Plushie: An Interactive Design System for Plush Toys

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Introduction

- Traditionally, 3D plush toys are designed from 2D patches of material
  - Difficult for non-professionals
- Idea: Generate 2D patches from a 3D model by drawing a silhouette
  - Problem: final sewn result may not match the original model
Introduction (cont.)

(a) Traditional framework

(b) Our framework
User Interface

- Two Windows:
  - 3D model being constructed
    - Produced from a physical simulation of the assembled 2D pattern
  - Corresponding 2D patterns
User Interface (cont.)

Figure 3: A screen snapshot of the Plushie system.
3D Modeling Operations

- Creating a New Model
- Cutting
- Part Creation
- Pull
- Seam Insertion/Deletion
Creating a New Model

- Draw a silhouette as a closed free-form stroke
- System generates two cloth patches corresponding to the stroke
- Shape visualized by applying a physical simulation
Cutting

- Makes relatively flat surfaces
- Starts outside the model, crosses it, and ends outside the model
- Model cut at intersection, and patch generated at cross section
Part Creation

- Draw silhouette for new part
- Endpoints should start and end on model
- Two potential shapes are available:
  - Part base connected with an open hole (for fat or rounded parts)
  - Part base is closed and connected (for thin parts)
Part Creation (cont.)

Figure 4: User interface of part creation. (a) The user draws a stroke and (b) the system suggests two different possibilities. The user chooses one (c, d).
Pull

- Modify shape by pulling a seam line
- 2D cloth pattern updated during pulling

Figure 5: User interface of the pull operation.
Seam Insertion/Deletion

- Seams can be inserted by drawing a stroke on the model.
- Deletion can be done by tracing over the seam to get rid of while in erasing mode.
Figure 6: Insertion of a seam line. (a) Before drawing a line. (b) After drawing a line. (c) The seam line’s two endpoints snap at other seam lines. (d) After pulling the seam line.

Figure 7: Deletion of a seam line.
2D Pattern View Operations

- Patch relationships detailed by connector lines or paired numbers

Figure 8: Patches connected to each other using connectors (b) and numbers (c).
2D Pattern View Operations (cont.)

- 2D patches can be pulled, with changes reflected in the 3D model

Figure 9: Pulling a 2D patch.
Implementation

- Physical Simulation
- 3D Modeling
Physical Simulation

- Produces a reasonable estimation of the plush toy shape
- Two parts:
  - Move each face slightly in the direction of its normal
  - Adjust length of edges to preserve cloth integrity
3D Modeling

- Generate two-sided mesh, and apply physical simulation to it
- Mesh inflates as simulation converges
- After convergence, adjust 2D patterns so model matches silhouette stroke
Figure 12: Adjustment process after creation. The system enlarges the 2D pattern so that the simulation result matches the input stroke. The 2D boundary vertex \( (v) \) moves in its normal direction by the amount proportional to the distance between the corresponding 3D vertex and the input stroke.
Results

Figure 17: A plush toy and a balloon designed in our system.
Figure 19: Example of original plush toys designed and created by children in the workshop.
http://www.den.rcast.u-tokyo.ac.jp/~yuki/plushie/index-e.html
Conclusion

Any Questions?