フルカラー生体画像を元にした 6面体有限要素メッシュ作成

REALISTIC METHOD FOR GENERATING A HEXAHEDRAL FEM MESH FROM BIOLOGICAL SOFT TISSUE

平田忍 Shinobu HIRATA

横田秀夫 Hideo YOKOTA

中村佐紀子 Sakiko NAKAMURA

牧野内昭武 Akitake MAKINOUCHI

Back Ground

We are studying to develop the detached retinas operation simulator of the eyeball which is using finite element method (FEM) analysis.

Now : CAD Model

Create the finite element mesh of eyeball which shows detail shape of eyeball.

FEM Program is using
Hexahedral Mesh Data

Hexahedral FEM Mesh Made of Real Image

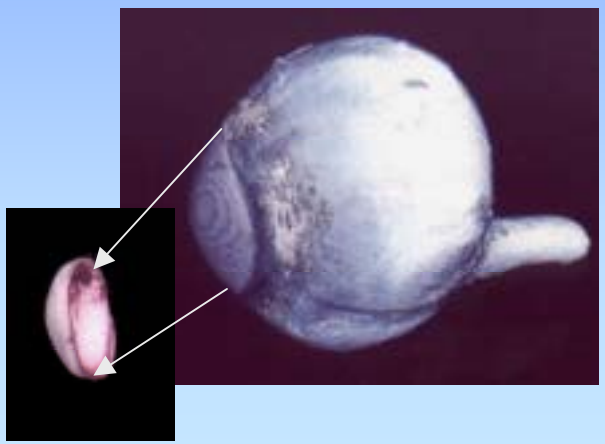
Purpose

Full-Colered Cross Sectional images of Eyeball

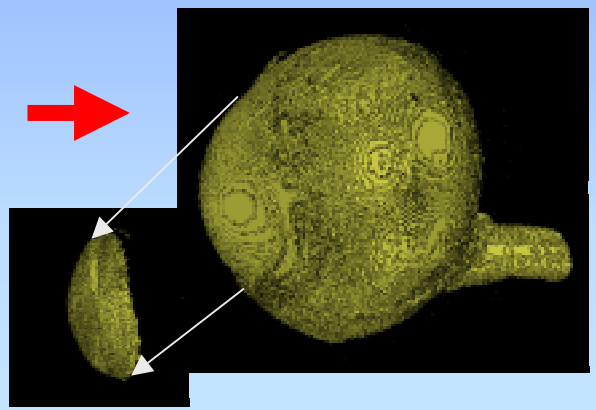
↓

Numerical Mesh Data

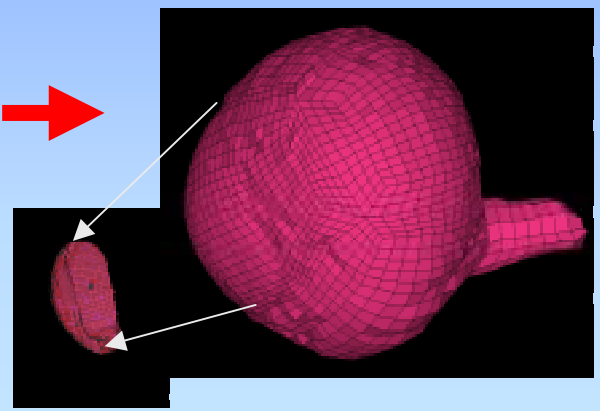
Create Multiple Part Mesh Create by Using One Volume Data



Voxel Data

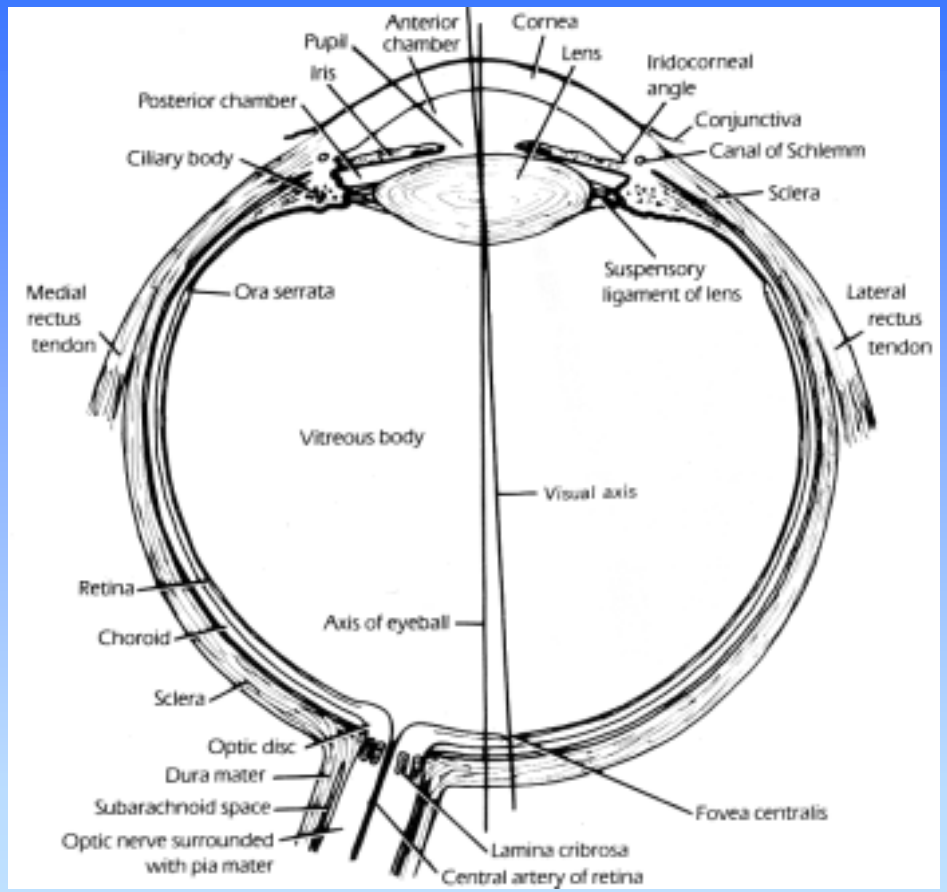


Polygon Data



Hexahedral FEM Mesh

Eyeball



Lens: Thickness 4mm

Diameter 10mm

Cornea: Front 1/6 part

Diameter about 11mm

Thickness 0.5~1.2mm

Sclera: Thickness 0.3~1mm

Choroid: Thickness 0.1~0.22mm

Retina: Thickness 0.1~0.56mm

All Length : about 30mm

Front : Radius of Curvature about 8mm

Back : Radius of Curvature about 12mm

Cross-Sectional Images

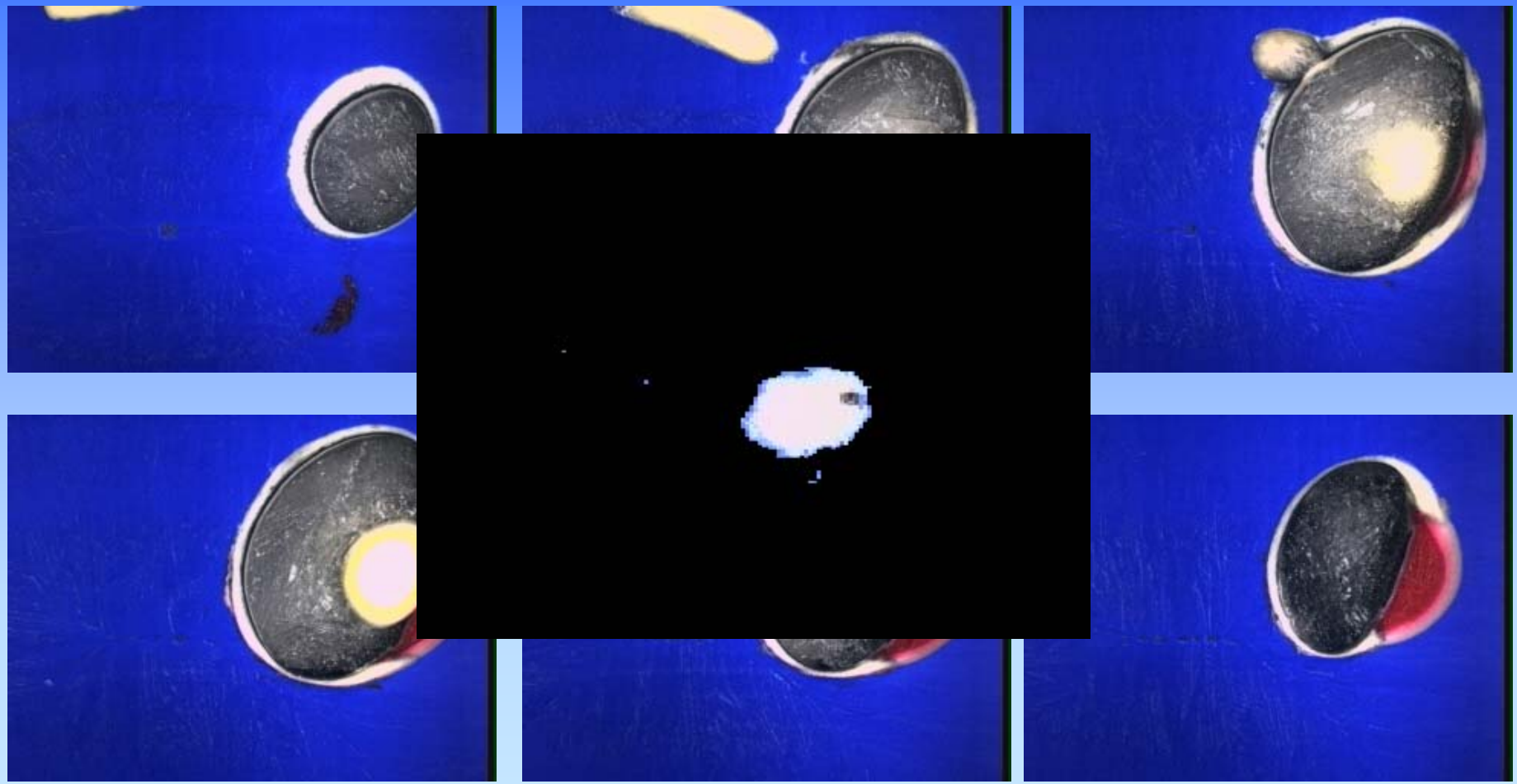
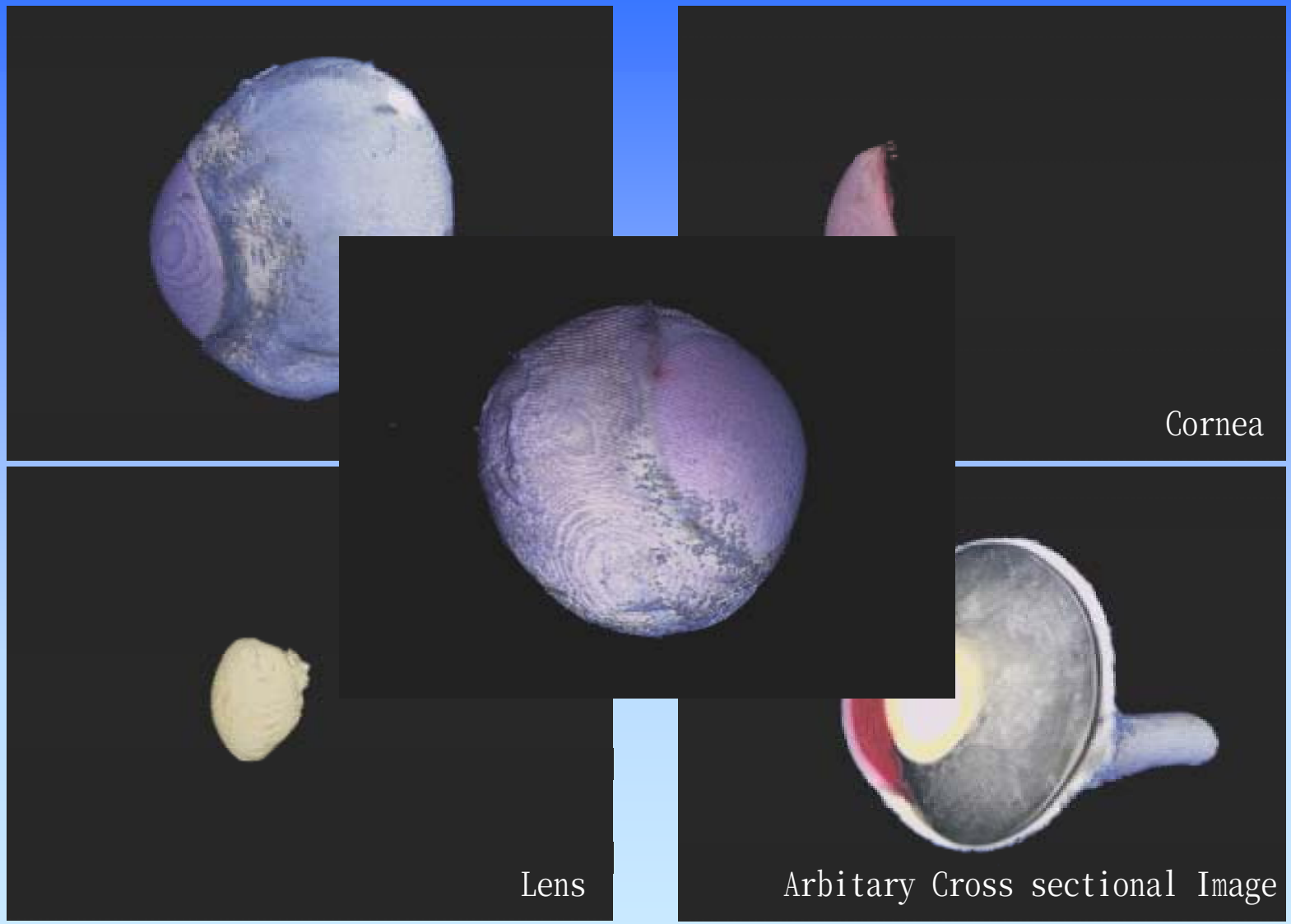


Image Size X:Y:Z 172×182×269

3D Image of Eye



Flow Chart

– Create STL Data –

Segmented Volume Data (X:Y:Z 172×182×269) is read in AVS

↓ Time : about 2-min.

Surface information of Volume Data Output by STL

↓ Time : about 5-sec.

– Create Mapped Mesh –

STL Data is read in ICEMCD

↓ Time : about 3-min.

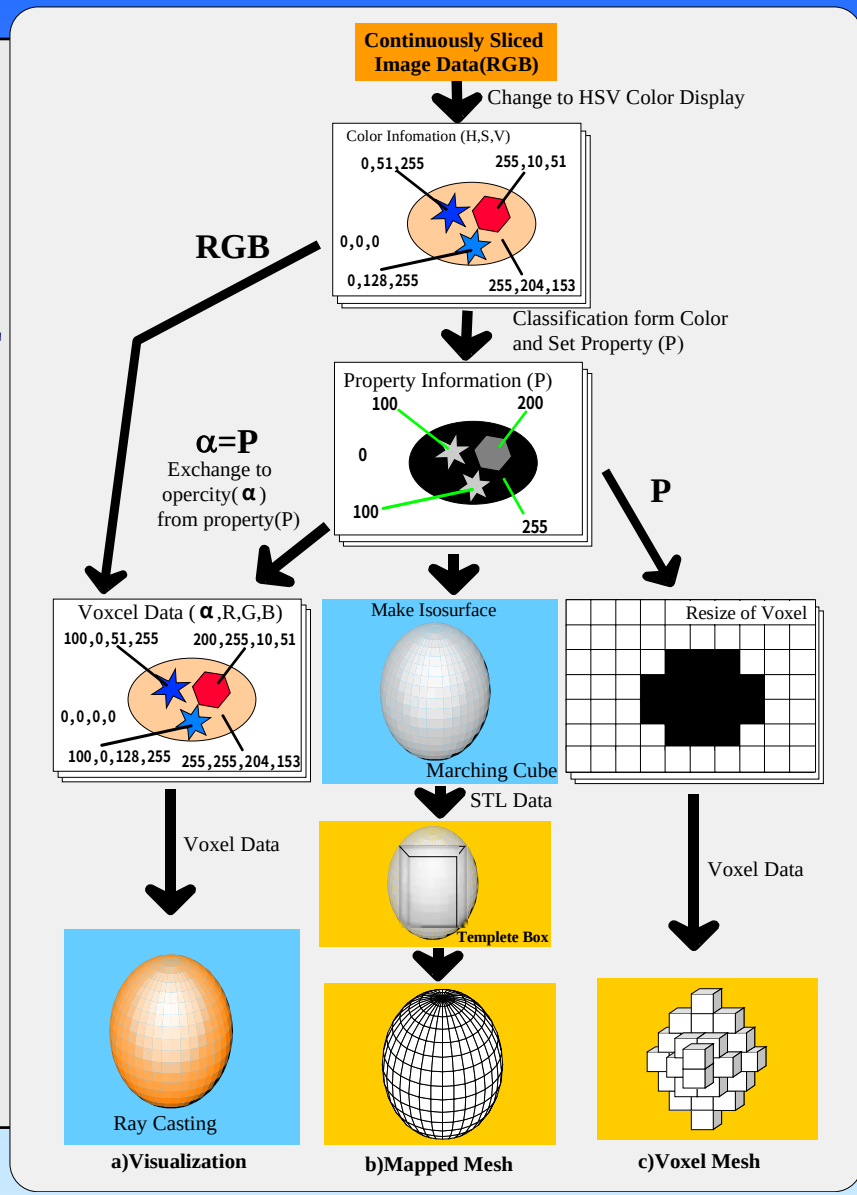
Create Global Block

↓ Time：about 20-min.

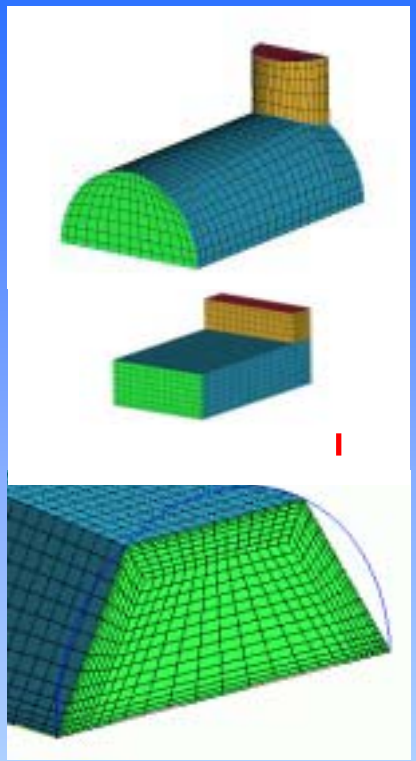
Projected Face to Global Block

↓ Time : about 1-min.

Total Time：about 27 minutes



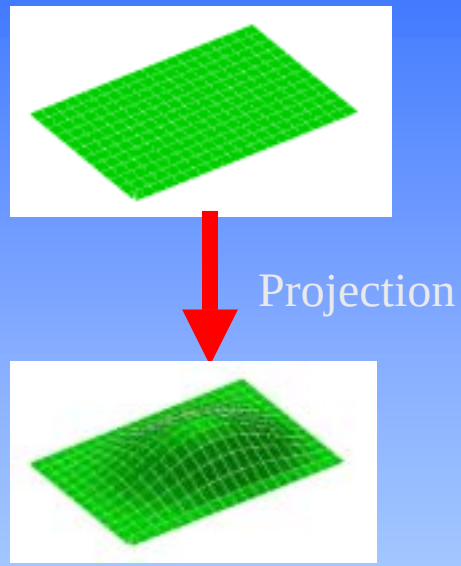
Mapped Mesh Method



Form Data

Global Block

Projected Mesh



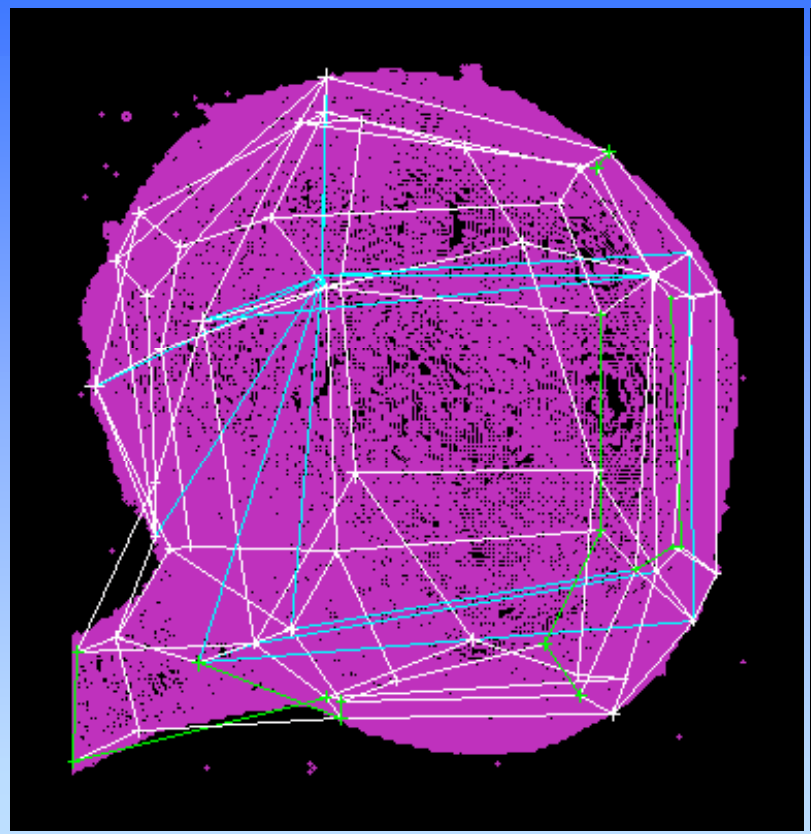
Semi-auto hexahedral mesh can created.

Global block can use similar form data.

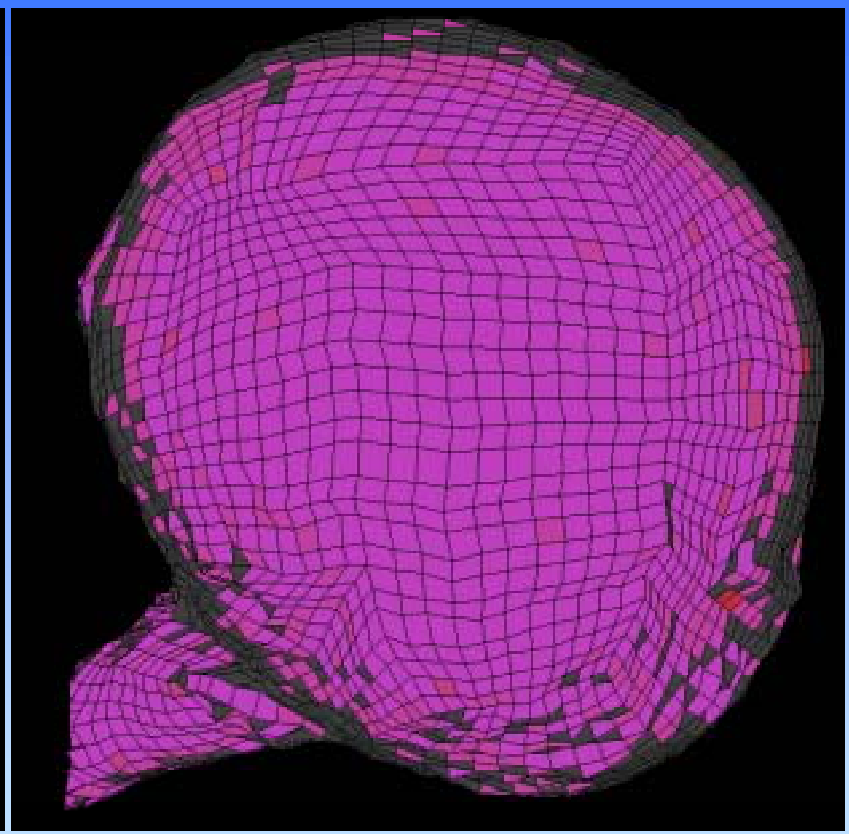
Layer structure mesh can created.

Contact Point of Organization is Connected Each Part.

Global Block Based on Hexahedral Mesh

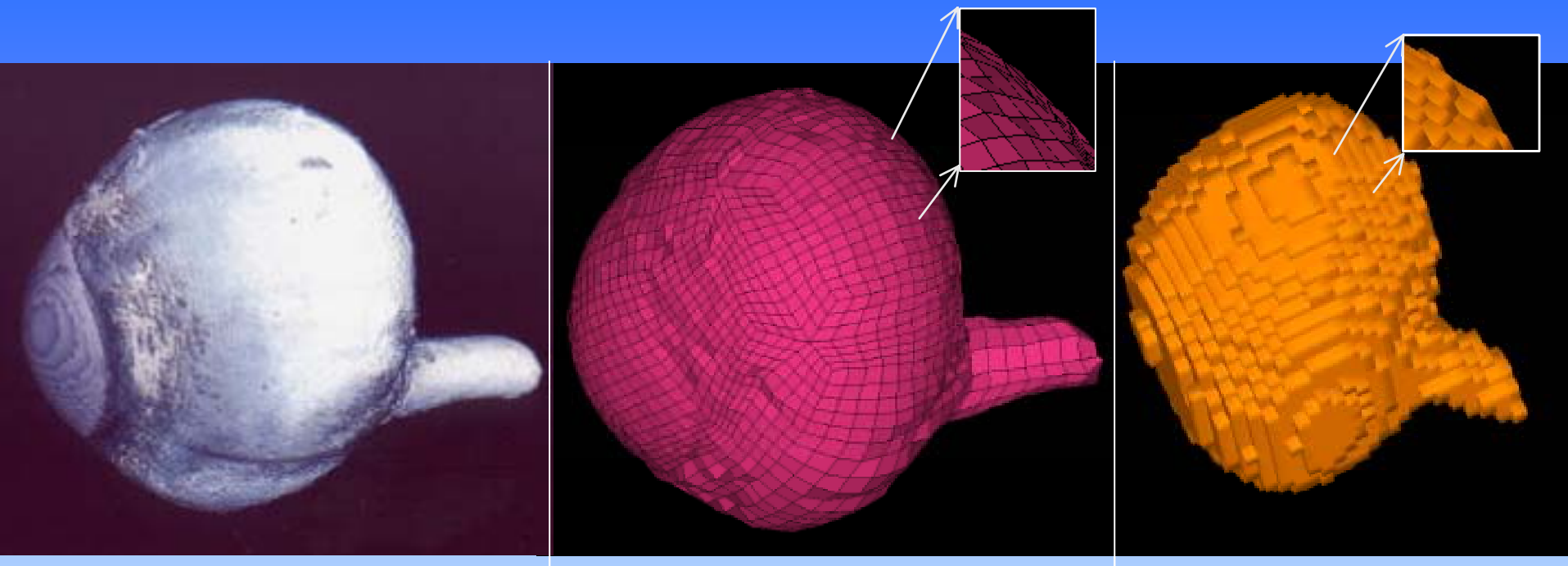


Global Block



Mesh

Mesh (Whole eye)



Volume Rendering

8,420,776 Voxels

Mapped Mesh

14,926 Elements

↑

1,912,512 Triangles

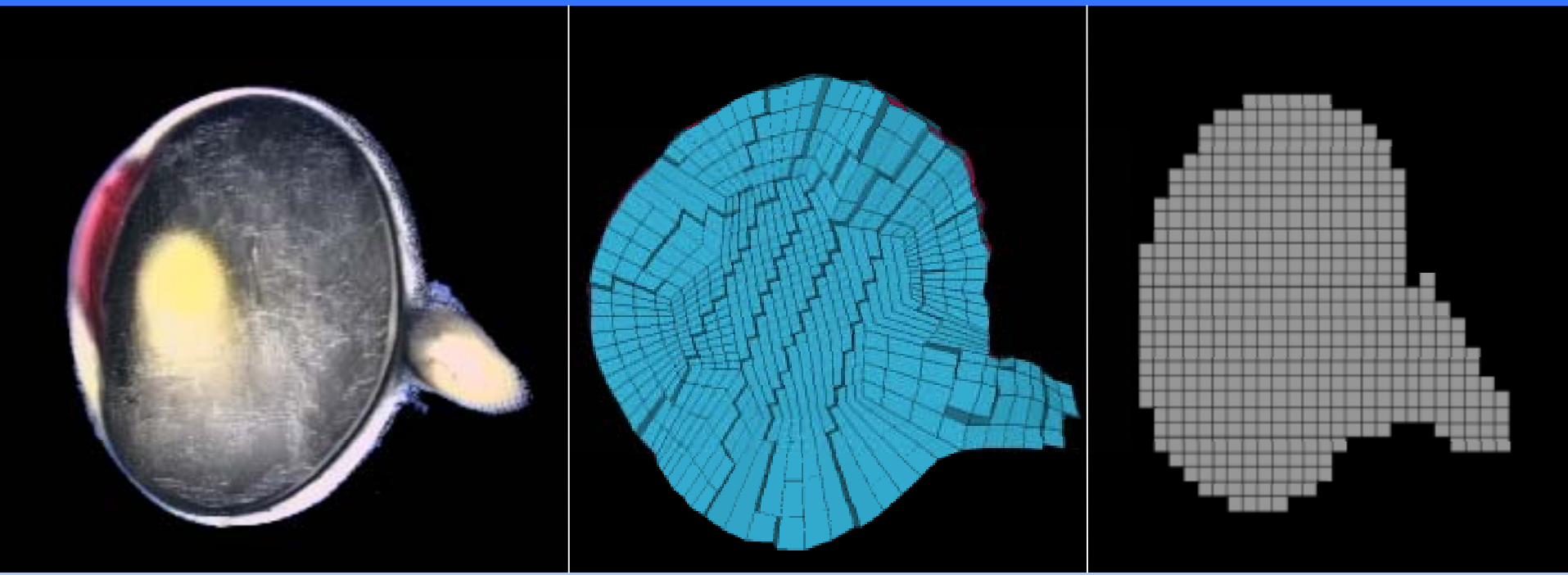
Voxel Mesh

14,296 Elements

↑

8,420,776 Voxels

Cross-sectional images (Whole eye)



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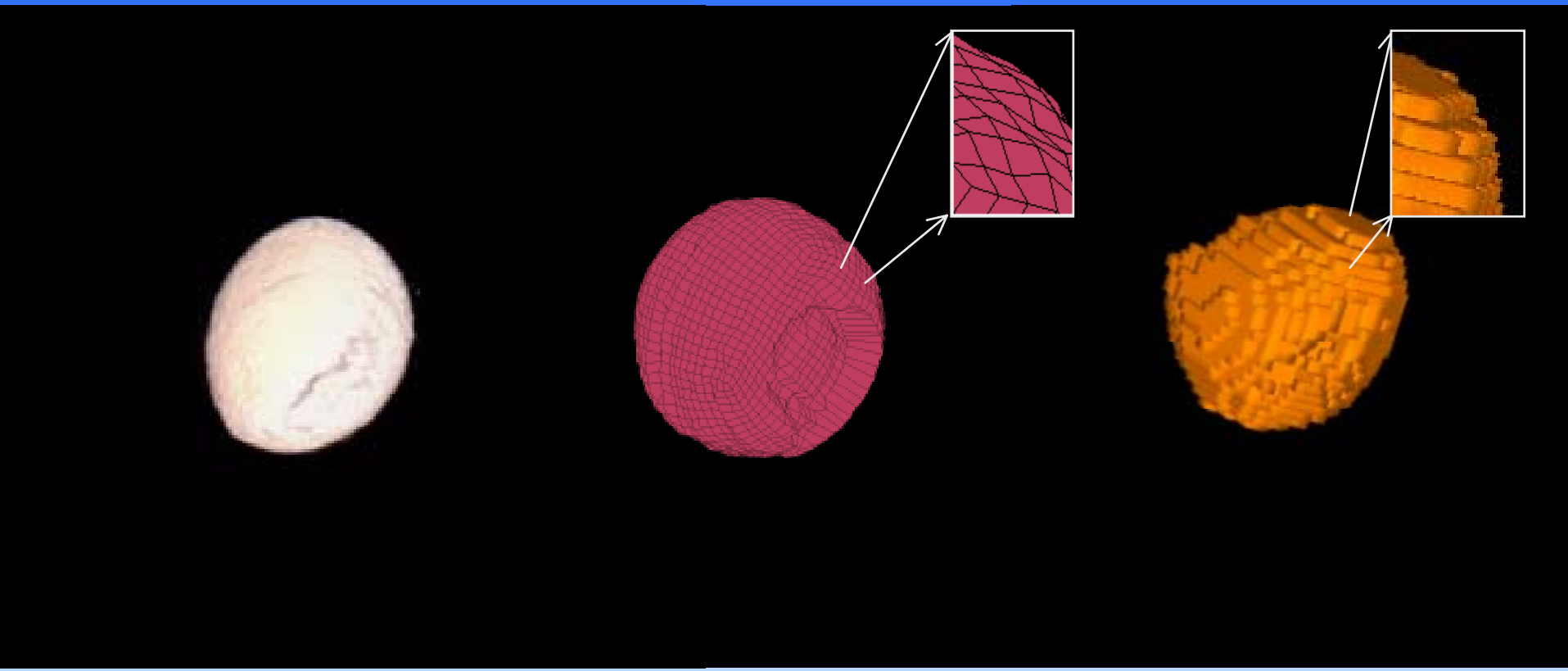
8,420,776 Voxels

Mesh (Lens)



Volume Rendering

8,420,776 Voxels

Mapped Mesh

4,860 Elements

↑

198,522 Triangles

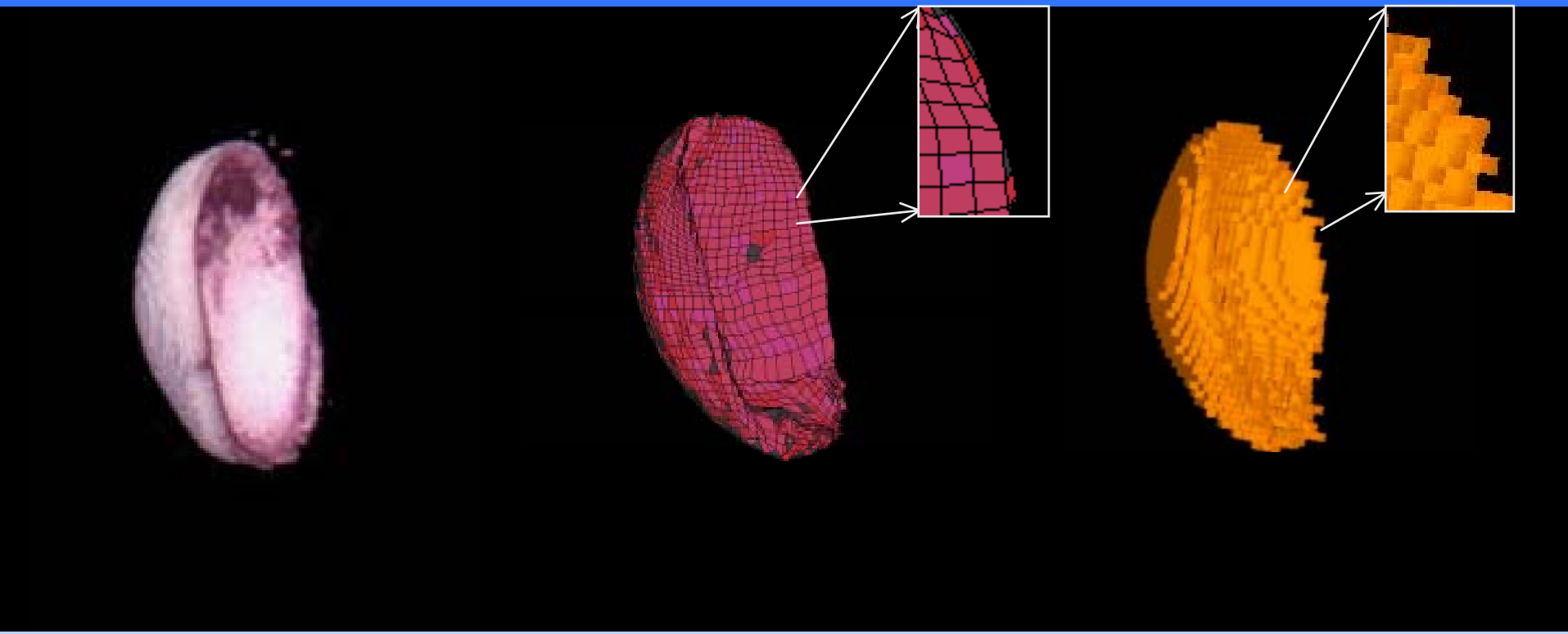
Voxel Mesh

5,196 Elements

↑

8,420,776 Voxels

Mesh (Cornea)



Volume Rendering

8,420,776 Voxcel

Mapped Mesh

5,013 Element

↑

531,184 Triangles

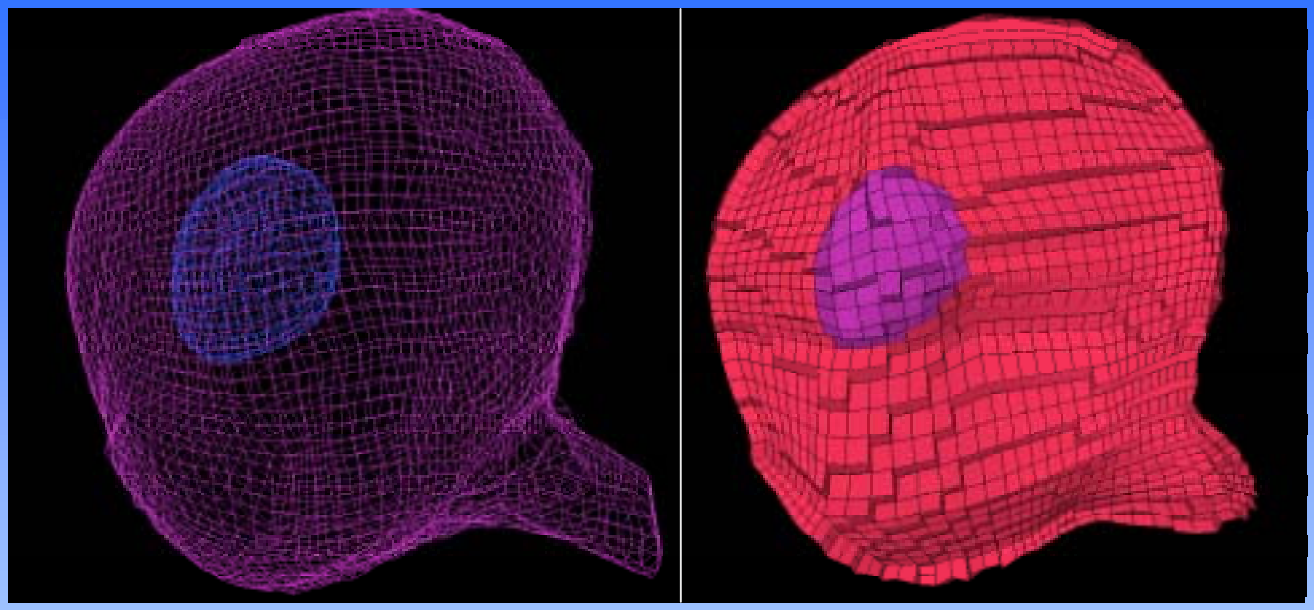
Voxcel Mesh

5,021 Element

↑

8,420,776 Voxcel

Multiple Part Mesh



Lens
512 Elements

All
31,694 Elements

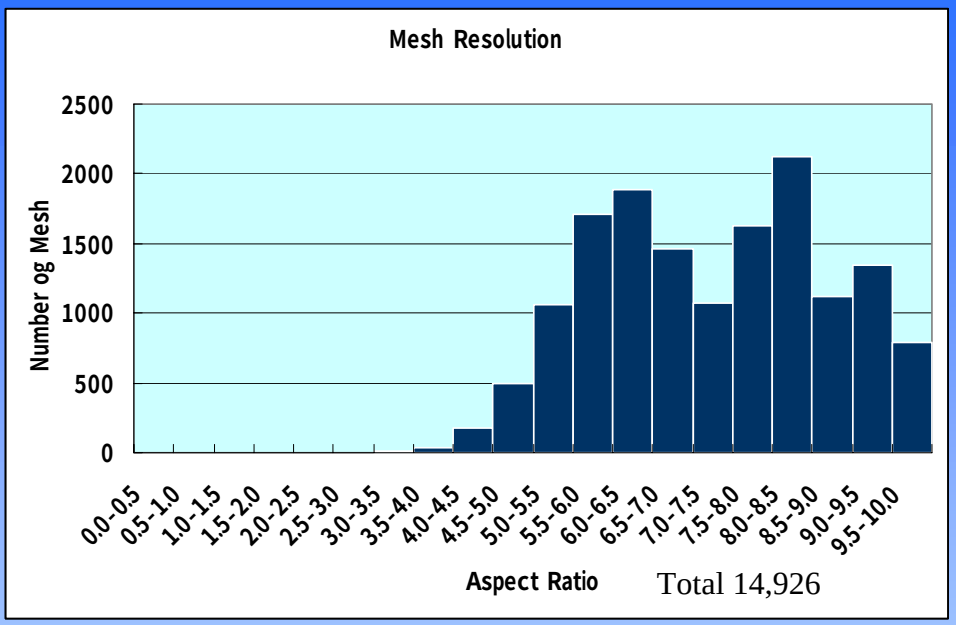
Lens in Whole Eye

Cross Sectional Image

The lens featured in the whole eye.

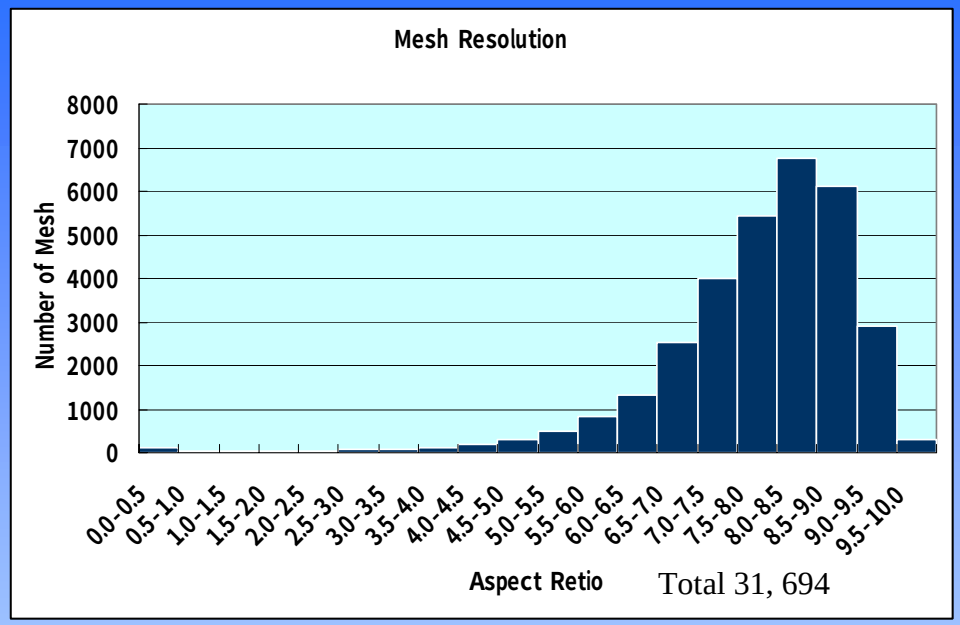
The lens and whole eye part of tissue boundary are connected.

Mesh Resolution



Total 14,926

Whole Eye



Total 31, 694

Lens in Whole Eye

Summary

We studied the generation of a hexahedral mesh from continuous sectional images that have full-color information.

The mapped mesh method applied to data defining a small number of elements created a shape resembling the real image.

The mapped mesh data’s all the element points of contact are connected and also the tissue boundary element points of contact are connected.

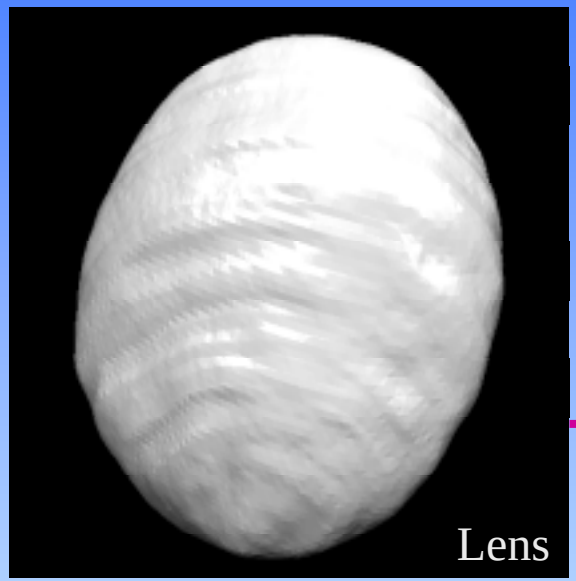
Future Work

Mesh Will Create by Multiple parts of Eye. → Segmented of Eyeball Surface the Sclera, Choroid, and Ratina

Mesh Resolution Will Be Improved → Using Analysis

Interpolate Data of Complex Shape → Polygon Data Interpolation

Future Work : Reduction



18,662 polygon

2,000 polygon

Original

Polygon Reduction

Smoothing