An "Origami" Support System by Using Finger Gesture Recognition

Koji Nishio(✉), Kazuto Yamamoto, and Ken-ichi Kobori

Osaka Institute of Technology, 1-79-1, Kitayama, Hirakata-City, Osaka, Japan
{koji.a.nishio,kenichi.kobori}@oit.ac.jp,
yamamoto_kazuto@is.oit.ac.jp

Abstract. We propose "Origami" simulation system using finger gesture recognition. "Origami" is a traditional and popular game using a square sheet of paper in Japan. It is built up only by folding called "Ori" operation. Thus the rule of "Origami" is very simple. However, it is difficult for children to use complicated "Ori" and it is necessary to retry "Ori" operation again and again. On the other hand, the durability of paper is limited. Therefore by using virtual paper and finger gesture recognition, there is no limitation of durability and people who play "Origami" can retry "Ori" operation until they are satisfied. Our system projects "Origami" image on the grass table and tracks fingers by using LEAP motion that is one of depth sensors. In addition, our system recognizes "Ori" gestures with finger motions and folds "Origami". Using our system, people can plays "Origami" with a feeling of folding a real paper.

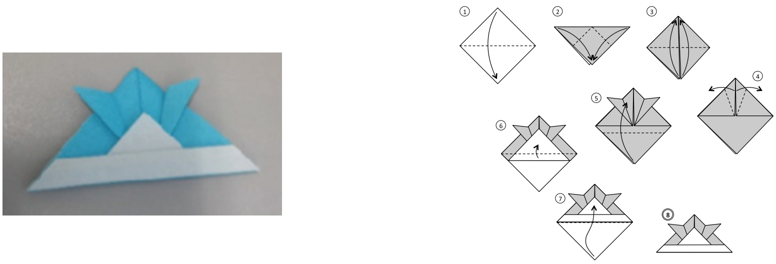
Keywords: Finger-motion · Hand-gesture · Image-recognition · Paper-craft

1 Introduction

"Origami" is the art of folding paper, which has been familiar to Japanese people through the ages. It is made with a square sheet of paper by folding and unfolding. Generally, beginners operate a origami according to a operation diagram. Figure 1(a) shows an example of "Origami" shaped a war helmet "Kabuto" and Fig. 1(b) shows its procedure of folding and unfolding step-by-step.

However, most operation diagrams are not easy to recognize to beginners because they are expressed in two-dimensional as shown in Fig. 1(b) even though Origami works are three-dimensional. And also most beginners need to retry to folding and un-folding repeatedly. This makes a sheet of Origami to be broken. Therefore we propose a virtual origami system that makes to be able to play Origami in virtual space. Our system displays the image of Origami and recognizes the finger gestures of player. In addition, a player can touch and operate a image of Origami. Our system enables beginners to retry to operate origami again and again. There is no need to prepare a lot of sheets of Origami. By the way, Origami needs different operation to each hand such as holding a sheet with left hand and applying a fold line with right hand. However, the conventional system uses two-dimensional input devices such as mouse or touch panel. Then our system uses a sensor device "Leap Motion" that can tracks finger motion.

© Springer International Publishing Switzerland 2015
C. Stephanidis (Ed.): HCII 2015 Posters, Part I, CCIS 528, pp. 513–518, 2015.
DOI: 10.1007/978-3-319-21380-4_87



(a) (b)

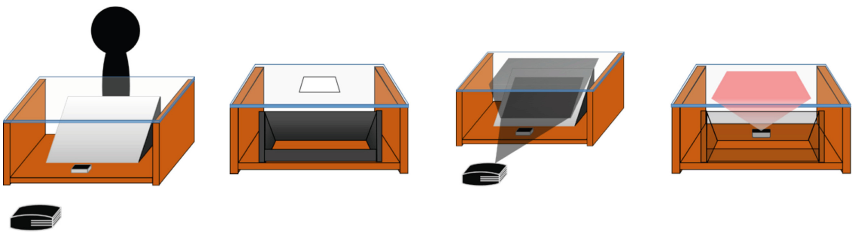
Fig. 1. (a) An example of "Origami", (b) is its procedure diagram

With this device, our system tracks player's finger motion in three dimension and recognize a hand gesture.

2 Proposed System

2.1 Components of the System

Proposed system consists of a reinforced grass plate, a mirror, a projector and a finger motion sensor as shown in Fig. 2(a). Figure 2(b) shows a view from player's eye point. A rendered image of Origami is projected as shown in Fig. 2(c) and the system watches player's finger motion in the area as shown in Fig. 2(d).

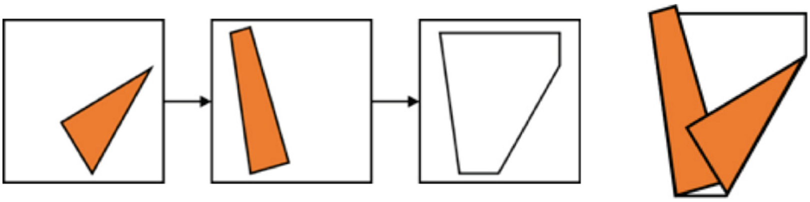


(a) (b) (c) (d)

Fig. 2. Appearance of our system

2.2 Rendering of Origami Model

Our system handles one and more polygons and holds them sequentially in order from front to back. For example, Figs. 2(a) and (b) shows a list of polygons and rendered image respectively (Figs. 3 and 4).



(a) (b)

Fig. 3. List of polygons and its rendered image

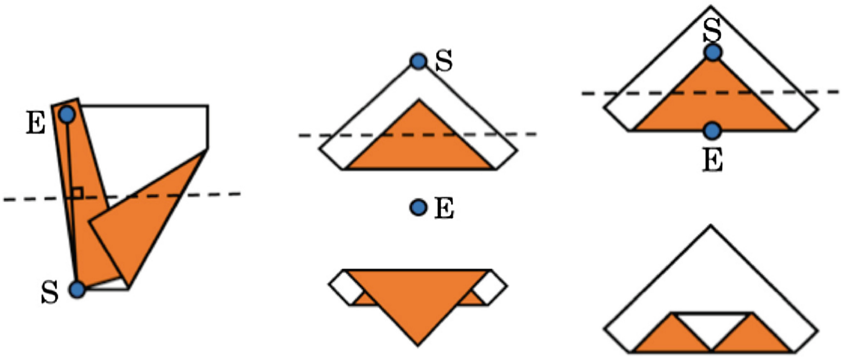
(a) (b) (c)

Fig. 4. Folding operation

2.3 Operations

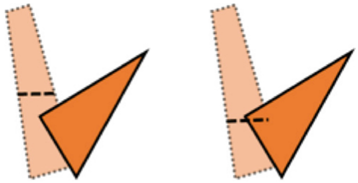
Our system provides four types of operations, FOLD, TURNOVER, ROTATE and UNDO/REDO.

FOLD. Hold a corner of the polygon which player wants to fold and move it to the position where player wants to be. After that, move the other hand along the folding line.



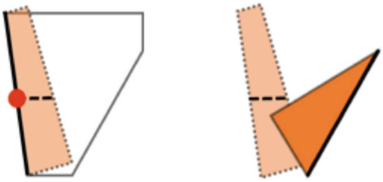
(a) (b) (c)

Fig. 5. Folding line and two cases of folding pattern



(a) (b)

Fig. 6. Determination of overlap



(a) (b)

Fig. 7. Edge sharing with the folding polygon

Calculation of a folding line. Assuming that S is the holding point and E is the destination, a folding line places on a perpendicular bisector of the line SE as shown in Fig. 5.

Detection of folding polygon. Even if player picks and moves same point, there are two cases about the folding operation as shown in Fig. 5. In case of Fig. 5(b), each polygon

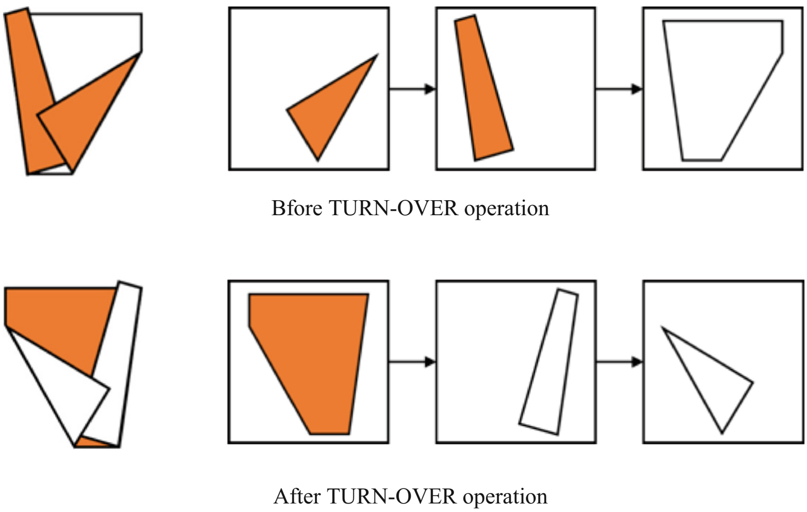


Fig. 8. Reordering images and reordering of polygons

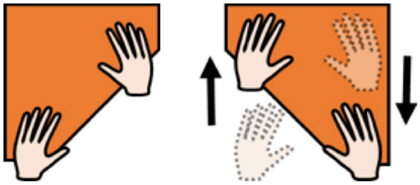


Fig. 9. ROTATE operation

across the folding line should be bent. On the other hand, in case of Fig. 5(c), some of polygons are not. Then the system judges whether bend or not. It is supposed that the polygon that has point S as its corner should be bent. If there are two or more such polygons, the one that places the front most is adopted. Polygons, which are placed in front of folding one, may also be bent as shown in Fig. 6. The dark one must not be bent in case of Fig. 6(a), and must be bent in case of Fig. 6(b). If some edge of folding polygon are shared with other polygons, those polygons must be bet too as shown in Fig. 7(a). Otherwise, the dark one sharing no edge with folding polygon does not needs to be bent as shown in Fig. 7(b).

Division and turning over. The polygon that places the front most is divided into two polygons by the folding line. One of divided polygons, picked by a player, are turned over around the folding line and places in front of the other one. After that, if a player traces the folding line, our system fixes the position of the folding line.

TURN-OVER. When a player turns over his hand picking up a corner of Origami, whole of Origami is reversed. At this time, the order of polygons in the list is reordered in reverse order as shown in Fig. 8.

ROTATE. To rotate whole of Origami, a player put his hand on the Origami image and move each hand in the opposite direction as shown in Fig. 9.

UNDO/REDO. When a player flips over his hand clockwise, the system cancels last operation. In case of anticlockwise, the system redo the operation.

3 Experiment

Using our system, some Origami work is created. Figure 10 shows one of Origami work created with our system. These experimental results show that our system works correctly and seems to be effective.

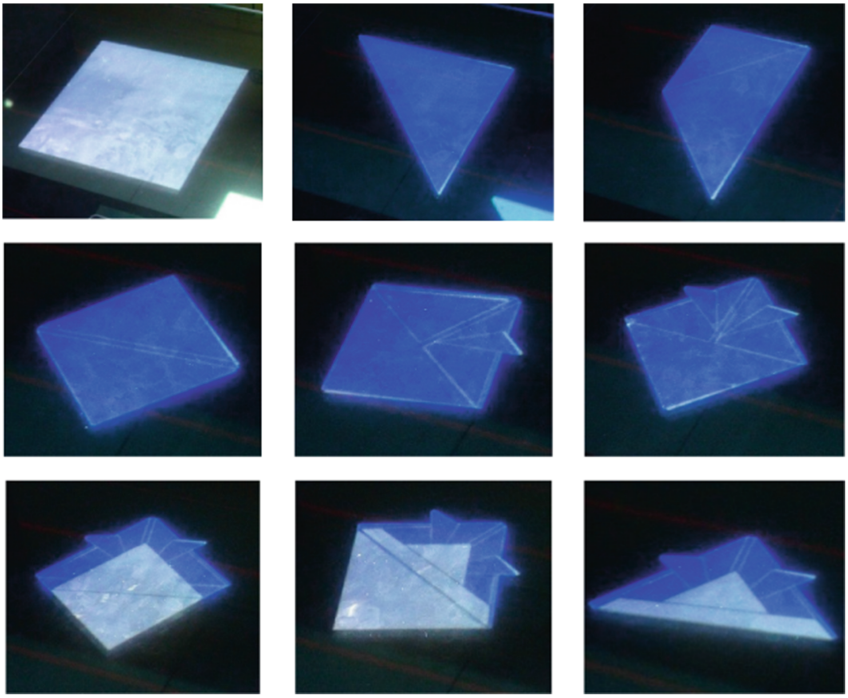


Fig. 10. Projected images on the grass-top of our system. These images show results by player's operation step by step from left top to right bottom.

4 Conclusions

We've proposed an "Origami" system by using hand gestures. To recognize those gestures, we apply one of the latest devices that can track finger motions to our system. In addition, our system projects images of "origami" on the grass top and players can operate them as real. However, the system fails to track fingers when player moves their fingers too fast. Therefore, we think that this is one of the future works.