A Surface-growing Approach for 3D Object Surface Representation

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Overview

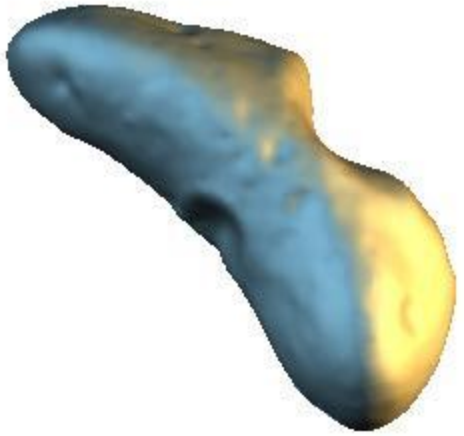
- Problem Statement
- Previous studies and solutions
- Related Investigation
- Algorithm Description
- Simulated Experimental Results
- Advantages/Disadvantages
- References

What problem are we solving?

Generate a complete surface model of a 3D object from point cloud data using a surface-growing method

Photograph

point cloud data

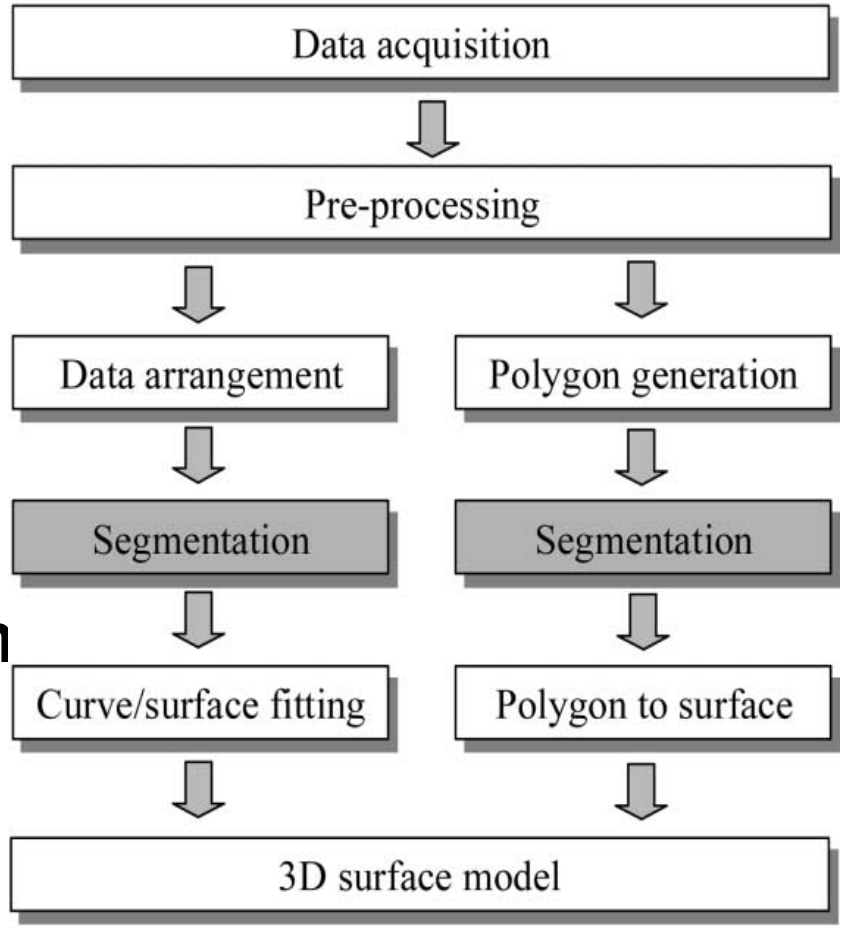


fitted surface

http://www.farfieldtechnology.com/casestudies/eros/

Different methods for 3D surface model

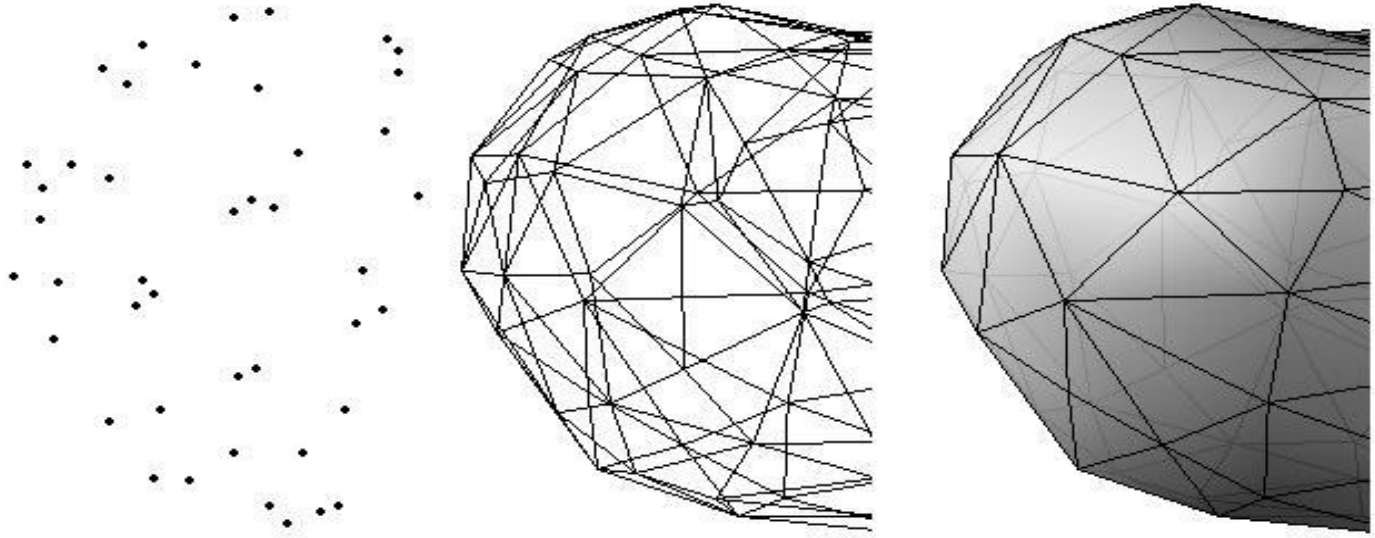
- Point cloud data
- Noise filtering,
  Smoothing, merging, etc
- Curve-net-based method
  polygon-based method
- **Several smooth regions divided by Segmentation**
- Modify fitting surface
- 3D Surface model



Segmentation

Partitioning a point cloud into meaningful regions and extracting important features

Points ⇒ **Regions/patches** ⇒ **Model**



http://www.magic.ubc.ca/artisynth/pmwiki.php?n=OPAL.MarkoMarjanovic

Existing segmentation methods

- Edge-detection method
- Region-growing method

Edge-detection Method

- Calculating curvature of scanned lines including most edge points
- Form closed boundaries of components in the point data

Region-growing Method

- Suitable selection of seed points required
- Determining a suitable threshold value for region membership criterion
- Absorbing the neighboring pixels of seed points which meet this criterion and growing the region until including all the eligible pixels
- Achieving regions with different criterions

Seed points

- Based on user criterion(pixel intensity, gray level range, pixels evenly spaced on grid, color, etc.)
- Homogeneity/ Similarity threshold value

Suitable criteria can be chosen according to different situations! Even multiple criteria can be proposed at the same time!

Region properties

(a) $\bigcup_{i=1}^{n} R_i = R.$

(b) R_i is a connected region, i = 1, 2, ...,n

(c) $R_i \bigcap R_j = \varnothing$ for all $i = 1, 2, ..., n.$

(d) $P(R_i) = TRUE$ for $i = 1,2,...,n.$

(e) $P(R_i \bigcup R_j) = FALSE$ for any adjacent region R_i and $R_j.$

Every pixel must be in a region! No points missed!

Shortcomings

- Time consuming and power consuming
- Noise or variety of intensity may result in holes or over-segmentation
- Discontinuities and outliers may result in under-segmentation(bridges across the discontinuities)

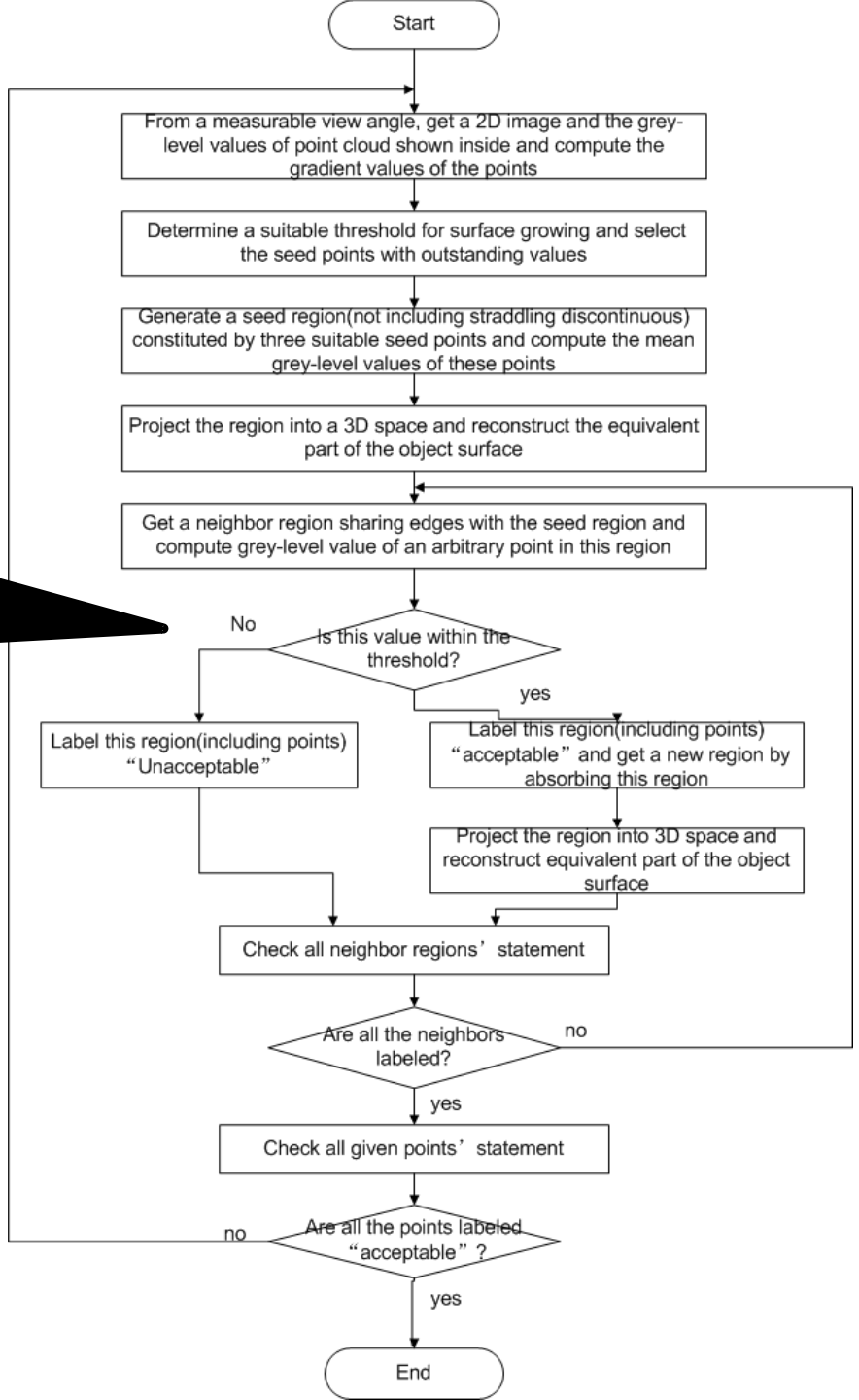
Surface-growing segmentation method

Similarly to the region-growing segmentation method, let's see how the surface-growing method works :

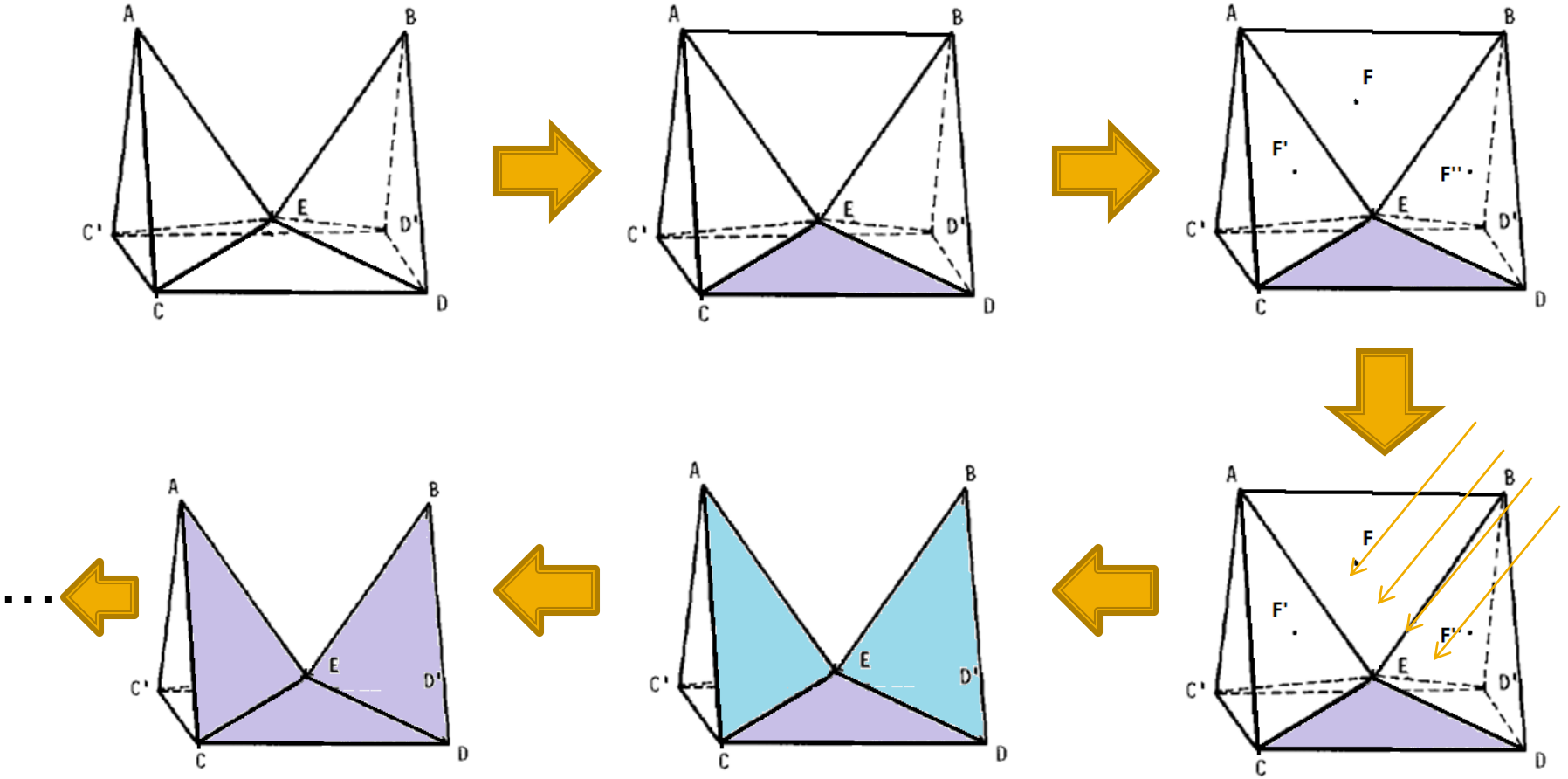
Seed points	seed regions
Region grows by absorbing points which satisfy a suitable threshold value	Surface grows by absorbing regions avoiding straddling discontinuous
Expanded until no eligible points detected	Expanded until no eligible regions available

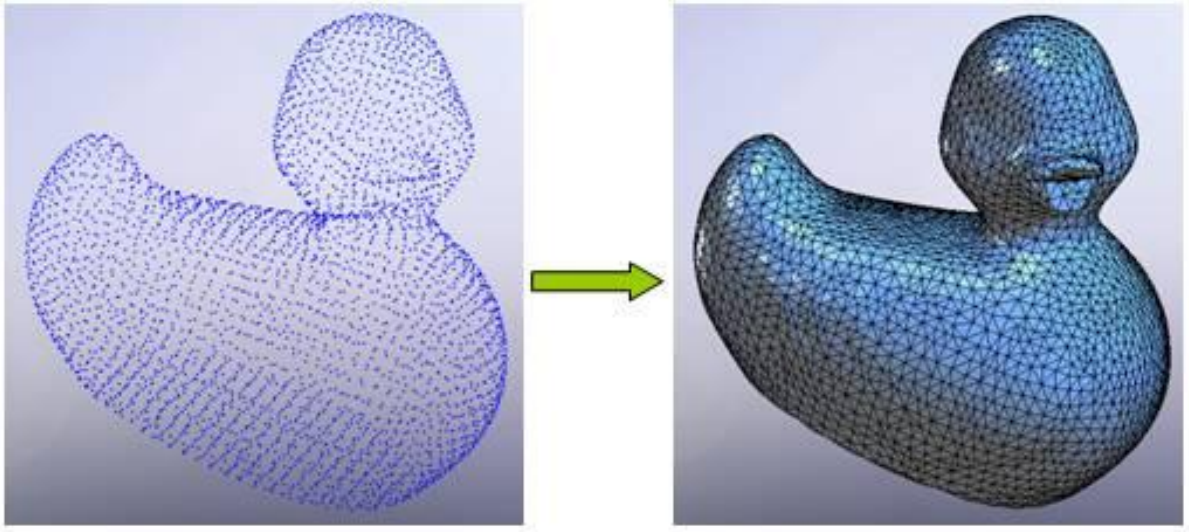
Algorithm Flow Chart

This part implements the surface-growing segmentation avoiding the under-segmentation problem



Algorithm Simulation





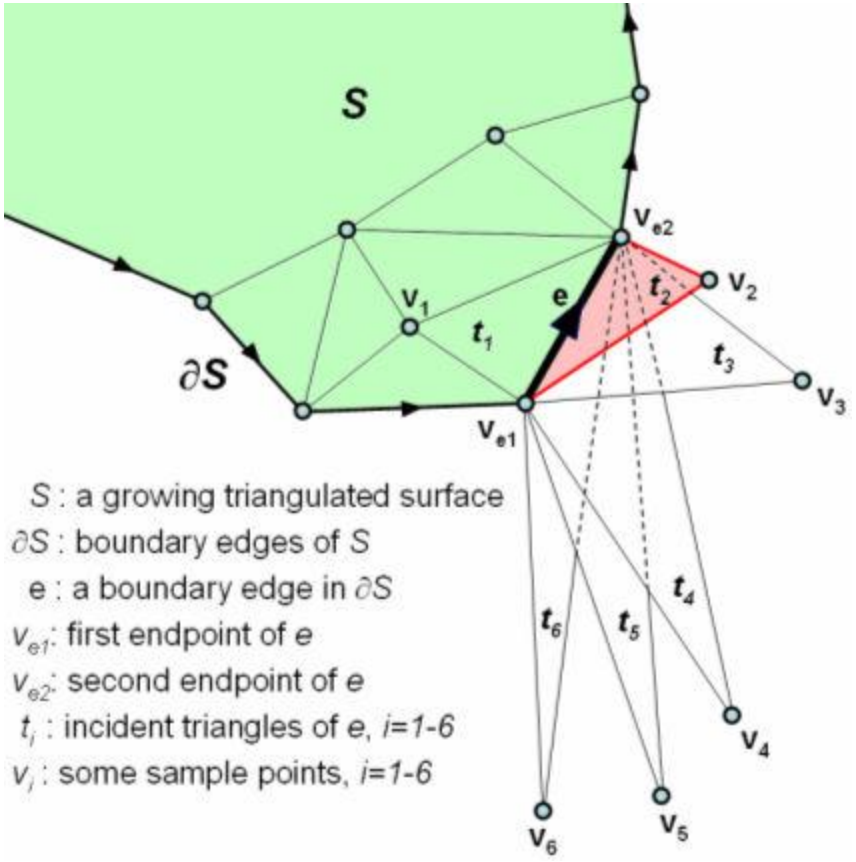
http://www.newdimchina.com/expertise/reverse_engineering.html

Problems to be solved

- Color shading

- Transparent body

- Tremendous computing



Minimum Goal

- Acquiring point cloud data from 2D images
- Avoiding the under-segmentation and achieve a model more closer to the real model using a small point cloud data
- Maintaining the performances of existing region-growing segmentation

Further research(if time permits)

- Implying this method into large point cloud data, finally the real 3D model
- Trying to reduce the computational complexity in the data processing procedure

References

- James V.Miller, Charles V.Stewart. "Prediction Intervals for Surface Growing Range Segmentation." Univ.RPI, NY, 2001.
- H.Woo, E.Kang, Semyung Wang, Kwan H.Lee. "A new segmentation method for point cloud data." International Journal of Machine Tools & Manufacture, 42(2002), 167-178.
- Shyi-Chyi Cheng, Chen-Tsung Kuo, Wei-Ming Lai. "A region-growing approach to 3D model segmentation using relaxation labeling." 16th IPPR Conference on Computer Vision, Graphics and Image Processing(CVGIP 2003)
- Jean Daniel Boissonnat. "Geometric structures for 3D shape representation." ACM Transactions on Graphics, Vol.3, No.4, 1984, P266-286.
- Retrieved from "http://en.wikipedia.org/wiki/Segmentation_(image_processing)" " http://en.wikipedia.org/wiki/Region_growing"

Q&A

The End

Thank you!