折紙式プリンターのための改良“Norigami”ロボット
“糊付折り紙” robot improvements for Origami 3D Printer

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Introduction

The idea of the "Origami 3D printer" [1] comes from the representation of any 3D object by means of an "origami pattern" that reproduces the 3D shape of the object after being folded. Once the pattern is obtained, as the most difficult and time-consuming task is folding the pattern, several investigations have focused on using robots to reproduce human abilities when folding the paper. However, this task remains a pending task for robots.

Materials and methods

As the task of teaching robots to reproduce human behavior is a costly task (in time and money), recent research focuses on using simulation environments [2]. In our work we develop a system that allows teaching a robot to fold paper in a virtual environment using human demonstrations. In the system it is possible to reproduce simple folds from a small database created with human demonstrations but the automatic annotation of the folds in the simulation environment is complicated. The need for an annotated database limits machine learning of robots even in a simulation environment.

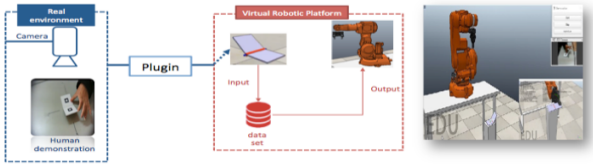

Figure 1. System to reproduce human demonstrations in a simulation environment

A simpler way would be to change the design of the patterns so that they are simpler to perform with simple robots like those developed in our previous works [3]. We call the robot "Norigami" robot because it combines folds with gluing areas in the pattern to obtain the 3D shape and reduce the number of manipulations to be carried out. In this work, the module in Figure 2 has been included to cut and paste at the same time so that any 3D shape can be made from a pattern like “Kirigami HoneyComb” [4].

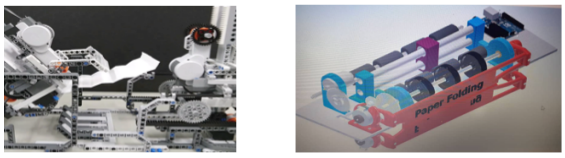

Figure 2. Norigami robot improvements

Preliminary Results

Figure 3 shows the developed prototype and an example of a reconstructed 3D object from a representation by means of a continuous HoneyComb pattern.

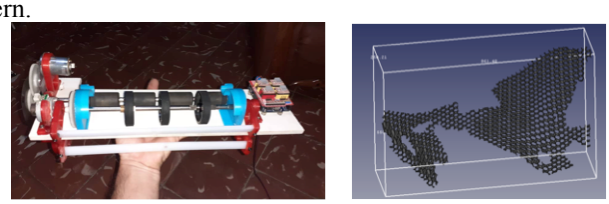

Figure 3. Developed prototype and example of a 3D model represented by a HoneyComb

References

[1] Bo Yu, Maria Savchenko, Junichi Shinoda, Luis Diago, Ichiro Hagiwara, and V.Savchenko. Producing Physical Copies of the Digital Models via Generating 2D Patterns for “Origami 3D Printer” system ، J. ADV. SIMULAT. SCI. ENG. 2016 Vol. 3, No. 1, 58-77
[2] Liudmila Rodriguez, Luis Diago, Ichiro Hagiwara, Yang Yang, Yan-en Wang “3D Simulated Robotic Origami Performing Using Deep Reinforcement Learning”, JSST 2019, November 5-7, Miyazaki, Japan
[3] J. A. Romero, L. A. Diago, C. Nara, J. Shinoda and Ichiro Hagiwara “NORIGAMI FOLDING MACHINES FOR COMPLEX 3D SHAPES” Proceedings of the ASME 2016 IDETC/CIE 2016 August 21-24, 2016, Charlotte, North Carolina
[4] Nojima, T., and Saito, K., 2006. “Development of newly designed ultra-light core structures”. JSME International Journal Series A Solid Mechanics and Material Engineer- ing, 49(1), pp. 38–42.