

3D Reconstruction of Individual Anatomy From Medical Image Data: Surface Extraction

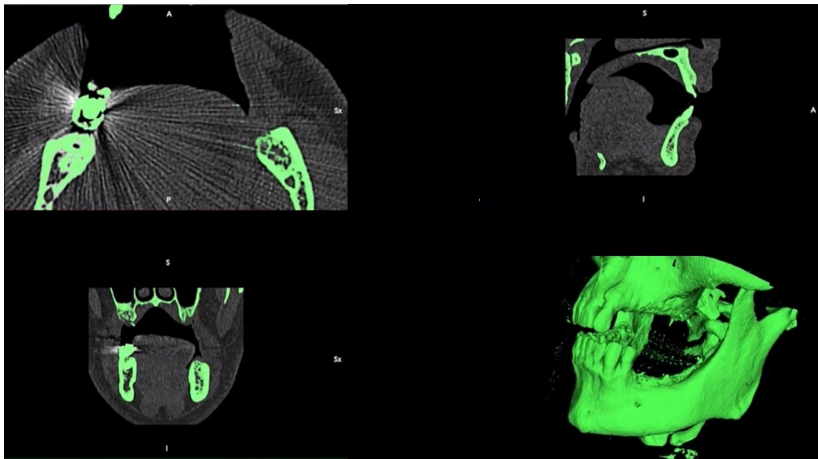
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November 24, 2020

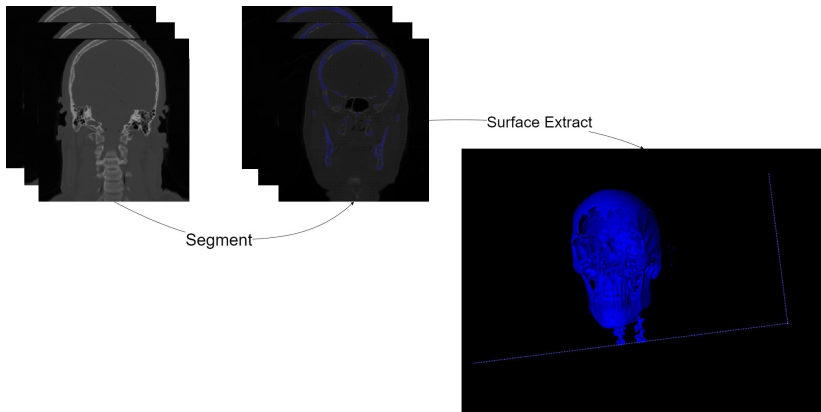
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Introduction



After the last meeting, you should've comprehended the flow of reconstructing 3D models from clinical image data.

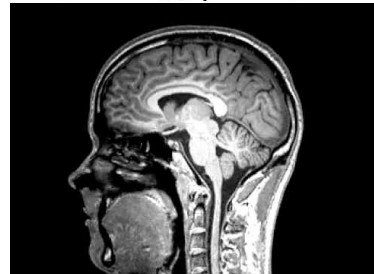
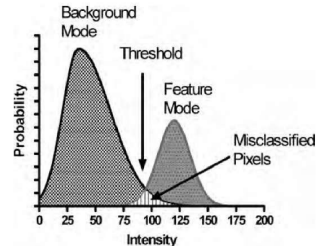
The main objective



This post will demonstrate how to read in a series of DICOM files from a CT examination and extract a mesh surface of the bone structures.

Knowledge Base

- Thresholding is a process of dividing an image into many classes of pixel.
- The purpose of thresholding is to separate one or more regions of interest in an image from regions that do not contain relevant information.



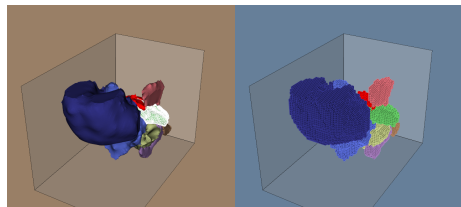
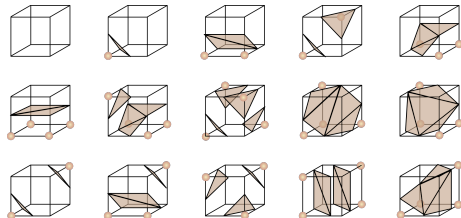
Intensity-Based Segmentation

A computer graphics algorithm published in the **1987 SIGGRAPH** proceedings by Lorensen and Cline.
Approach:

- Iso-surface cuts volume can approximately represent the ground-truth surface.

Idea:

- Devide the Iso-Surface into a per-volume cell presentation.
- Use triangles.



Drawback:

- Highly over-sampled.
- Abnormal surface.
- Aliasing artifacts.
- Sharp features within cells are lost.

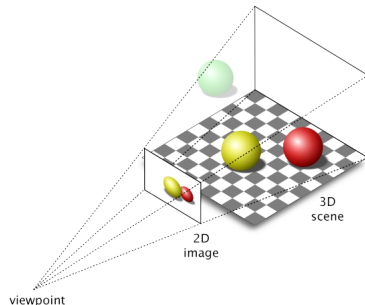
Solution: Deep learning approach


- **Occupancy Networks.**
- **MeshSDF.**
- **Deep Marching Cubes.**

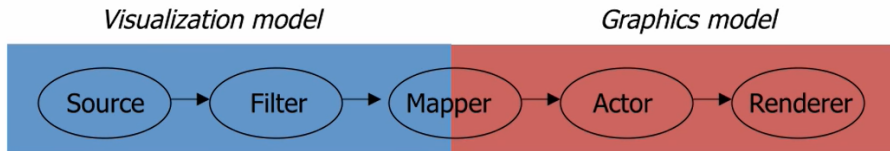



Rendering process could be looked at a two steps process:

- Projecting 3D shapes on the surface of a canvas and determining which part of these surfaces are visible from a given point of view.
- Simulating the way light propagates through space, which combined with a description of the way light interacts with the materials objects are made of, will give these objects their final appearance.



Direction of data flow 



 Direction of 'update'

- Visualization model: generating graphical objects to present the data.
- Graphics model: rendering screen image from the graphical objects.

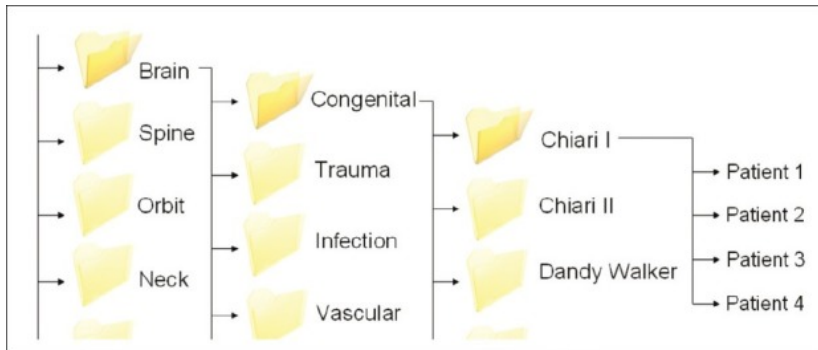
Dataset

DICOM standard is the de-facto solution to storing and exchanging medical image-data.

There's a wealth of freely available DICOM datasets online.

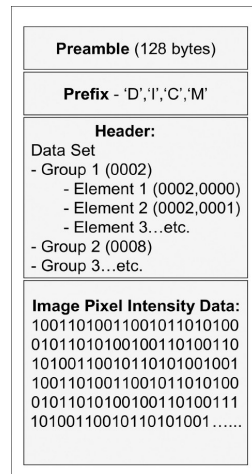
- **Osirix Datasets**
- **Visible Human Datasets**
- **The Zubal Phantom**
- **Kaggle**
- **Scientific Data**

Most databases forbid their re-distribution by third parties.



This is a useful method to organize small image collections, especially when the diagnostic categories are relatively straight-forward.

- The header stores demographic information about the patient, acquisition parameters for the imaging study, image dimensions, matrix size, color space, and a host of additional nonintensity information required by the computer to correctly display the image.
- Programmatically reading and processing DICOM depend on whether the files store the pixel data in a compressed form or not.



DICOM PS3.5 2020 - Data Structures and Encoding
Indian J Radiol Imaging. 2012 Jan-Mar

Development

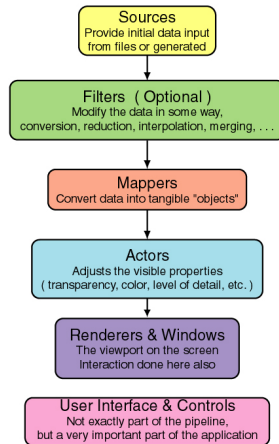
- An open-, freely available software system for image processing, 3D graphics, volume rendering and visualization.
- Including many advanced algorithms (e.g., surface reconstruction, implicit modelling, decimation) and rendering techniques (e.g., hardware-accelerated volume rendering, LOD control).
- Object-oriented design with different interpreted language wrappers.



Source: Visualization Toolkit

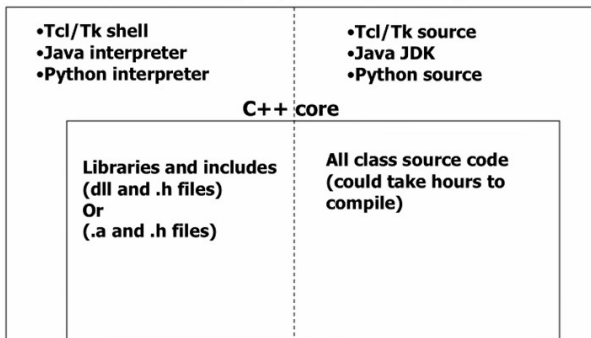
- The central structure of the Visualization Toolkit is a pipeline of data, from a source of information to an image rendered on the screen.
- The individual modules do not necessarily update their output until they are called upon to do so by some other module.

VTK Visualization Pipeline



Source: General Architecture of the VTK Pipeline

Interpreted Wrapper (Tcl, Java, Python)



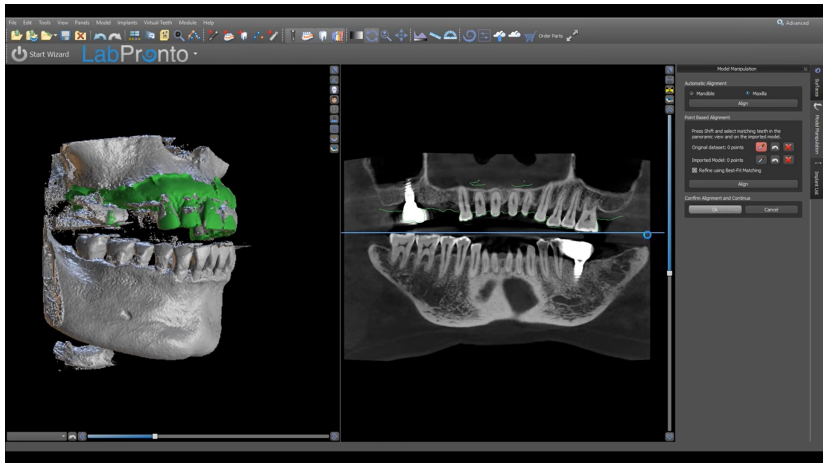
Binary Installation: if you will use
The classes to build your applicatoin

Source code Installation:
If you want to extend vtk

Application

A 3D medical imaging reconstructions application must provides several tools:

- DICOM support including ACR-NEMA version 1 and 2 and DICOM version 3.0 (Various encodings of JPEG).
- Image manipulation features (zoom, pan, rotation, brightness/contrast, etc).
- Pre-defined threshold ranges according to tissue of interest.
- Segmentation and Semi-automatic segmentation based on watershed.
- Region growing segmentation.
- 3D surface creation, exportation, and connectivity tools.
- High-quality volume rendering process.
- Picture exportation (BMP, TIFF, JPG, PostScript, POV-Ray, etc).



The End

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