

# Introduction to 3D imaging

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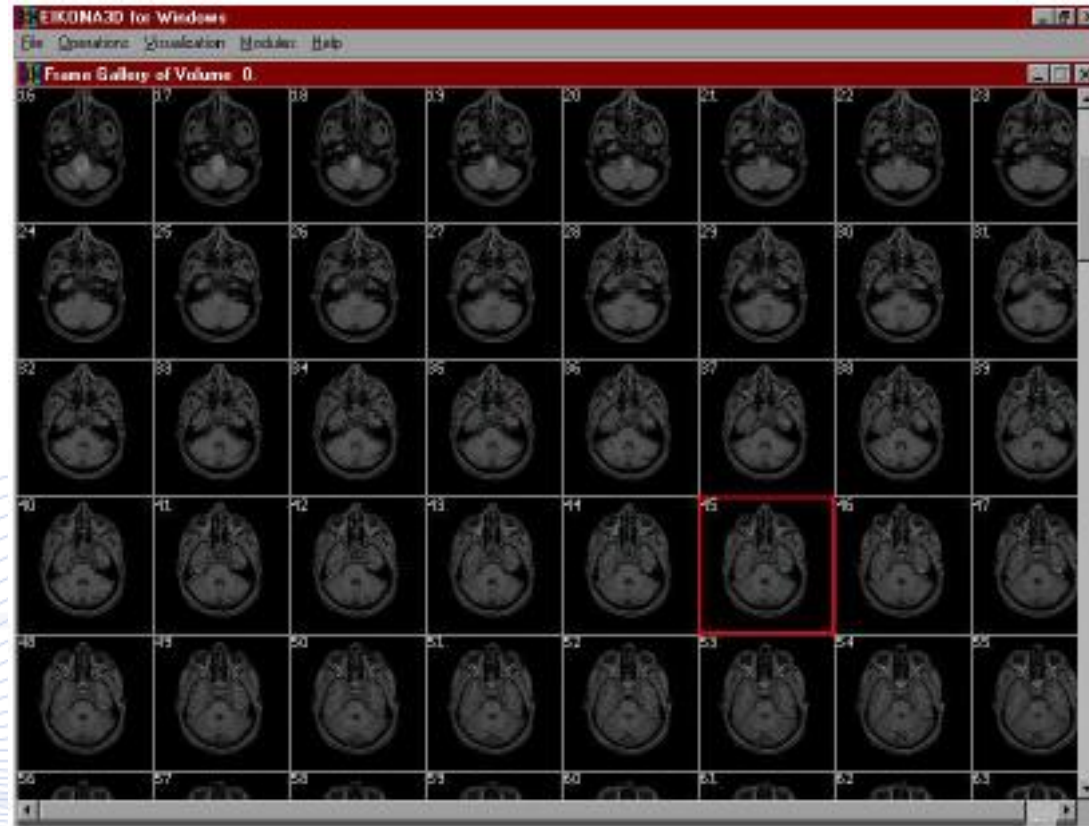
# 3D Imaging Overview

- Volumetric images, 3D points clouds, 3D surfaces
- Medical image acquisition
- 3D Image and Video Quality
- 3D Data Processing
- 3D Image and Shape Compression
- 3D Video Coding And Broadcasting
- 3D Image and Video Analysis
- Image/volume registration
- Image Rendering and View Synthesis
- 3D Video Content Description
- 3D Display Technologies

# 3D data types: volumetric images

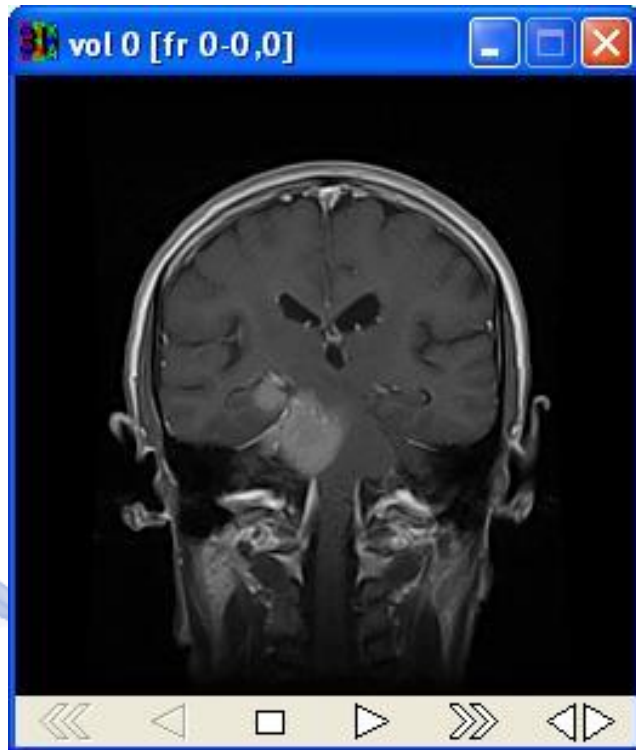
- *3D volumetric images*: 3D signals of the form  $f(x, y, z): \mathbb{R}^3 \rightarrow \mathbb{R}$ .
- Discrete versions (defined on a Euclidean grid  $\mathbb{Z}^3$ ) :  
 $f(n_1, n_2, n_3): \mathbb{Z}^3 \rightarrow \mathbb{R}$ .
  - $x = n_1 \Delta x, y = n_2 \Delta y, z = n_3 \Delta z$
  - $\Delta x, \Delta y, \Delta z$ : *spatial sampling intervals* defining 3D image resolution
  - each *voxel* is a real number.

# 3D data types : volumetric images



Horizontal head cross sections.

# 3D data types : volumetric images



Vertical head cross section: a) BW, b) pseudocolored.

# 3D data types : volumetric images



Three orthogonal head cross sections.

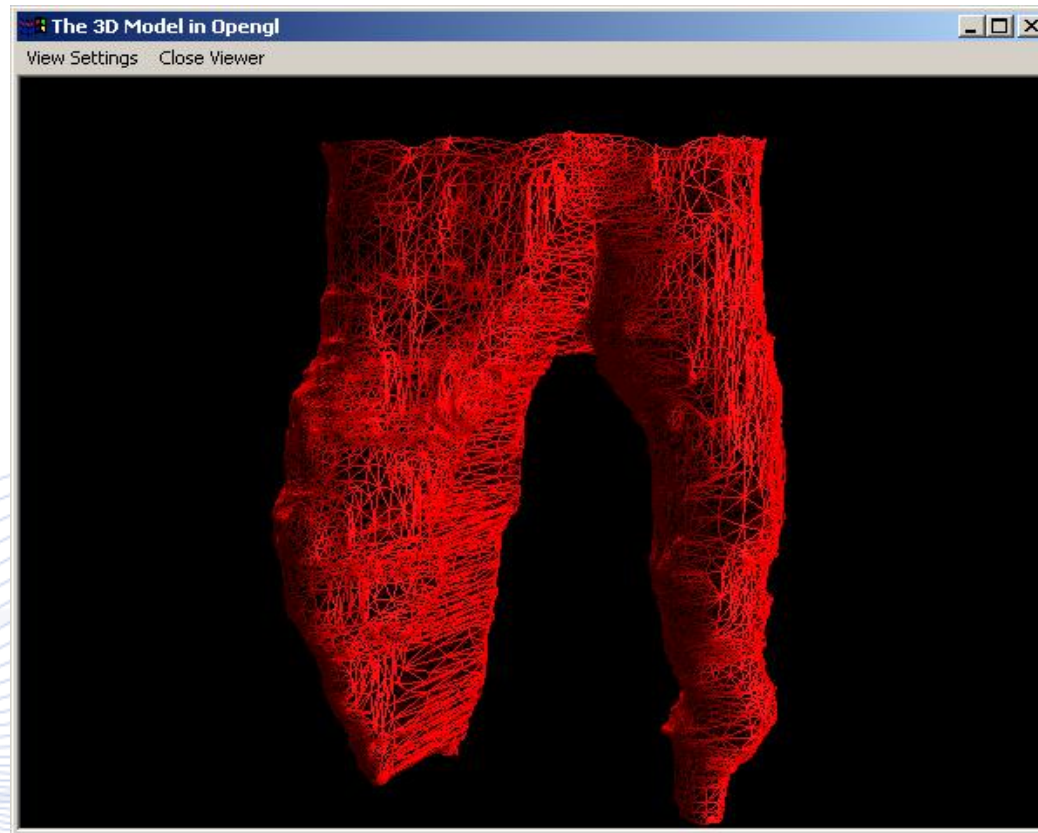
# 3D data types: 3D surface images

- *3D surface images*: 3D signals defined on a 3D surface:

$$f(x, y, z): \mathcal{S} \rightarrow \mathbb{R}, \quad \mathcal{S} \in \mathbb{R}^3.$$

- Google earth images.
- Discrete versions:
  - Triangular or polygonal surface meshes
  - 3D image texture on 3D surfaces

# 3D data types: 3D surface images



Triangular tooth surface mesh .



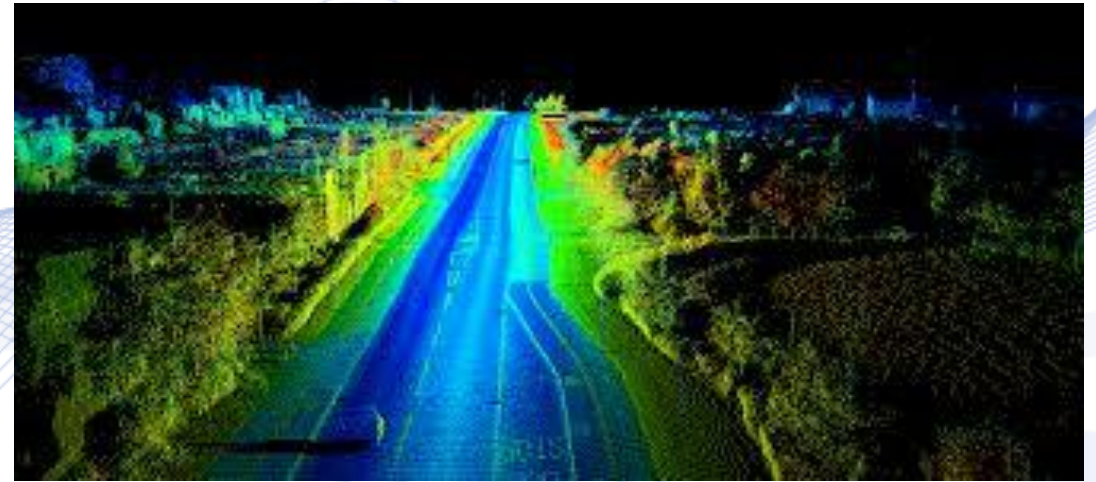
# 3D data types: 3D surface images



Head bone surface rendering (no texture).

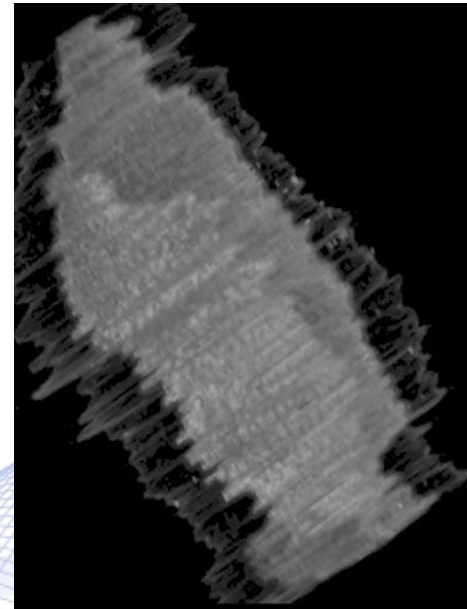
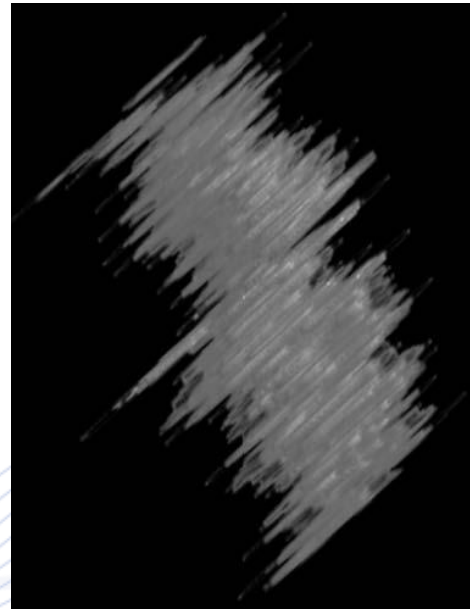
# 3D data types: 3D point clouds

- *3D point clouds*: 3D points typically belonging to 3D surface:  
 $[X_i, Y_i, Z_i] \in \mathbb{R}^3, i = 1, \dots, N.$
- Typically acquired by LIDAR.
- 3D road scenes.



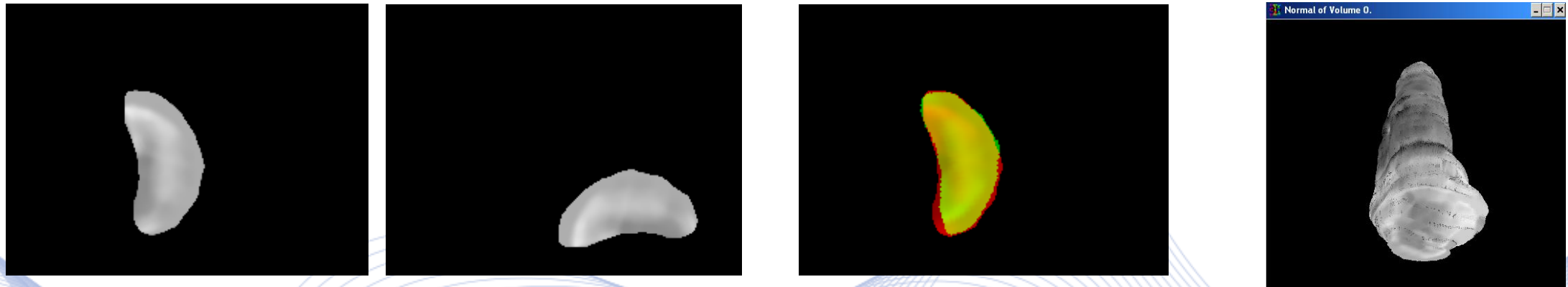
3D road scene [GEO].

# 3D image registration



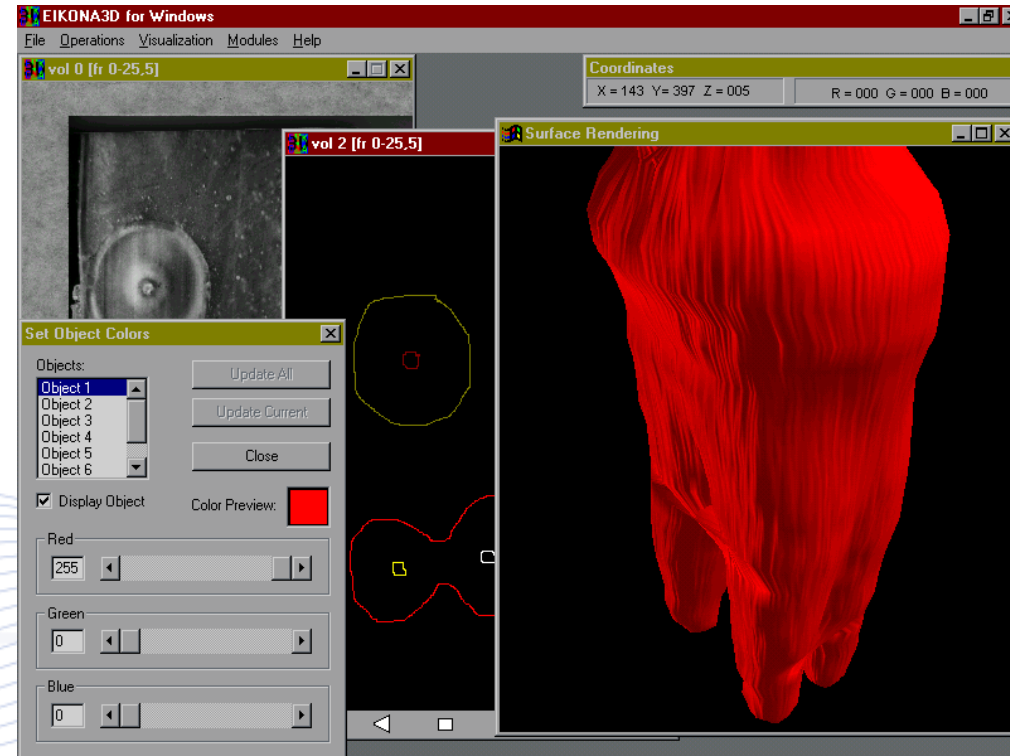
a) Misaligned b) aligned tooth volume.

# 3D image registration



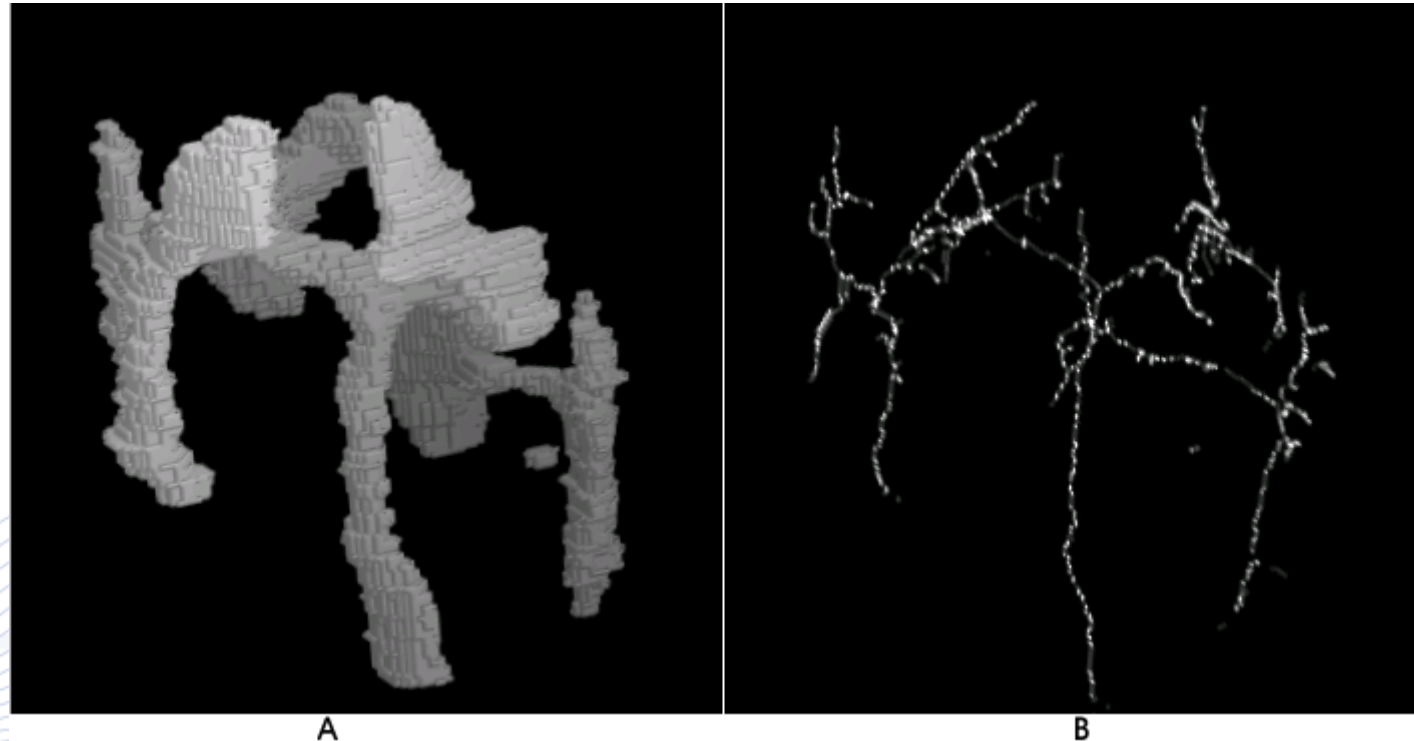
a-b) 3D volumes to be registered, c) registered volume, d) tooth volume.

# 3D surface rendering



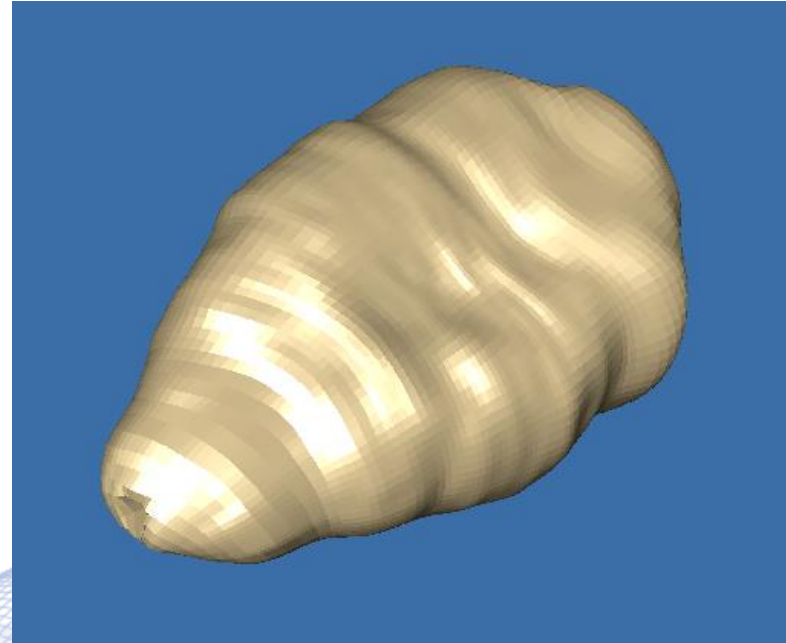
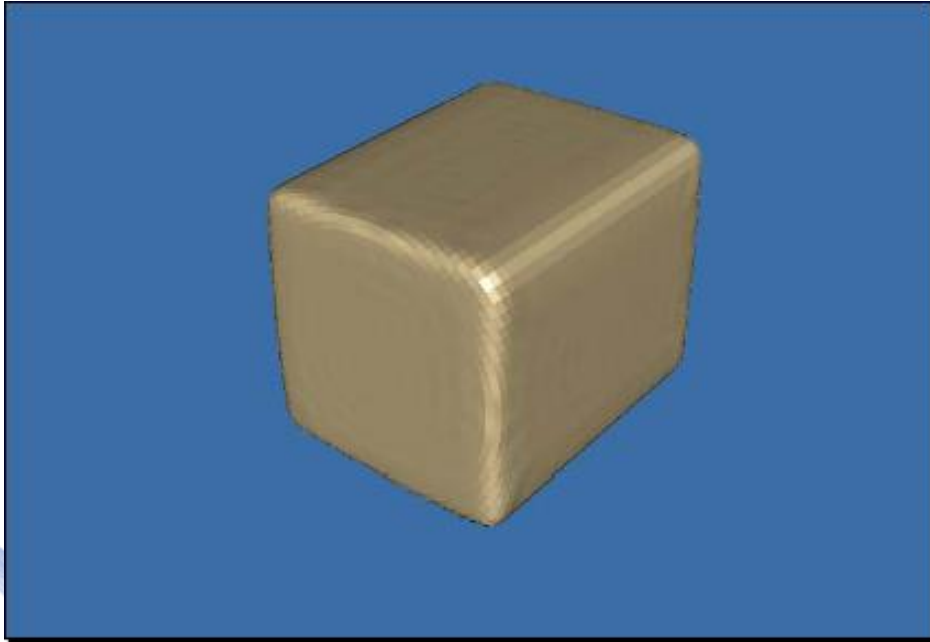
Tooth a) cross-sections, b) contour, c) surface rendering.

# 3D shape analysis



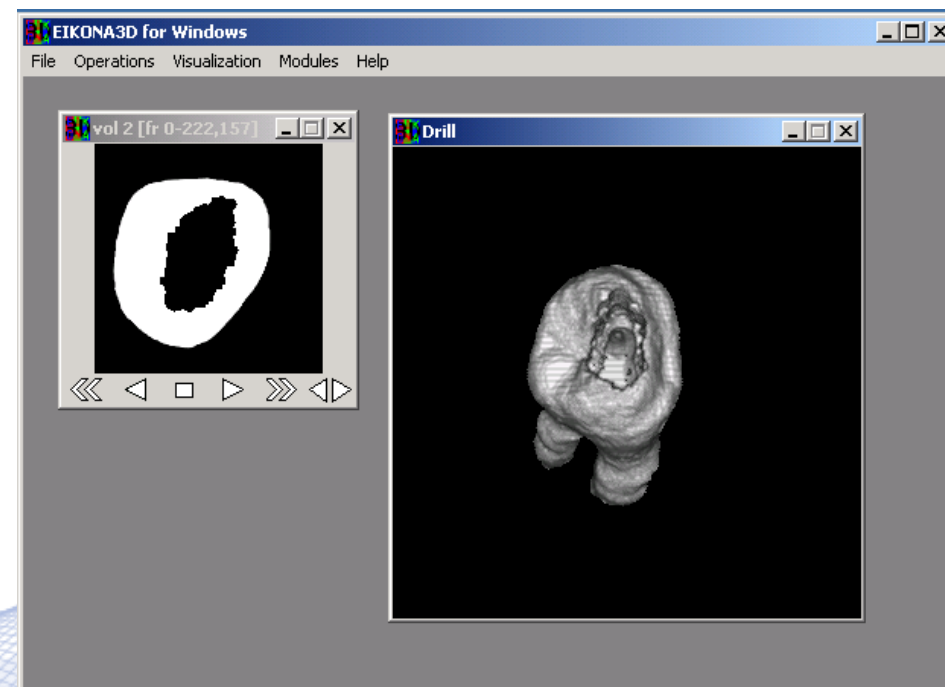
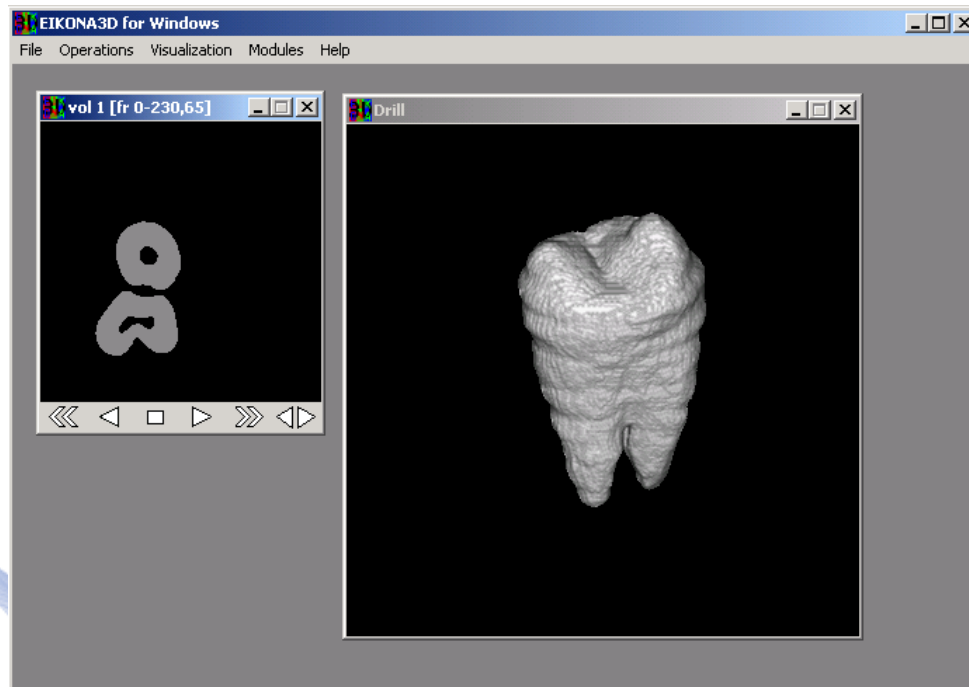
a) 3D rendering of pulmonary airway tree b) its skeleton.

# 3D surface models



VRML surface models.

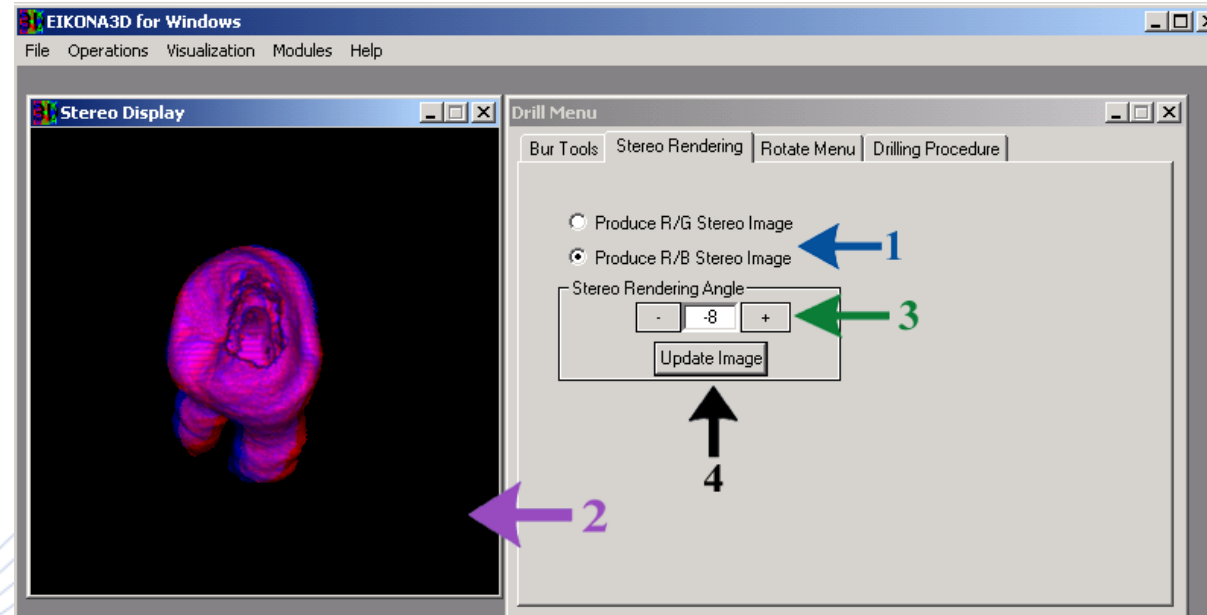
# Virtual medicine/dentistry



Virtual tooth drilling.



# Stereo image display



Stereo display of a drilled tooth.

# Bibliography

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# Q & A

**Thank you very much for your attention!**

**More material in  
<http://icarus.csd.auth.gr/cvml-web-lecture-series/>**

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