users can tweak data in channel 1 (for e.g. carving) to achieve the required result.

localmax

Find locally maximum values.

Localthickness

localmax : Find locally maximum values.

Masktf

masktf [tf] : Specify which transfer function set to use for generating the mask buffer. If the "tf" parameter is -1, then contributing transfer functions from all the sets are considered for generating the empty space skipping mask buffer. -1 is default value, if no value is specified. For example :

mop masktf -1 - use transfer function from all the sets.

mop masktf 1 - use transfer functions from set 1 only.

Max

max [ch1] [ch2] : Take maximum of current mask buffer channel ch1 and saved buffer channel ch2 - behaves as union of current buffer and saved buffer. If specified, ch1 and ch2 can be either 0,1,2. If not specified, all channels are considered.

Maxvalue

maxvalue : Displays maximum buffer value for each channel.

Min

min [ch1] [ch2] : Take minimum of current mask buffer channel ch1 and saved buffer channel ch2 - behaves as intersection of current buffer and saved buffer. If specified, ch1 and ch2 can be either 0,1,2. If not specified, all channels are considered.

Nop

nop : Dilate mask buffer by 1. This is the default option.

Open

open [sz] [chan] : Morphological opening of channel chan - erode followed by dilate dictated by size parameter. Default value for sz is 1 and chan is 0.

Paint

paint [off] : switch on/off paint mode. When in paint mode, users can paint tags on the data. Tags are shown as colours mixed on top of the transfer function. Tag colours are mixed based on opacity parameter of the colour, which can be set individually for each tag color. The tag colours are set via Preferences - Tag Colour menu.

Rdilate

rdilate [val] [sz]: Restricted dilate - dilate mask buffer by "sz" only for voxels with value "val". Default values for sz and val are 1 and 255 resp.

removepatch

removepatch : remove the patches that were added using paths. Patches are usually added to help contain the interior region during shrinkwrap process.

sat0

sat0 [val] [chan] : Mask value of channel chan less than val will be set to 0. Some mask value will be greater than 0 but less than 255 for cityblock, thicken or shrinkwrap operations. Default value for val is 255 and chan is 0

sat1

sat1 [val] [chan] : Mask value of channel chan greater than val will be set to 255. Some mask value will be greater than 0 but less than 255 for cityblock, thicken or shrinkwrap operations. Default value for val is 0 and chan is also 0.

Save

save : Save mask buffer to raw file or image. The data will be save as 1-byte per voxel. The mask value will range from 0 to 255.

Setvalue

setvalue [val] [minval] [maxval] [chan] : If channel chan maskbuffer value lies between minval and maxval, then set it to val. Default value for chan is 0.

This option can be used to create a shell - for e.g.

apply distance transform : mop cityblock 20

set voxels away from surface to 0 : mop setvalue 0 5 255 - all 5 and above voxel deep are set to 0

set non-zero voxels to 1 : mop sat1 0 - (or : mop setvalue 255 0 255)

shrink

shrink [sz] [chan] : Erode channel 0 by sz based on values in channel chan. Erosion operation is only applied at voxels where value of chan is zero. Default value for sz is 10 and chan is 1.

This operation is useful for eroding filled cavities on the exterior of the structure by shrinkwrap operation.

Shrinkwrap

shrinkwrap [sz]: Very similar to close, except erosion starts from the edge of the subvolume box. Default value for sz is 1. This operation applies following protocol :

thicken current buffer by sz

set 1-voxel thin edges of the bounding box to 0 thicken 0 valued edge by sz

smoothchannel

smoothchannel [chan] : Apply 3x3x3 averaging for mask buffer values in channel "chan". Only non-zero values are considered for smoothing.

Swap

swap [ch1] [ch2] : Swap mask buffer channel ch1 and savedbuffer channel ch2.

Tag

tag [val] : Set tag value for painting. Value must be between 0 and 255.

Thicken

thicken [sz]: Very similar to dilate - except mask buffer values decrease as one goes into empty region away from original surface like distance transform. Default value for sz is 1.

Update

update [off] : Switch on/off updating of mask buffer. By default the mask buffer will be updated every time a transfer function is changed. Users can switch off these updates and freeze the mask buffer by specifying "off" or "no" for the parameter. If no parameter is specified the updates will be swithed on. The mask buffer will always be updated whenever any morphological operaion (listed below) are performed.

For example :

mop update off - to turn of updates to mask buffer.

mop update - to turn on updates for every transfer function change.

Even when updates to the buffer via transfer function changes are switched off, all morphological operations do update the current buffer. This enables user to perform multiple operations one after another.

Xor

xor [ch1] [ch2] : XOR mask buffer channel ch1 with savedbuffer channel ch2. Result is stored in channel ch1 of mask buffer. If specified, ch1 and ch2 can be either 0,1,2. If not specified, all channels from mask buffer are xored with savedbuffer.

move

move x y z

Move camera from the current position by x,y,z units.

Example : move 50 20 20

movescreenx

movescreenx x

Move camera horizontally as seen by the viewer from the current position by x units.

Example : movescreenx 10

movescreeny

movescreeny y

Move camera vertically as seen by the viewer from the current position by y units.

movescreenz

movescreenz z

Move camera in/out as seen by the viewer from the current position by z units.

movex

movex x

Move camera from the current position by x,0,0 units.

Example : movex 50

Movey

movey y

Move camera from the current position by 0,y,0 units.

movez

movez z

Move camera from the current position by 0,0,z units.

opmod

opmod [front op] [back op]

Opacity modifier to modulate opacity of the transfer functions from front to back of the volume.

This modulating factor is multiplied to the opacity value. Default value is 1 for both front and back - i.e. no modulation.

Example :

opmod 1

opmod 0 1 : front slice opacity will be multiplied by 0.

back slice opacity will be multiplied by 1.

In-betweens will be multiplied by linearly interpolated values between 0 and 1.

opmod 0.1 : multiple all opacity values by 0.1

opmod 0.1 0.5 : front slice opacity will be multiplied by 0.1.

back slice opacity will be multiplied by 0.5.

inbetweens will be multiplied by linearly interpolated values between 0.1 and 0.5.

path - Add a path going through the selected set of points. If none of the points is selected, the path is created through all the available points.

The order of selection of points affects the path.

Path consists of at least 2 points.

Once a path is created points used for creating the path are removed. The path can be modified after it has been created - points can be added, moved and removed from the path.

point

point x y z

Add a point at the given x,y,z coordinates.

Example : point 10 20.5 123

Users can also add points by using Shift+Left click on visible region of the volume.

pointcolor

Set the point colour for display. A colour dialog will pop via which colour can be selected.

pointsize

pointsize [size]

Set the point size for display.

Default value is 20 pixels.

removebarepoints

Remove all points that were loaded as bare points.

removepoints

removepoints [all | selected]

Removes all points or the selected set of points.

Example :

removepoints all

removepoints selected

rescale

rescale [sampling] [tag]

Similar to reslice, except the data is saved in the original orientation.

User can specify new volume size.

This facility can be used to upscale as well as downscale the volumes along any of the dimensions.

The amount of sampling is governed by the sampling parameter. Default value is 1 - i.e. take every voxel. Sampling parameter can take real values - for e.g. 0.5 (upscale by factor of 2), 0.25 (upscale by factor of 4), 2.5 (downsample by factor of 2.5) etc. Values greater than 1 will result in downscaling the volume and those less than 1 will result in upscaled volume.

User will be asked to check and set new volume size. This facility can be used to upscale as well as downscale the volumes along any of the dimensions.

Applying this operation to double volumes gives the ability to perform volume calculations such as $A-B$, $|A-B|$, $A+B$, $\min(A,B)$, $\max(A,B)$, $A*B$ and A/B , where A and B are voxel value/opacity of respective volumes.

resetcamera - Reset camera to examine mode. Show entire scene.

resetfov - Reset the (vertical) field of view to default value. Default value is 45 degrees.

resetimage - Reset background image. No background image will be drawn, instead the background color will be used to fill the background.

Resettempdir

tempdir/resettempdir

Set temporary directory to store temporary files created by the program.

When not set (which is default), these files are stored in the directory where .pvl.nc file resides.

Give "resettempdir" to reset temporary directory.

reslice

reslice [sampling] [tag]

Save resliced volume as defined by the current orientation. The selected subvolume is resliced along the view direction. Users can save value or opacity using this option.

The amount of sampling is governed by the sampling parameter. Default value is 1 - i.e. take every voxel. Sampling parameter can take real values - for e.g. 0.5 (upscale by factor of 2), 0.25 (upscale by factor of 4), 2.5 (downsample by factor of 2.5) etc. Values greater than 1 will result in downscaling the volume and those less than 1 will result in upscaled volume.

The tag parameter controls the tagged voxels that are saved. Default value is -1 - i.e. save all voxels whether they are tagged or not.

Applying this operation to double volumes gives the ability to perform volume calculations such as $A-B$, $|A-B|$, $A+B$, $\min(A,B)$, $\max(A,B)$, $A*B$ and A/B , where A and B are voxel value/opacity of respective volumes.

Example :

reslice 2 : downsample by factor of 2, save all voxels.

reslice 2 0 : downsample by factor of 2, save only voxels that are tagged 0.

reslice 2 1 : downsample by factor of 2, save only voxels that are tagged 1.

reslice 0.5 : upsample by factor of 2, save all voxels.

reslice 0.25 : upsample by factor of 4, save all voxels.

Rotate

rotate x y z a

Rotate camera by a degrees about the axis defined by vector x,y,z. The vector x,y,z is internally normalized.

Example : rotate 0.1 1.0 0.5 40

Rotatescreenx

rotatescreenx a

Rotate camera by a degrees about horizontal screen axis from its current orientation.

Example :

rotatescreenx 30

rotatescreeny

rotatescreeny a

Rotate camera by a degrees about vertical screen axis from its current orientation.

Rotatescreenz

rotatescreenz a

Rotate camera by a degrees about axis perpendicular to screen from its current orientation.

Rotate

rotatex a

Rotate camera by a degrees about X-axis.

Example : rotatex 30

Rotate

rotatey a

Rotate camera by a degrees about Y-axis.

Rotatez

rotatez a

Rotate camera by a degrees about Z-axis.

Savepath

Save all paths into a file. User will be asked for the text file name into which the path points will be saved. For each path this file will have number of coordinates at the top followed by point coordinates.

Savepoints

Save points into a file. User will be asked for the text file name into which the points will be saved. This file will have number of points at the top followed by one point (i.e. 3 values) per line.

Scalebar

scalebar [voxels/voxelunit]

Adds scale bar to the display. Multiple scale bars can be added.

By default scalebar will display 100 voxels/voxelunits across. If the dataset has voxelunits specified in the volume information, then the number is taken in voxelunits (i.e. micron, cm, mm etc), otherwise it is taken to mean number of voxels.

The scale is correct for orthographic projection.

For perspective projection the scale is correct for the central portion of the object. In perspective projection, the object scaling will be larger for closer regions than for the away regions. Hence the scalebar displays the scale that is correct at the center of the object.

Hover over scalebar to activate it.

The scalebar can be moved around.

Press h/v to change the style - horizontal/vertical.

Press u/d/l/r to change the text position - up/down/left/right for appropriate style.

Press DEL to remove it.

Scalebars positions can be animated.

Examples :

scalebar 10 - If voxelunits are specified then the scalebar is drawn such that it shows 10 voxelunits across otherwise it will be 10 voxels across.

Search

search text

Search keyframes for text within captions. The captions could be either normal caption on screen or those that are added using paths. If found, first keyframe with given search text within captions is displayed and current frame is set to that keyframe.

Setfov

setfov fov

Set (vertical) field of view, fov, in degrees. Default value is 45 degrees.

Setlod

setlod lod

Set the highest Level of Detail (lod) to load in hires mode. The highest level of detail is the amount of subsampling needed to fit the selected subvolume in the available texture memory. Default value is 1 (i.e. no subsampling required - load full resolution whenever possible). The program will automatically calculate level of detail that is needed taking into account the user defined limit. For e.g. To set level 3 subsampled volume as the most detailed version : setlod 3

Tempdir

tempdir/resettempdir

Set temporary directory to store temporary files created by the program.

When not set (which is default), these files are stored in the directory where .pvl.nc file resides.

Give "resettempdir" to reset temporary directory.

Texsizereducefraction

texsizereducefraction frc

The volume data is loaded in 2D textures on graphics card. Sometime (seen on cards allowing 8Kx8K textures) the volume data does not get loaded properly onto the texture memory. Use this option to restrict the size of 2D textures that Drishti can use. Default value is 1.0.

Example :

To reduce texturesize by half : `texsizereducefraction 0.5`

Translate

`translate x y z`

Translate camera to the x,y,z position.

Example :

`translate 200 250 200`

translatex

`translatex x`

Translate camera to the x,0,0 position.

Example : `translatex 200`

Translatey

`translatey y`

Translate camera to the 0,y,0 position.

Translatez

`translatez z`

Translate camera to the 0,0,z position.