Interactive Modeling for Craft Band Design

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CCS CONCEPTS
• Computing methodologies → Computer graphics → Shape modeling → Mesh models

KEYWORDS
Modeling, Craft, Interactive System, Novice Users

ACM Reference format:

1 INTRODUCTION
Although traditional computer-aided design (CAD) systems are mainly intended for expert users, research involving systems incorporating CG and interactive techniques that are easy to use by novices is also active. In this paper, we propose a design support system that can be used by a novice to easily design a craft band object of his or her desired pattern. We propose an algorithm that can automatically calculate geometric shapes based on rectangular parallelepipeds and cylinders according to the sizes desired by users (Fig. 1).

Craft band creation involves cutting strips of paper tape called craft bands to appropriate lengths, and then creating the object by braiding the strips together. (Fig. 2 left). It is a process that is popular with children today because it allows them to handcraft easy-to-enjoy objects such as dishes, bags, or baskets using off-the-shelf patterns. Craft bands are usually connected to belt-like shapes with 12 cores flattened and glued together (Fig. 2 right).

Techniques for quickly outputting 3D shapes to the real world have also been proposed. Tao et al. [2017] proposed a method for automatically generating a plurality of band type shapes, and then developing them into 2D patterns. Takezawa et al. [2016] introduced a system that can be used to reconstruct freeform objects by using orthogonal two-layered and woven principal strips. We aimed at a system that allows novices to easily use patterns with equal widths.

2 SYSTEM
We implemented the proposed system with Java™. When starting the system, the user first selects whether it is a rectangular parallelepiped or cylindrical shape, and then inputs the size of the outline. The system then automatically calculates and presents the initial shape. The system also allows the user to see the result in real time while correcting details such as the width and color of the craft band, numbers, and shape.

After the modifications are entered, the color and length of each of the craft bands that will ultimately be required are calculated and presented to the user. The system guides the manual construction of the designed physical craft band by providing step-by-step instructions (Fig. 3). The user can then actually fabricate the object while using this construction guide.

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https://doi.org/10.1145/3283289.3283298
2.1 Rectangular Parallelepiped Design

In the rectangular parallelepiped shape (Figs. 2 and 4), the system automatically generates the shape by taking the width, depth, and height as input. These three numbers can be changed interactively. When creating a box, there are three kinds of craft bands that need to be used. One is a craft band in the width direction, which is used as for the vertical side \( V \). The second is a craft band in the width direction, which is only intended for the bottom surface \( W \), and the last is a craft band in the depth direction, which is intended to be used for the vertical side \( D \) (Fig. 4 bottom).

The number of wicks \( w_V, w_W, \) and \( w_D \) of each craft band can be set. After the bottom is braided, the user bends these craft bands and then braids the side. Let \( w_H \) be the number of wicks in the horizontal craft band on side \( H \). We set \( w_V = 8, w_W = 6, w_D = 6, w_H = 6 \), width = 150 (mm), depth = 100 (mm), height = 80 (mm).

![Figure 4: Parameters that can be set in a rectangular parallelepiped shape.](image)

2.2 Cylindrical Shape Design

In the cylindrical shape, radius and height can be input as shown in Fig. 5. These two numbers can be changed interactively. The number of wicks \( w_B \) of the helical craft band on the bottom surface, and side spiral craft band \( w_S \) can be changed as a more detailed control. We set the initial setting to radius = 50 (mm), height = 80 (mm), \( w_B = 2, w_S = 6 \), respectively. For spiral shape braiding, the number of lateral longitudinal craft bands needs to be an odd number. In addition, it should be noted that when the \( w_B \) value of the core of the spiral shape craft band braiding on the bottom side is set too large, the curvature becomes too high and cannot be bent, so \( 1 \leq w_B \leq 3 \). These restrictions are included in the system, and the user can change the parameters without worrying about exceeding them. Furthermore, it is possible to add widening section (Fig. 6 (a, b)) and narrowing section (Fig. 6 (b, c)). The user can add some parts such as eyes, ears (Fig. 6(e)).

![Figure 5: Parameters that can be set for a cylindrical shape.](image)

3 RESULTS

Fig. 6 shows shapes designed by users using our system. The users were able to design these results in about 5 to 10 minutes (Fig. 6 top). In the user study, it was found that users typically input the size to be created and then examine the color scheme in the rectangular parallelepiped shape. In contrast, in the case of a cylindrical shape, it turned out that users often perform operations to adjust the height and width while observing the balance of the outline in order to obtain the desired results. Fig. 6 bottom shows sample works that were actually created by users using our system.

![Figure 6: Results of designing with our system.](image)

REFERENCES
