Sketch-Based Modeling with the BlobTree

Ryan Schmidt, Brian Wyvill, Mario Costa Sousa
University of Calgary
Canada
Motivation

- Current 3D modeling interfaces are not suitable in early design stages
  - Very time-consuming compared to a pencil
Motivation

• Simplify modeling interface by leveraging designers existing drawing skills
  – Create 3D shapes using 2D sketches
  – Edit models using 2D sketches
ShapeShop

- Build on ideas from SKETCH [Zeleznik et al 96], Teddy [Igarashi et al 99], GiDES++ [Jorge et al 03]

- Use Hierarchical Implicit Volume Modeling (BlobTrees [Wyvill et al 99]) as underlying shape representation
ShapeShop

- ShapeShop is a tool for creating BlobTree models using sketches

BlobTree + Sketching = ShapeShop
What is a BlobTree?

- 3D Implicit model
  - \( F(p) = v_{iso} \)
- Like a CSG Tree with Blending, Warping, and many other operators
- Procedural definition
- Scene graph
BlobTree Modeling

• Benefits Include:
  – Solid (Volume) Modeling
  – Shape composition is easy and robust
  – BlobTree is a full construction history and can be animated

• Underlying scalar fields $F(p)$ have local influence
Hierarchical Spatial Caching

Standard BlobTree

BlobTree with Cache

Approximated
Caching Evaluation

![Graph showing the impact of caching on polygonization time in seconds over multiple time steps. The graph compares 'Cached', 'Cached (No Hair)', 'Cached (2x Resolution)', 'No Cache', and 'No Cache (No Hair)'. The graph indicates a significant speedup in performance when caching is used.]

Order of Magnitude Speedup

Schmidt, Wyvill, Galin – SMI 2005
ShapeShop

- “Free-Form” Sketch-Based Modeling
  - Largely in the style of Teddy
  - Integrated with CAD-style BlobTree modeler

- Non-modal sketching interface
  - No mouse buttons ("Clickless")
“Blobby” Inflation

- Mimic inflation technique of Teddy
  - Based on smooth distance field approximation
- Width variation generated by falloff function
Distance Field Approximation

Initial Curve

Exact Distance Field (C^1 Discontinuities)

C^2 Smooth Distance Field Approximation

Schmidt & Wyvill – UofC TR 2005
Sweep Surfaces

- Linear Sweeps
  - Flat endcaps
  - Rounded or sharp edge

- Surfaces of Revolution
  - Toroidal or Spherical
  - Interior Holes
Blending

- Parameterized Blending Operator
- Blend surface is recomputed interactively
Cutting

- CSG Subtraction with a linear sweep
- Interactively manipulate hole by manipulating sweep
Surface Drawing

- Find polyline on surface with ray intersection
- Add new primitives
- Entire stroke can be removed at any time
Sketching Interface
Interaction Design

- Sketching interface is Non-Modal
  - No Mouse Buttons or Keyboards
- Pencils have no buttons
- Large display input systems are often non-modal (SmartBoard, etc)
Non-Modal Widgets

• Pure gesture interface is challenging
  – Complex gestures, sketch/gesture collision

• Adapt ideas from CrossY [Apitz et al, UIST 04]

• Crossing for button selection

• Capture-Drag for changing continuous values
Model Interaction

- Expectation List

- View Control Toolbar
Visualization Assistance

- Dynamic Clipping
- Internal Volume Visualization
Piston Model
Heart Model
Car Model
Skeleton Model
3D Doodle
Thank You

• Details:
  Full Paper in Sketch-Based Interaction and Modeling Workshop @ Eurographics

• Questions?