

3D-Laboratory, Nov. 1, 2007

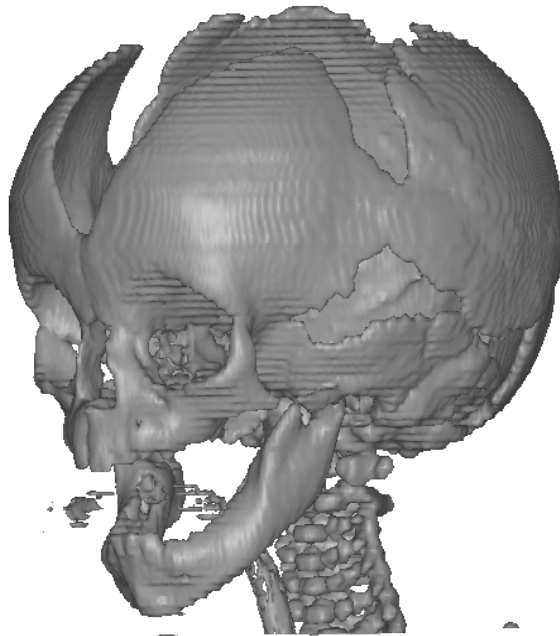
## “SELF-DEMO”: landmarker

**Purpose:** Explore a tcl/tk application based on VTK

**Explore** some of the functionality of landmarker

**Discuss** the program and possible applications

**Present** one or more of your results to the other groups (4 minutes): purpose, method and result.



# Part 1. 3D Images

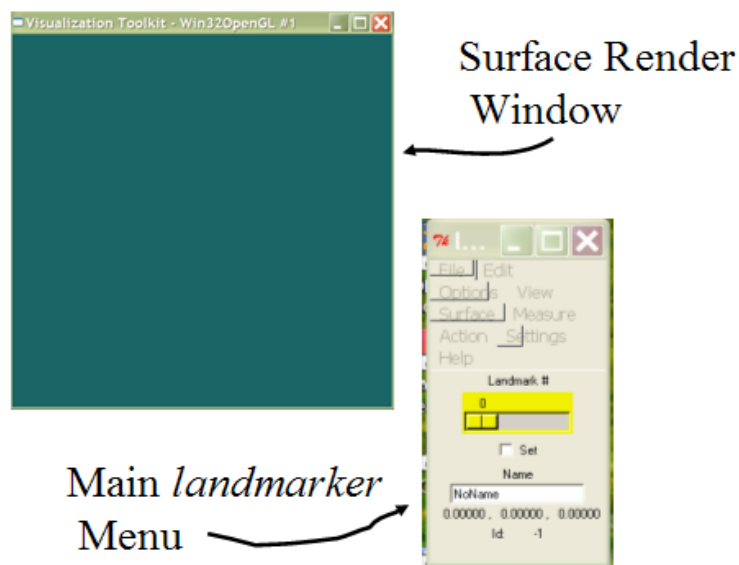
In this part of the tutorial you will learn three ways of viewing images from a 3D CT-scan:

- a) Axial slice viewing
- b) Viewing of 3 orthogonal slices (axial, coronal, lateral)
- c) Viewing of arbitrary oblique slices

**Start *landmarker***: Linux: by typing `landmarker` in a terminal window on your computer; Windows: Double click the `landmarker.tcl` icon.

Two windows will appear on the screen:

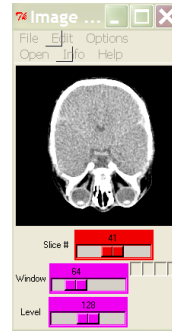
- a Surface Render Window (which is currently empty), and
- the Main *landmarker* Menu



**Load a 3D CT-scan** into *landmarker* by File→Load(New)→ImageFile and select the file named `cooked.hea`.

Abbreviations used in the text: M1, M2 and M3: left, middle and right mouse buttons. (If your mouse has only 2 buttons: M2 = M1+M3.)

**1a)** The middle (axial) slice of the data will be shown in an Image Viewer.



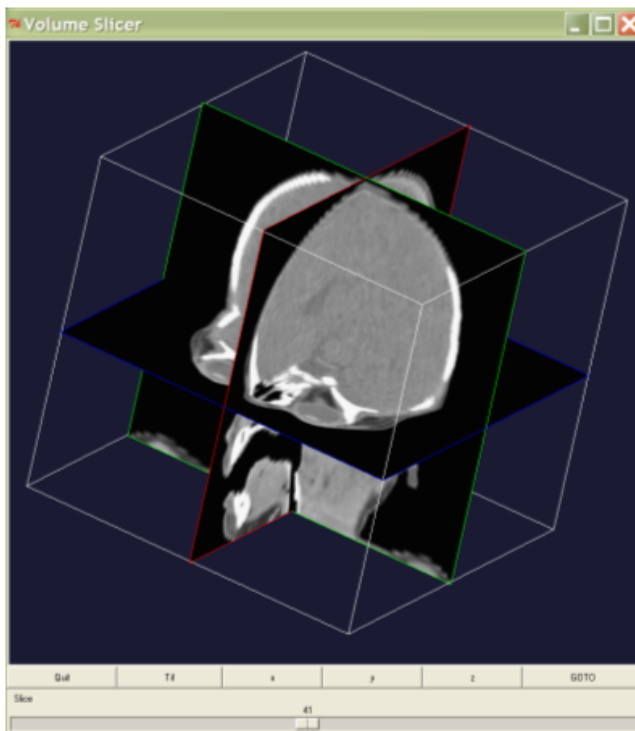
**Explore the dataset** by moving the “Slice #” slider: this will let you select different slices.

Change the Window and Level (what are these?) of the display by using the purple sliders. What happens?

Can you recognise the anatomy in the slice images?

Check image dimensions by Info→ImageDimensions

**1b)** **Open a Volume Slicer** by selecting Open→VolumeSlicer in the Image Viewer.



**Volume Slicer showing 3 orthogonal slices.**

To rotate view: M1 outside white box.

To zoom view: M3 outside white box.

To move a slice: M2 at a slice

(but not too close to the edge of the slice).

To change Window/Level: M3 while pointing at slice.

x, y and z buttons let you set a particular slice direction

Slider lets you move a slice

**Try to rotate and zoom, and to move each of the three orthogonal slices.** Click M1 somewhere on a slice, then try the GOTO CURSOR button. What does it do?

1c) Create oblique slices that cut through the volume at arbitrary locations: Point M2 close to the slice border in the Volume Slicer and drag the mouse.

## Part 2. 3D Surfaces

In this part of the tutorial you will learn to create and work with 3D surfaces.

- a) Create a surface based on an intensity threshold in a CT-scan.
- b) Load and view other 3D surfaces:
  - o laser scanner face surface
  - o dental plaster cast model

Learn how to cut, color, and measure the surfaces.

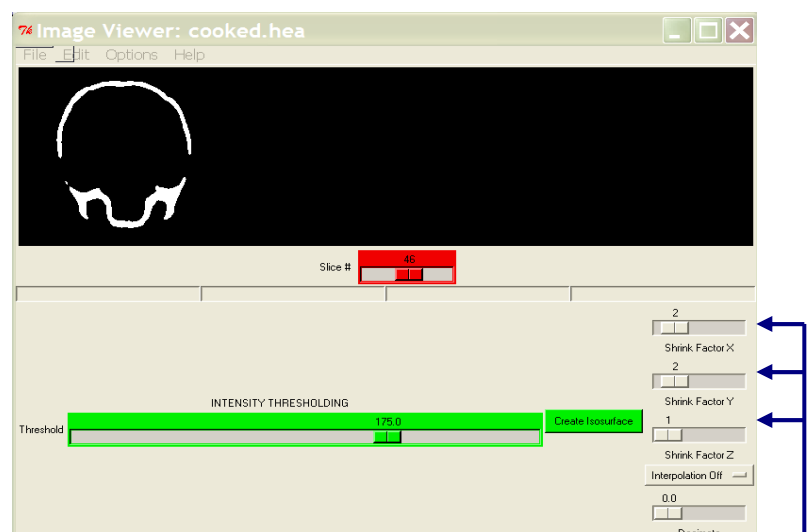
2a) Create a surface of the cranium of the child from the CT-scan used in Part 1 of the tutorial.

If you still have the “cooked.hea” CT-scan loaded in the Image Viewer on the screen (From Part 1 of the tutorial) you can use it for this part. Otherwise you need to start by loading this dataset.

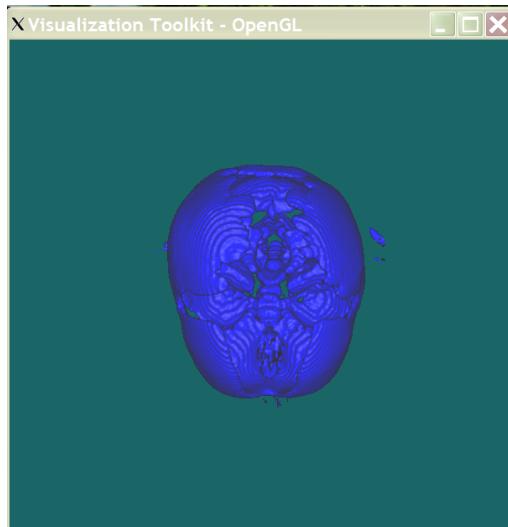
In the Image Viewer, select Options → Threshold/Isosurface

Select a threshold for bone (approx. 175) and inspect several slices to make sure you have the correct threshold value.

Press Create Isosurface and wait until the surface appears in the Surface Render Window.



You may reduce the resolution of your surface by setting Shrink Factors larger than 1 in x, y and/or z. Default is 2,2,1; (full resolution is obtained with 1,1,1).



To rotate surface: M1  
To zoom surface: M3  
To pan surface: M2

Try rotating and zooming the surface.

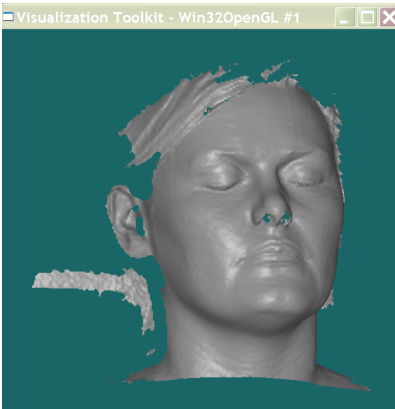
Inspect the polygons (triangles) this surface consists of by pressing “w” (for wireframe) (then wait) and zoom in on the surface to see the triangles. You can get a shaded surface back by pressing “s” (for solid).

You can obtain information on the number of polygons by Surface→Number of Cells/Points in the Main Landmarker Menu.  
How many vertices (points) does the surface consist of ?

Try different thresholds: change the threshold value, then press “Create Isosurface” again.

Close *landmarker* (File→Exit) when you are done.

**2b) Load a laser scan of a face** into landmarker:  
File→Load(New)→SurfaceFile and select the file face1.stl.



Try rotating and zooming the surface.  
Press keyboard 'w' to see wireframe.  
How many points are there in the model?  
Press keyboard 's' to get shading back.

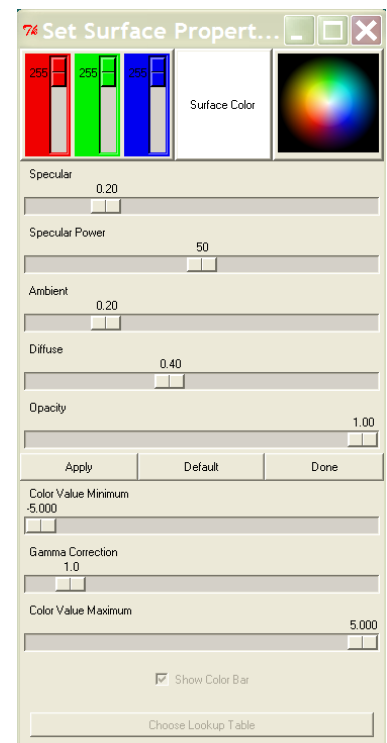
**Change the surface properties of the facial surface:**

Settings→SurfaceColor (if you can't find "Settings",  
try making the Main Menu wider)

Using the Set Surface Properties Menu,  
move sliders as to change the color and  
opacity (transparency) of the surface.

Press the "Apply" button to apply a new setting.

Press the "Default" button to get back to the original  
settings.

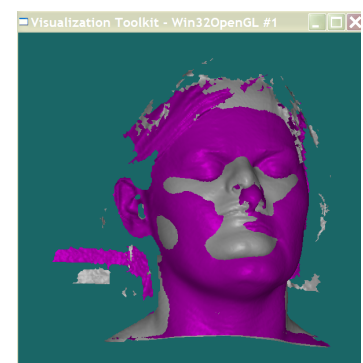


**Load an additional laser scan of a face:**

File→Load(Additional)→SurfaceFile and select  
the file named face2.stl.

The two laser scans are now displayed together.

Change the surface properties by using  
Settings→SurfaceColor



Show the two surfaces with two different colors.

Compare the two surfaces by fast flicking between them:

Surface→AnimateSurfaces.

You can change the animation speed by moving the “Set Time Delay” Slider in the “Surface Animation” menu.

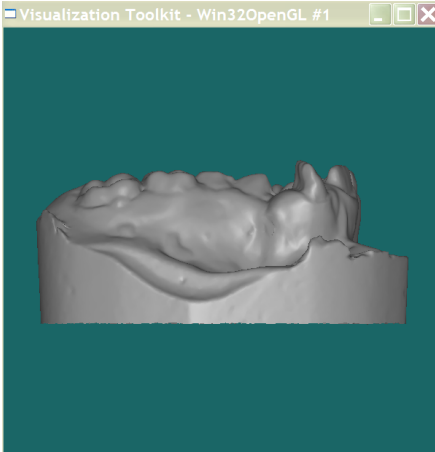
Try changing the animation speed.

Try rotating the surfaces while they animate.

Close *landmarker* (File→Exit) when you are done.

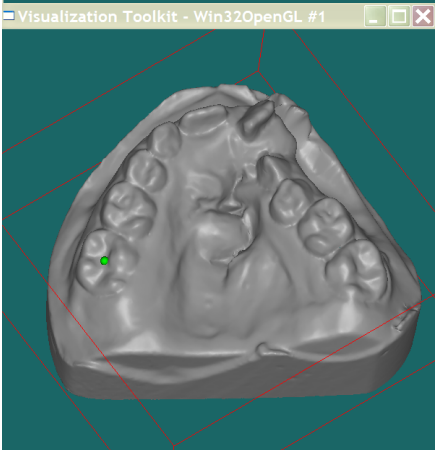
**2c) Load a laser scan of a dental cast into landmarker:**

File→Load(New)→SurfaceFile and select the file named adult.stl.



**Insert a 'landmark'** at some point of interest: e.g. at a tooth by clicking M1 at the wanted location and (briefly) pressing keyboard 'p' (for 'picking').

In the *landmarker* Main Menu Landmark #0 (the first landmark) has now changed status to "Set" and its 3-dimensional coordinates are displayed.

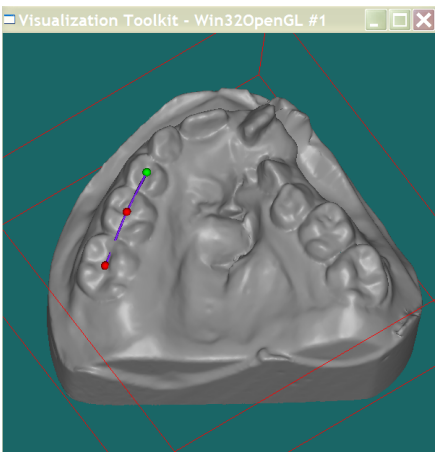
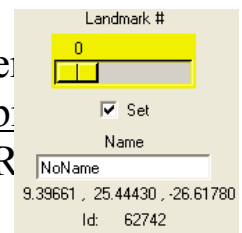


**Try moving the landmark**

by briefly pressing 'p' (do not keep the button down for a long time) at a slightly different location and see how the 3-dimensional coordinates change.

**Insert more landmarks:**

Move the "Landmark #" slider to the next landmark (#1) and press 'p' b again, e.g. at another tooth. Repeat for landmarks #2, 3 and 4.



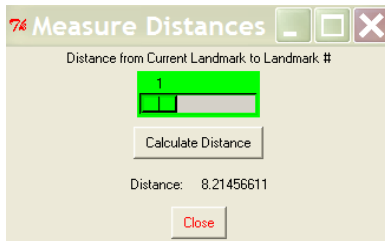
Display a curve through the landmarks:  
Options→ShowSpline



## Measure the distance between a pair of landmarks:

Measure → Distances

To calculate a distance, press the “Calculate Distance” button in the “Measure Distances” pop-up menu.



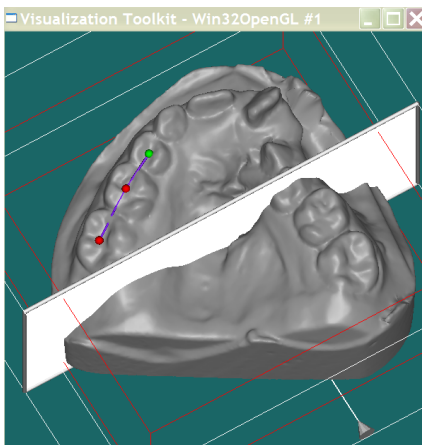
Distance is given in mm.

Calculate the distance between some different pairs of landmarks (the “Current Landmark” is the landmark indicated with green color.)

## Close the “Measure Distances” pop-up menu when done.

## Cut the surface using a clipping plane.

Edit → InsertClippingPlane

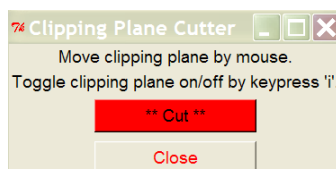


**Move the clipping plane:** point to the plane and keep M1 down while slowly dragging.

Notice how the plane “clips” the surface when you release M1.

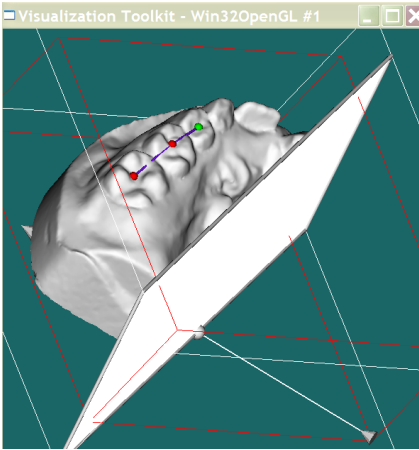
Try pressing keyboard ‘i’ repeatedly, toggling the clipping plane on and off.

**Tilt the clipping plane** by grabbing the head of the arrow connected to the clipping plane and move it slowly using M1.



**Cut the surface** by pressing the “\*\*Cut\*\*” button in the “Clipping Plane Cutter” pop-up menu (the red button).

Cutting will modify the surface permanently. Press keyboard ‘i’ to inspect your result.



Use the clipping plane repeatedly to cut out a (nearly) arbitrary section of the surface.

Can you cut out a single tooth surface?

Close *landmarker* (File→Exit) when you are done.

2d) Load a CT-scan surface into *landmarker*:

File→Load(New)→SurfaceFile and select the file named cleftsurf.stl.

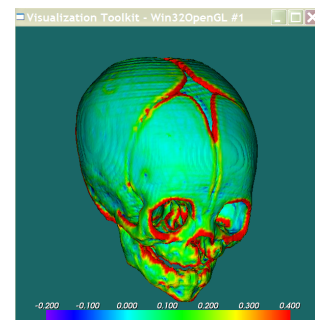
Load a color file:

File→Load(New)→Color(.clr)File and select the file named cleftsurf\_k1.clr.

(Please wait while colors are loading.)

Inspect the colored surface from various angles. These colors indicate surface curvature: high (red) values indicate ridge areas where the first principal surface curvature is high.

Try to change the range of the colors (Settings→SurfaceColors) using Color Value Minimum and Maximum sliders. (Try e.g. Color Value Maximum = 0.2)



Also try another color table (press the “Choose Lookup Table” button, select a table name and press “Apply”).

Close *landmarker* (File→Exit) when you are done.