Pillow: Interactive Pattern Design for Stuffed Animals

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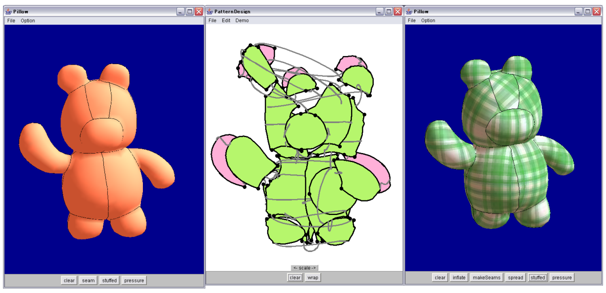
1. Introduction

This sketch describes an interactive pattern design system for creating stuffed animals. The user imports a 3D model into the system and specifies the segmentation boundaries interactively by drawing seam lines on the model surface. Given the user-defined segmentation, the system generates a 2D pattern by flattening the pieces [Lectra]. The system then visualizes the shape of the resulting stuffed animal by applying a simple physics simulation to the virtual stuffed animal created by assembling the flattened pieces. This closed loop framework allows the user to experiment with various seam patterns before actually working on real fabric to obtain the best-looking result.

Julius *et al.* [2005] presented an automatic segmentation algorithm for stuffed animals and demonstrated its viability by creating real toys using the machine-generated pattern. However, their automatic method relies on purely geometric criteria and it is difficult to capture the perceptually important features of the original shape. As a result, seams can appear in undesirable ways, such as those that cross the face or ignore the symmetry of the model. Our approach focuses on the user's artistic process of pattern design and provides tools to support the exploration process.



(a) (b) (c)

Figure 1. Outline of our system: (a) The original 3D model with seam lines drawn by the user; (b) 2D sawing patterns generated by flattening the pieces; (c) The reconstruction result generated by applying a physics simulation to the pattern.

2. User Interface

Figure 1 shows a snapshot of the system. The left window shows the original 3D model, the center window shows the flattened 2D pattern, and the right window shows the reconstruction result. This system takes a 3D surface model as input. The user draws free-form lines on the 3D model surface indicating the segmentation boundaries (Fig. 1(a)). When the user completes the segmentation, the system automatically flattens the pieces (Fig. 1(b)). The pattern view shows lines connecting corresponding seams to help the user understand the relationships among the pieces. The system also reconstructs the 3D geometry by virtually sewing the flattened pieces together and applying a simple physics simulation (Fig. 1(c)). This view visualizes how the stuffed toy might look when the user creates a real toy using the current segmentation. If the user dislikes the result, he or she can quickly change the segmentation by erasing and redrawing seam lines.

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3. Implementation

Pillow, our prototype system, is implemented as a Java™ program. Flattening and reconstruction run in real-time on a standard PC. We use ABF++ as the flattening algorithm [Sheffer 2005]. For the physics simulation, we currently use a very simple mass-spring model, but plan to combine our system with more sophisticated simulation methods [Grinspun 2002].

4. Result

We created 2D patterns for a teddy bear model using our system and then created real stuffed animals using the resulting patterns. Figure 2 presents the result. It shows that the user can quickly experiment with various segmentation strategies using the system, and the simulation results successfully capture the overall shape of the real stuffed animals.

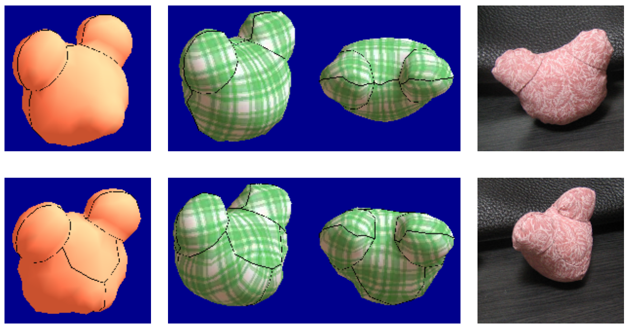

Figure 2. Pattern design examples. The user experiments with two different segmentations (top and bottom). The figures show (left) the user-specified seam lines, (center) the result of applying the physics simulation to the patterns generated automatically from the user-specified segmentation, and (right) the real stuffed animals created using the given patterns.

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