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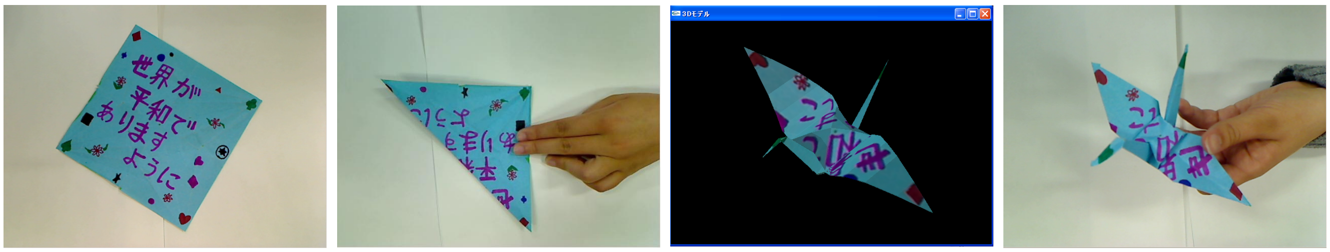

(a) (b) (c) (d)

Figure 1: *(a) Origami before the folding, (b) folded origami observed by a camera, (c) texture-mapped 3D digital origami model generated by our system through the recognition of origami states, (d) the actually folded origami for comparison.*

1 Introduction

The paper folding as known as "origami" is the Japanese traditional folkcraft that everyone can enjoy. Recently, several researchers are dedicated to virtually representing the origami in personal computer. However, previous methods less reflect the uniqueness of the actual origami folded by people. In this project, we build a software in order to represent the 3D model of origami crane which has the same message on its surface drawn by the user who folded it in the real world.

Origami is one of the popular Japanese tradition which is familiar to men and women of all ages for a hobby and an education purpose. Especially, origami crane is very popular with many people since it is said that the people will recover from their diseases if they fold one thousand of origami crane. Sadako Sasaki, who was diagnosed with leukemia due to the atomic bomb, continued to fold origami cranes, hoping her recovery and world peace. This episode is well known in Hiroshima, and many origami cranes are sent every year from the whole country, with the hope for world peace; however, today, Hiroshima city is suffering from keeping large number of these origami cranes. Therefore, we develop a software in order to reconstruct the folded origami crane in the virtual space.

Recently, Mitani [Mitani 2006] used 2D barcode (*i.e.*, matrix code) for detecting the origami state of the folding process, while Kinoshita and Watanabe [Kinoshita and Watanabe 2010] used silhouette for detecting it. However, it is difficult to reflect the user's originality to the virtually created model using these systems.

Our system requires the users to draw some messages on the sheet of paper in order to represent the uniqueness of the user's origami. Our origami crane has high uniqueness since the texture of the model is just the same as the messages written in the real world by the user. In addition, we reckon that the users will put their strong feelings of world peace into the origami cranes through the folding process in the real world. The future goal of our project is to build a system that the people all over the world fold the origami cranes with their longings for enduring peace and send them virtually to Hiroshima Peace Memorial Museum.

2 Our Approach

The image of the origami paper before folding (Fig. 1 (a)) is used as the texture to be mapped to the 3D origami model, which is given a priori, in order to represent the uniqueness of the virtual model. However, four different types of origami crane model can be made from the square sheet of paper before folding. Therefore, we have to analyze the origami image in order to determine which corner of the paper is used as the crane's head. Our system recognizes the origami's orientation of folding from the image sequences taken during the user's paper folding process.

We represent the folding operation of origami crane with 13 states. Each state has four possible appearances. The origami state and orientation of folding are recognized from the image (Fig. 1 (b)) taken by a camera. The color and edge information are used to calculate the difference between the actual input image and each four images expected by our system.

The shape of origami crane will become more complex and the area of the texture in the input image will become smaller during the progress of folding process. The image recognition will become difficult for the latter states in the folding process. However, we can prospect the appearance of the next state from the appearance of the current state due to the characteristics of the origami folding. Our system use the probability of transition from the current origami appearance to the four possible appearances of the next state.

Consequently, the origami state and orientation of folding are determined from four possible cases using the color and edge information and the probability of Markov chain.

References

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MITANI, J. 2006. Recognition, modeling and rendering method for origami using 2d bar codes. In *Proc. of International Conference on Origami in Science, Mathematics, and Education (4OSME)*.