Surface Modeling and Display from Range and Color Data

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Introduction

Goal

- develop robust algorithms for constructing 3D models from range & color data

- use those models to produce realistic renderings of the scanned objects
Surface Reconstruction

Step 1: Data acquisition
Obtain range data that covers the object. Filter, remove background.

Step 2: Registration
Register the range maps into a common coordinate system.

Step 3: Integration
Integrate the registered range data into a single surface representation.

Step 4: Optimization
Fit the surface more accurately to the data, simplify the representation.
Problem

Noisy registered data

Signed distance fn & marching cubes

Hierarchical & directional space carving
Carve space in cubes

Label cubes

- Project cube to image plane (hexagon)
- Test against data in the hexagon
Several views

Processing order:
FOR EACH cube
   FOR EACH view

Rules:
any view thinks cube's out
   => it's out
every view thinks cube's in
   => it's in
else
   => it's at boundary
Hierarchical space carving

- Big cubes => fast, poor results
- Small cubes => slow, more accurate results
- Combination = octrees

RULES:  
- cube's out => done
- cube's in => done
- else => recurse
Hierarchical space carving

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RULES:  
- cube's out => done
- cube's in => done
- else => recurse
The rest of the chair
Same for a husky pup
Optimizing the dog mesh

Registered points

Initial mesh

Optimized mesh
View dependent texturing
Our viewer
Overview of VBR

Choose 3 close views

Render meshes from the current viewpoint

For each pixel
  * read it from each view
  * remove occluded ones
  * calculate a weighted average
  * paint the pixel
Reconstruction of Blood Vessel Trees from Visible Human Data

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Introduction

• **Goal**
  – to reconstruct the blood vessels of the lungs from Visible Human Data

• **Computer vision**
  – semi-automation
  – low-level image processing
  – model construction
Visible Human Data: Slice through the Lung
Problems Encountered

• **Data source**
  – black spots that are not blood vessels
  – variations of lighting

• **Characteristics of blood vessels**
  – similar color surrounds
  – lack of knowledge
  – close location
  – shape variety
  – continuous change not expected
  – dense data
Finding the contours of a vessel being tracked (1)

Previous contour

Current slice

EM Segmentation

False color for the segmentation
Finding the contours of a vessel being tracked (2)

- The results after selecting regions of similar color to the tracked region
Finding the contours of a vessel being tracked (3)

- The results after selecting the region that overlaps most with the previous contour

![Selected regions](image1.png) ![Region that overlaps most](image2.png)
Find the contours of a vessel being tracked (4)

- The results after morphology to close holes and remove noise

Selected region  
After noise removal
Find the contours of a vessel being tracked (5)

- The contour is determined through a fast-marching level-set approach

Previous contour

Current contour
How branching is handled

• One contour divides into two

• Two contours merge into one
The use of resampling when the axis is not vertical

- **Track** the axis through the center points of found contours
- **Fit** a spline curve
- **Resample** the data perpendicular to the spline curve
- **Use** the resampled contours for model creation
Detect the axis

Center points of found contours

Spline-fitted axis
Resample the data perpendicular to the spline curve
Overall Procedure for finding Vessel Trees

• The user selects a starting point

• The program automatically tracks the selected vessel and any branches it finds

• The program creates a generalized cylinder representation of the vessel tree

• The user may select more starting points
Some Initial Results

Artery tree from single seed

Vein tree from single seed
Typical Cross Section
Results: blood vessels in right lung from previous section