Hair Meshes

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Hair Modeling

Previous Work
Previous Work on Hair Modeling

- Flat surfaces

Kim and Neumann 2000

Koh and Huang 2001
Previous Work on Hair Modeling

- Wisps and generalized cylinders

Yang et al. 2000
Previous Work on Hair Modeling

- Wisps and generalized cylinders

Kim and Neumann 2002
Previous Work on Hair Modeling

- Guide curves

Alter 2004
Previous Work on Hair Modeling

- Physically-based approaches

Anjyo et al. 1992
Previous Work on Hair Modeling

- Physically-based approaches

Hadap and Magnenat-Thalmann 2000
Previous Work on Hair Modeling

- Physically-based approaches
Previous Work on Hair Modeling

- Physically-based approaches

Choe and Ko 2005
Previous Work on Hair Modeling

- Physically-based approaches

Ward et al. 2007
Previous Work on Hair Modeling

- Sketch-based interfaces

Wither et al. 2007
Previous Work on Hair Modeling

- Sketch-based interfaces

Fu et al. 2007
Previous Work on Hair Modeling

- Hair Capturing

Paris et al. 2008
Hair Modeling

- Question: Why not use polygons?
  - Polygons are widely accepted
  - Artists are already familiar with polygons

- Unfortunately,
  - Polygons represent surfaces
  - Hair is volumetric

- However,
  - We perceive hair as a surface
Hair Modeling with

Hair Meshes
Hair Meshes

- Volumetric Structure
  - Topological connections
  - Can uniquely trace a path from root to tip

- Editable as a surface
  - Polygonal modeling concepts
  - Obey topological constraints
Hair Modeling with Hair Meshes

- Hair Mesh Modeling
- Hair Generation
- Hair Styling
Hair Meshes

- **Layers**
  - Root Layer
  - Tip Layer

- **Vertices**
  - External Vertices
  - Internal Vertices
Hair Meshes

Hair Generation

- Pick a point at root layer
- Find corresponding points on all layers
- Connect them with a curve (ex. Catmull-Rom splines)
Hair Meshes

- Tip layer can be different for each face
Hair Meshes

- Tip layer can be different for each face
- Topology can change between layers
Hair Mesh

Topological Operations
Topological Operations

- Face Extrude
Topological Operations

- Face Extrude
Topological Operations

- Face Delete
Topological Operations

- Face Delete
Topological Operations

- Face Delete
  - Only tip faces
Topological Operations

- Layer Insert
Topological Operations

- Layer Insert
Topological Operations

- Layer Delete
Topological Operations

- Layer Delete
Topological Operations

- Edge/Vertex Separate
Topological Operations

- Edge/Vertex Separate
Topological Operations

- Edge/Vertex Weld
Topological Operations

- Edge/Vertex Weld
Topological Operations

- Edge/Face Divide and Subdivision
Topological Operations

- Edge/Face Divide and Subdivision
Topological Operations

- Edge/Face Divide and Subdivision
Hair Mesh

Geometrical Operations
Geometrical Operations

- User interacts with the external surface
- Internal structure is automatically shaped

- External Vertices
- Internal Vertices
Geometrical Operations

- Internal Vertex Placement
  - Part of the modeling process
  - It has to be fast
  - Constrained quadric minimization
    - Operates on the whole hair mesh
    - External vertices are fixed
    - Error is the difference between tangent edges
      - Favor local uniformity
    - Initial conditions are the previous positions
    - Solved using Conjugate Gradients
      - Converges after a few iterations
Geometrical Operations

- User SELECTs vertices to move
Geometrical Operations

- User MOVES selected vertices
Geometrical Operations

- Internal vertices are automatically placed
Geometrical Operations

- Internal vertices are automatically placed
Hair Styling

- All operations on hair strands are **styling** operations

![Hair Styling Diagram](image_url)
Hair Styling

- All operations on hair strands are **styling** operations
- Procedural Styling
Hair Styling

- All operations on hair strands are \textit{styling} operations
- Procedural Styling
- Combining with wisp-based methods
Hair Meshes

Results
Wrapping Up...

- Hair Meshes
  - Polygon-like modeling
  - Intuitive

-Direct Control

Lee Perry-Smith, www.ir-models.com
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