iCutter: A Direct Cut Out Tool for 3D Shapes

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Outline

- Problem statement
- User interface
- Segmentation method
- Experimental results
- Conclusion
Surface Segmentation

How does a shape consist of the subparts?

Part Type (Volume)  Patch Type (Surface)
Segmentation of Meaningful Parts

- Automatic
- Interactive
  - User intension
  - Application dependent
User Interfaces

How can users express their intention?

"I want to cut out the head part of the bunny model"
User Interfaces

- User interfaces should be
  - Easy to use
  - Intuitive

Specify vertices on surface

Specify cutting plane
iCutter: Intelligent Cutter

- The user does not care much about how to draw the sketches
Sketching user interfaces

I want to cut out the head part from the bunny model...

What you draw is what you get!
Basic idea

- Sample the foreground and background seeds along the input stroke
- Compute the cut based on these initial seeds
Adaptive sampling

- Stroke sampling
- Feature points selection
- Foreground/background candidate
Scalar field

- Harmonic fields for pairs
- Weighted averaged field

\[ F = \frac{\sum_{i=1}^{n} \mu_i F_i}{\sum_{i=1}^{n} \mu_i} \]
Cutting boundary

- Isoline selection
  - Centerness
  - Concaveness
Comparison of scalar field

- Comparison between the naive harmonic field and our scalar field

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Geometry aware harmonic field

\[ \Delta u_i = \sum_{j \in N_i} w_{ij} (u_i - u_j) \]

\[ w_{ij} = \gamma \left( 1 + \frac{\alpha_{ij}}{\text{avg}(\alpha_{ii})} \right)^{-1} \]
Experimental results

- Intensive to input strokes, noise, pose
Experimental results

- Cut out local parts
Experimental results

- Multiple strokes
Experimental results

- Running time

RT₁, RT₂, RT₃ denote the computation time of sampling, scalar field and isoline selection respectively.

<table>
<thead>
<tr>
<th>Model</th>
<th># Vertex</th>
<th>RT₁ (ms)</th>
<th>RT₂ (ms)</th>
<th>RT₃ (ms)</th>
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<tbody>
<tr>
<td>Feline</td>
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<td>Neptune</td>
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</table>
User study

- Compare the performance of three boundary-based cutting tools
  - Mesh scissor [Lee et al. 2005]
  - Cross-boundary brush [Zheng et al. 2010]
  - iCutter
User study

Analysis

Average measured accuracy

Survey of User feedback
Limitation

- Difficult to cut out parts from smooth surface
- Not suitable for cutting out the patch-type components
Conclusion

- Easy-to-use tool for interactive mesh cutting
- Provide users a favorable experience on cutting mesh surfaces
- **What you draw is what you get!**
Thank you for your listening!