

フルカラー生体画像を用いた
6面体有限要素メッシュ作成手法の検討

STUDY OF GENERATING A HEXAHEDRAL FEM MESH
FROM FULL-COLORED BIOLOGICAL IMAGES

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Back Ground

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

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-Colored Cross Sectional images of Eyeball

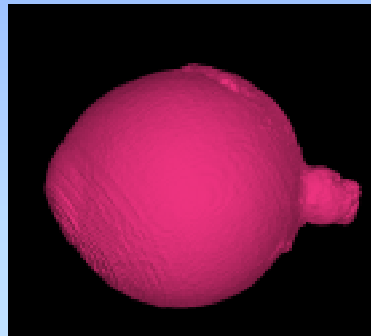
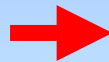


Numerical Mesh Data

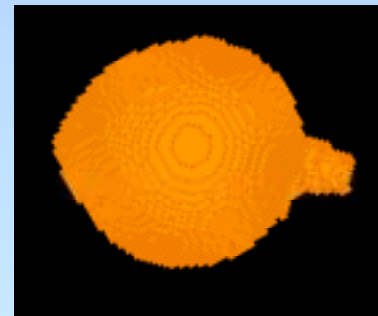
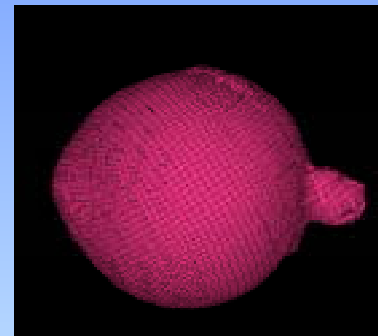
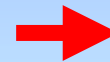
Create Multiple Part Mesh Create by Using One Volume Data



Voxel Data

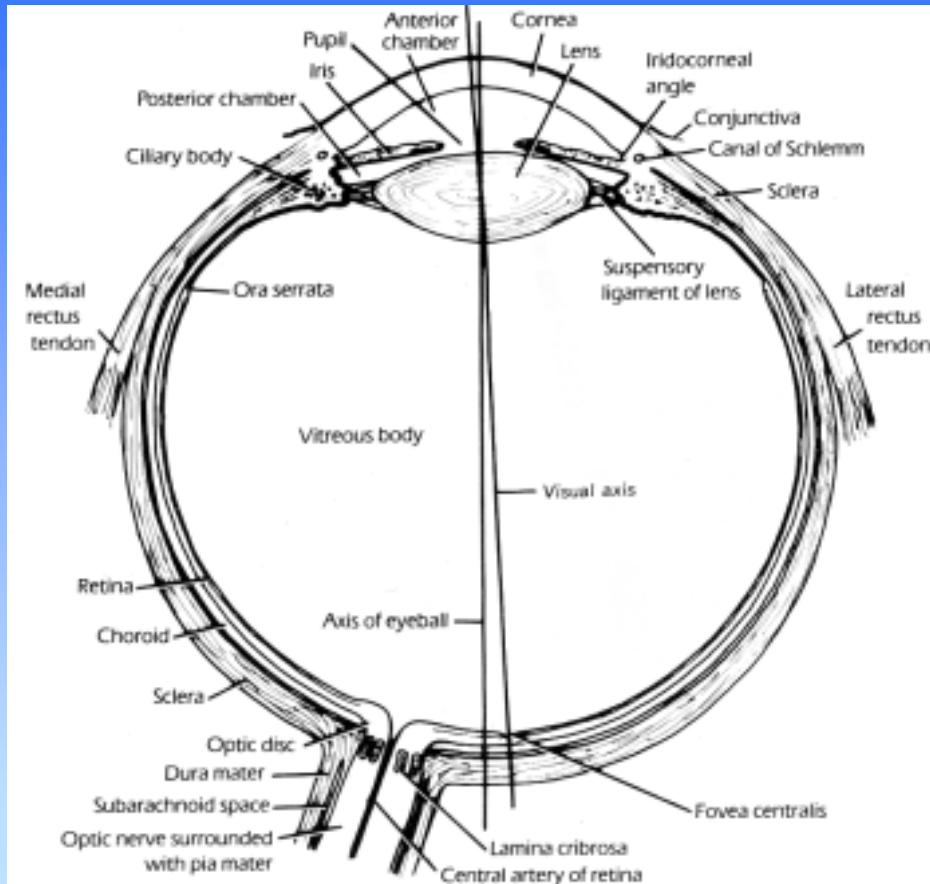


Polygon Data



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

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** - - **Create Voxel Mesh** -
 STL Data is read
 in ICEMCFD in VOXELCON

Time : about 3 min.

Create Template Box

Create Voxel

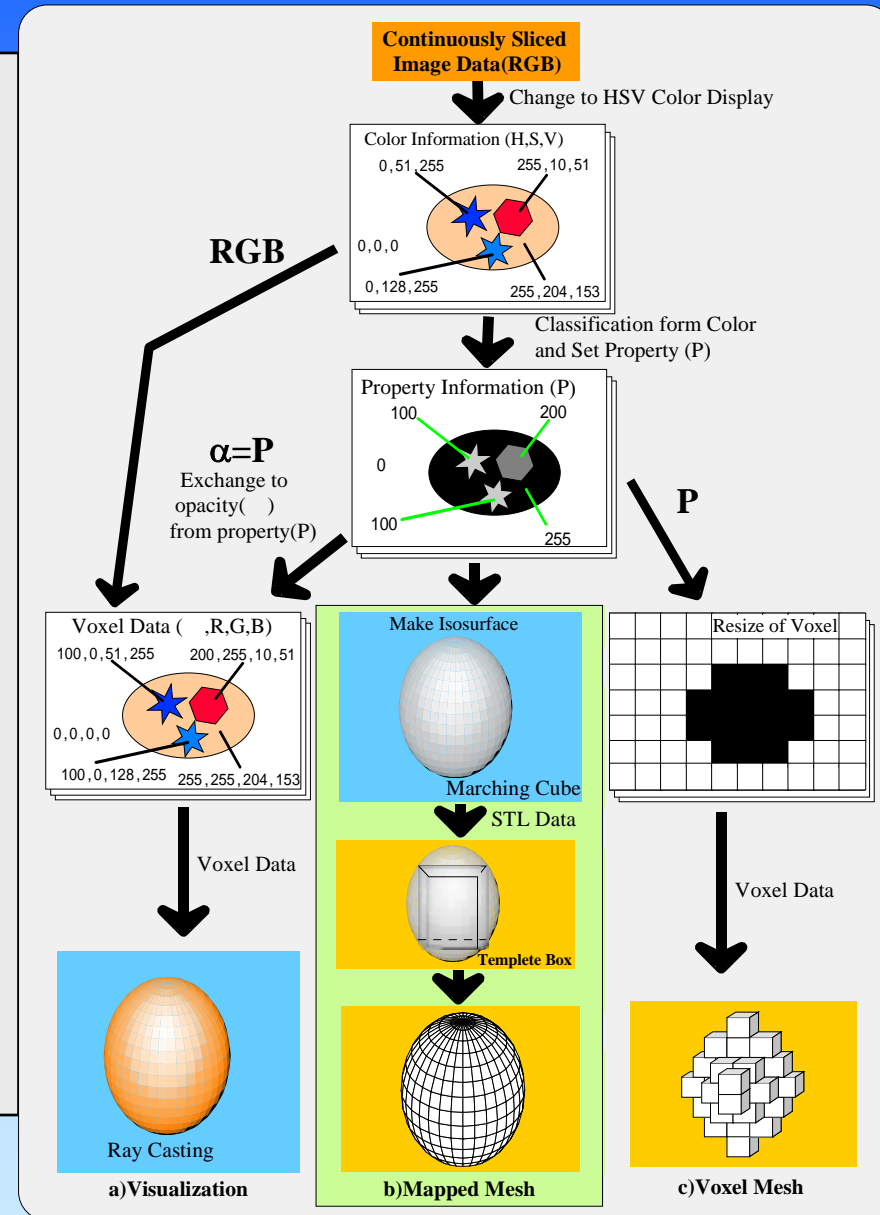
Time : about 20 min.

about 1 min.

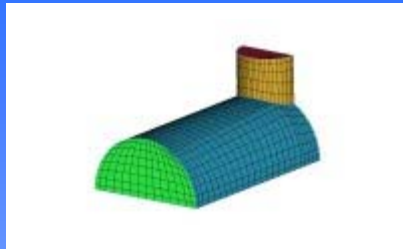
Projected Face to Global Block

Time : about 1 min.

Total Time : about 27 minutes about 4 minutes



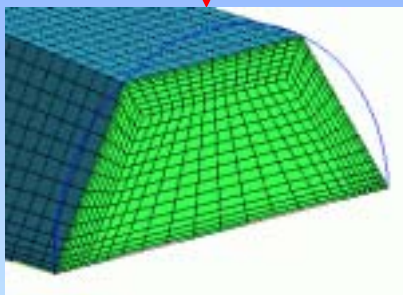
Mapped Mesh Method



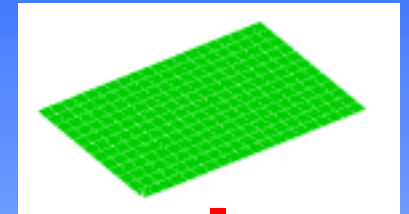
Form Data



Global Block



Projected Mesh



Projection



It Can Create Semi-Auto Hexahedral Mesh.

Global Block Can Use Similar Form Data.

It Can Create Layer Structure's Mesh.

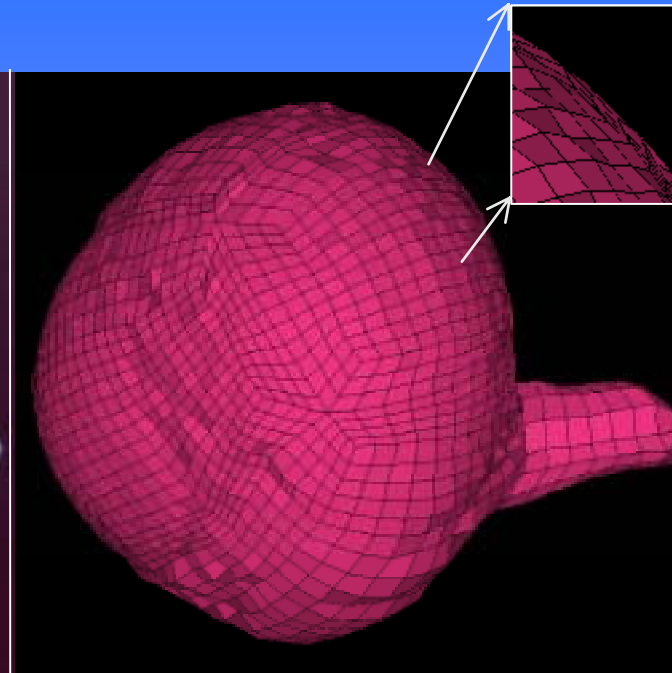
Contact Point of Organization is Connected Each Part.

Mesh (Whole eye)



Volume Rendering

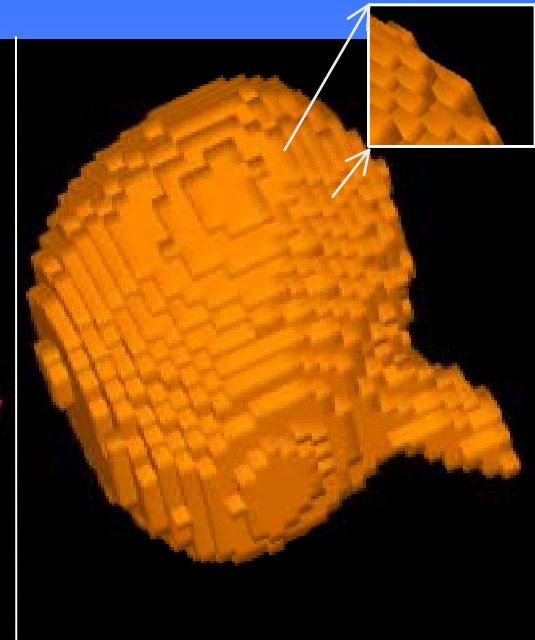
8420776 Voxels



Mapped Mesh

14,926 Elements

1912512 Triangles



Voxel Mesh

14,296 Elements

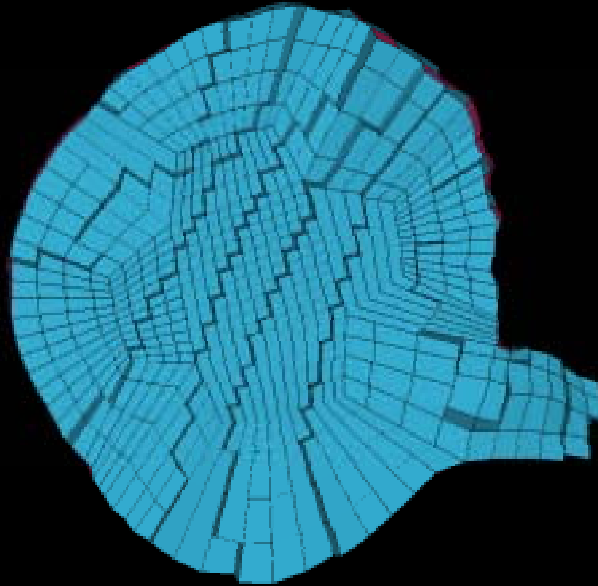
8420776 Voxels

Cross-sectional images (Whole eye)



Volume Rendering

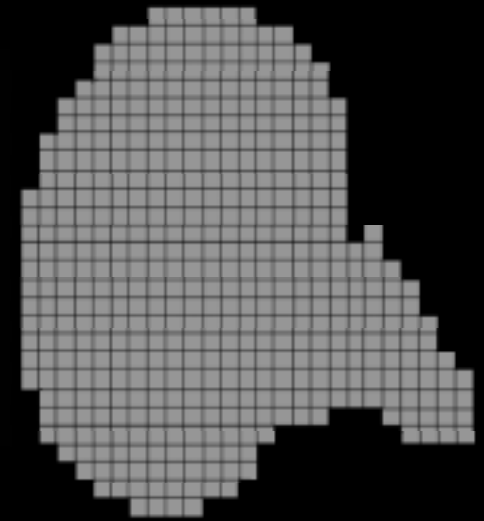
8420776 Voxels



Mapped Mesh

14,926 Elements

1912512 Triangles



Voxel Mesh

14,296 Elements

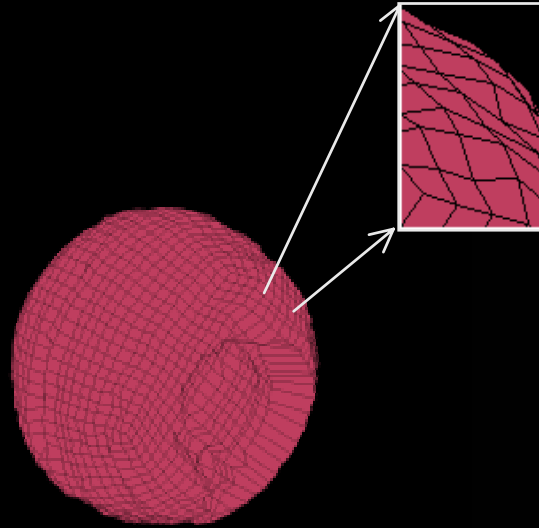
8420776 Voxels

Mesh (Lens)



Volume Rendering

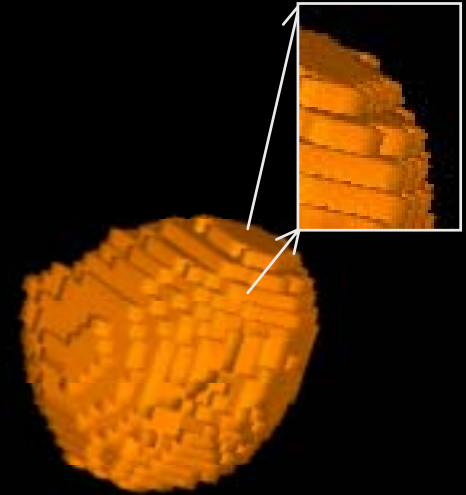
8420776 Voxels



Mapped Mesh

4,860 Elements

198522 Triangles



Voxel Mesh

5,196 Elements

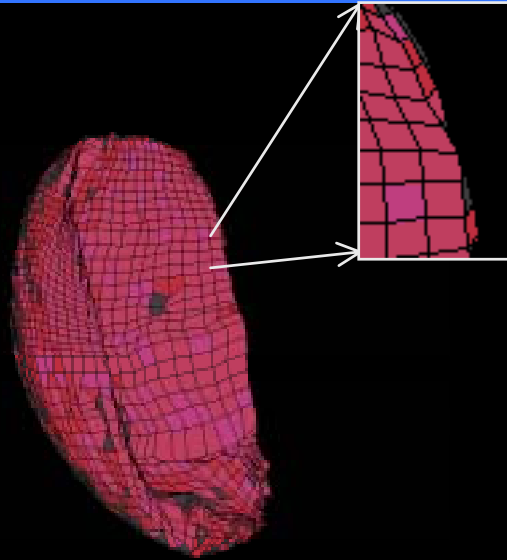
8420776 Voxels

Mesh (Cornea)



Volume Rendering

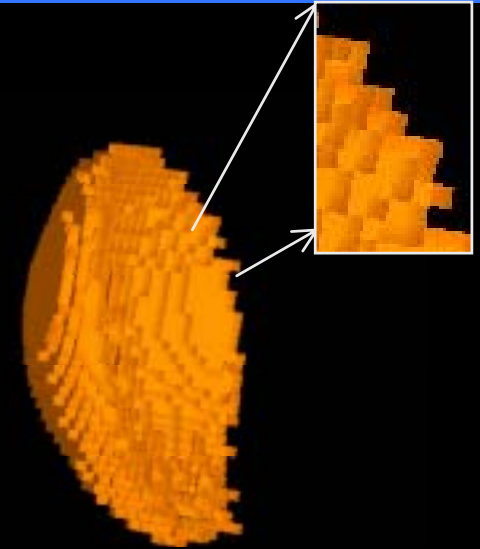
8420776 Voxel



Mapped Mesh

5,013 Element

531184 Triangles

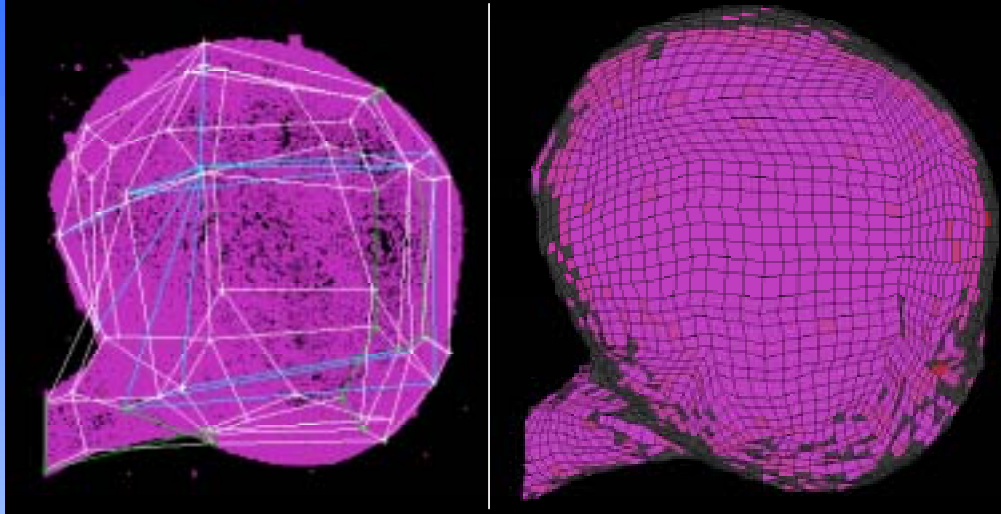


Voxel Mesh

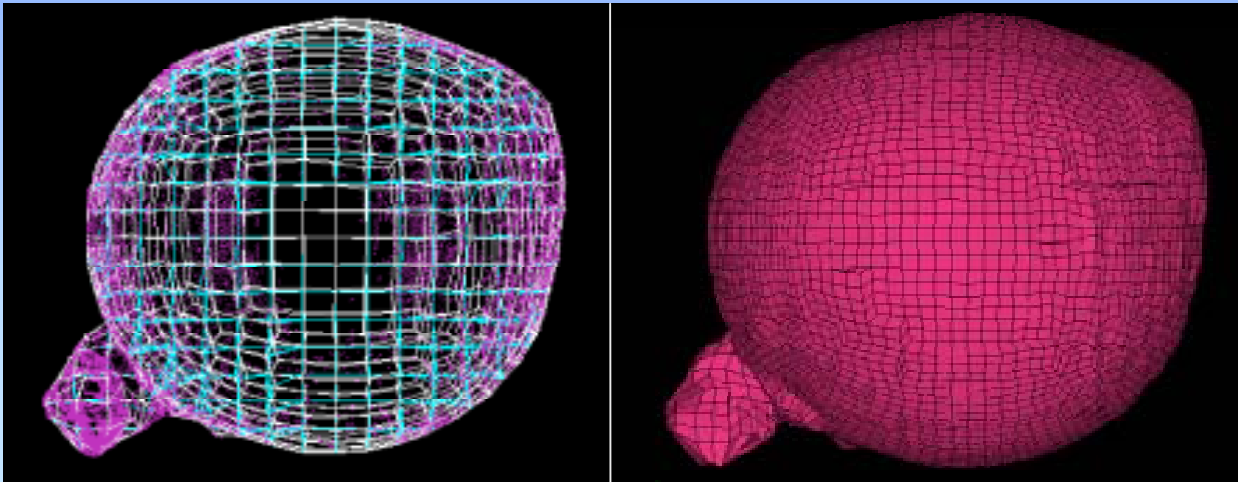
5,021 Element

8420776 Voxel

Global Block Based on Hexahedral Mesh



We devised template box which makes high quality mesh.



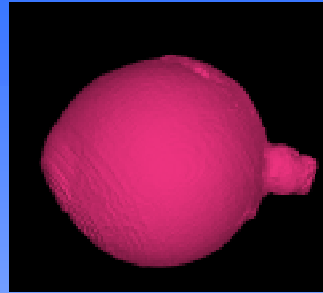
Global Block

Mesh

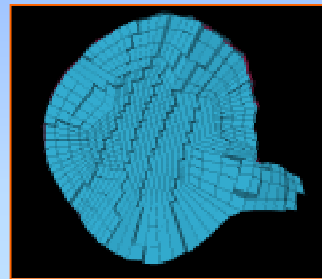
Mesh (Whole eye)



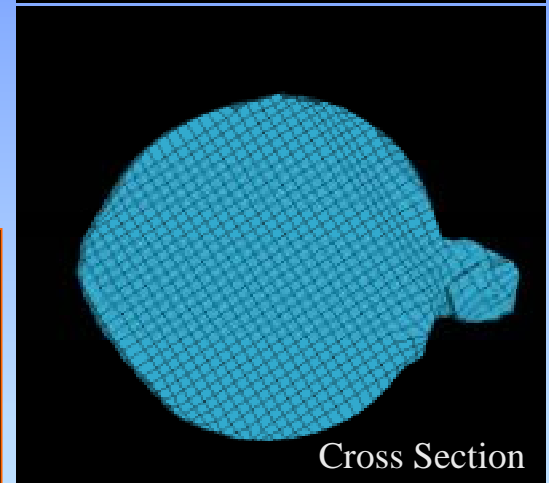
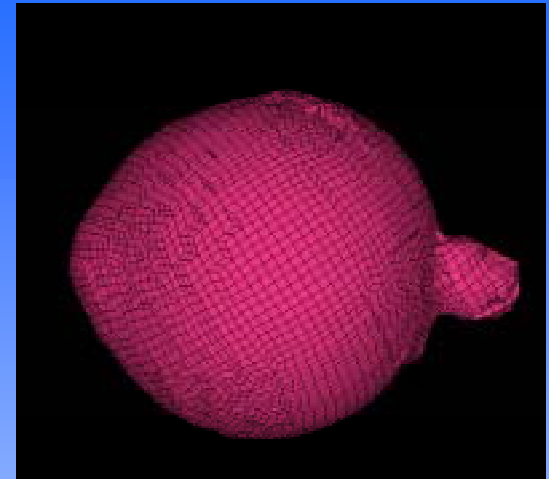
Volume Rendering
25,495,538 Voxels



Polygon Model
881,340 Triangles



Before

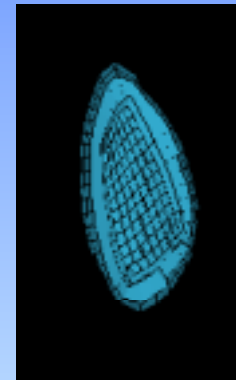
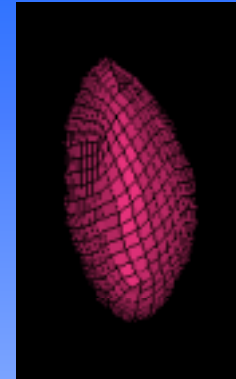


Mapped Mesh
17,844 Elements

Mesh (Lens)



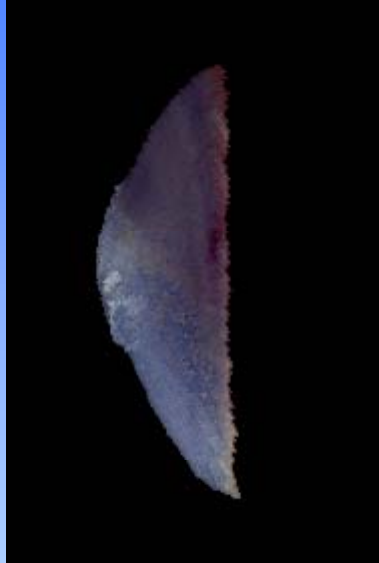
Volume Rendering
396,638 Voxels



Mapped Mesh
2,736 Elements

Polygon Model
281,520 Triangles

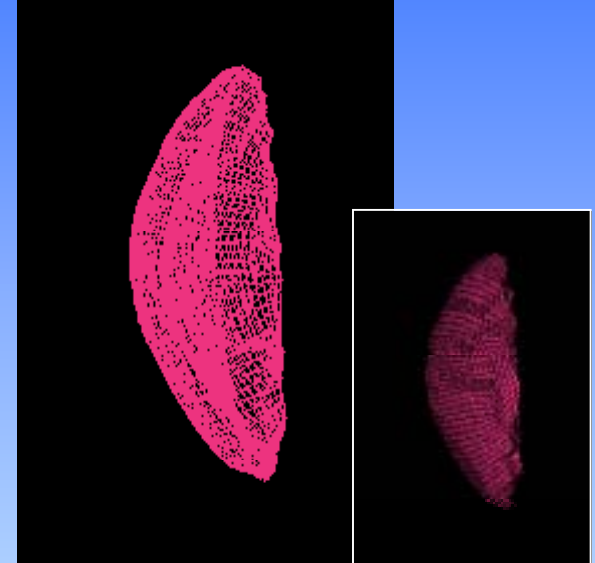
Mesh (Cornea)



Volume Rendering
224,211 Voxcel

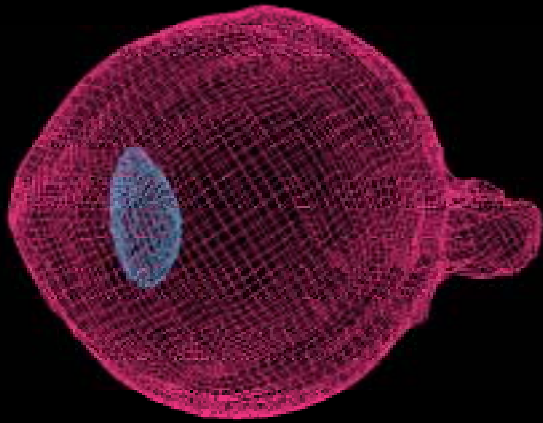


Polygon Model
537,656 Triangles

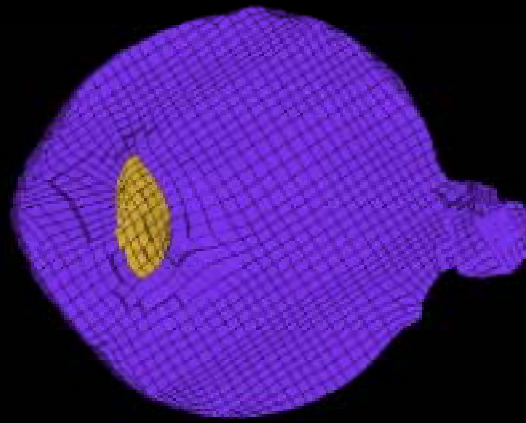


Mapped Mesh
6,464 Element

Multiple Part in Same Mesh (1)



Lens in Whole Eye



Cross Sectional Image

Lens

720 Elements

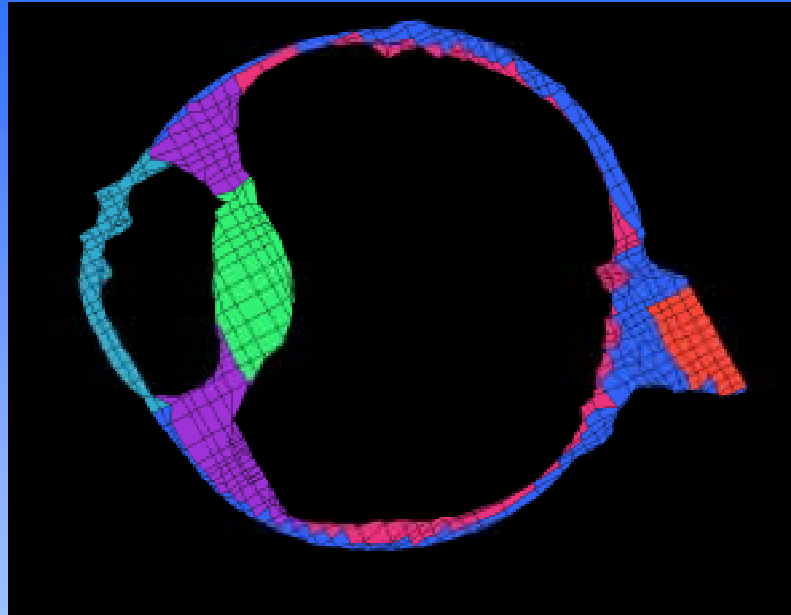
All

2,9133 Elements







The lens featured in the whole eye.

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

Multiple Part in Same Mesh (2)



Total 44,890 Elements

	Sclera	23,590 Elements
	Lens	953 Elements
	Cornea	2,526 Elements
	Optic Nerve	608 Elements
	Front Parts of Retina and Choroid	6,824 Elements
	Back Parts of Retina and Choroid	10,389 Elements

Summary

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

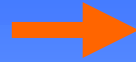
If we generate several parts of the eye in the one data, it is all the element points of contact are connected between part and part.

Also the tissue boundary element points of contact are connected.

The quality of the mesh improves when the shape of the template block is devised.

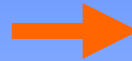
Future Work

Mesh Will Create by
Multiple parts of Eye.



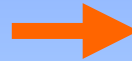
More Segmented of Eyeball
the Sclera, Choroid, and Retina

Mesh Resolution
Will Be Improved



Using Analysis

Interpolate Data
of Complex Shape



Lightening Data by Using
Polygon Reduction