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The Development of a Scalable Underactuated Gripper based on Flexural Buckling

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***Abstract*—In this paper, we verify the scalability of an underactuated mechanism based on flexural buckling by applying the mechanism to multi-scale adaptive grippers. For verification, we design and fabricate two grippers having different sizes and install the grippers to a manipulator. As a result, the scalability of the mechanism will be shown by grasping from small electronic parts to large wine drinking glasses.**

I. Introduction

In gripping devices, various underactuated mechanisms have been employed for reliable and robust grasping. In large scale, differential mechanisms have been widely used to make enough number of contacts with even contact forces. In micro scale, most of devices used compliant mechanisms due to the reduced assembly. These mechanisms enabled the gripping devices to adapt to environments where information is hardly given. As mentioned above, however, different kinds of underactuated mechanisms need to be employed depending on the scale of usages. In this paper, we verify the scalability of the previously proposed underactuated mechanism based on the flexural buckling [1]. For verification, we fabricate two different size grippers with simple design modifications and test the grasping performance by installing them to a 5 DOF manipulator.

II. Design and Fabrication

Fabrication of the grippers starts from a single layer patterned by laser machining [2]. In Fig. 1(b), the glass fiber prepreg and the polyimide film are used as the rigid links and flexures, respectively.

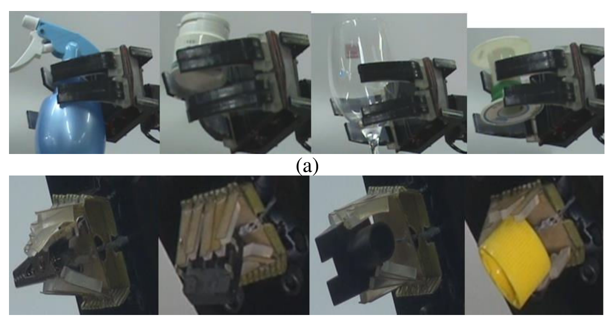
By simple folding, the gripper can be obtained as shown in Fig. 1(a). The two grippers have same length ratio of the flexure but different thickness of the film for different contact force requirement. As shown in Fig. 1, the grippers have dimensions of 100× 70× 40 (mm) and 20× 17× 6 (mm) each. Also, four fingers in the large one and ten fingers in the small one are attached. To reduce the slip between the fingers and the objects, the thin dragon skin (Smooth On Co.) is used.

III. Results

To show the performance of the scalable underactuated mechanism, we tested both grippers for grasping and manipulating various shaped objects. The manipulator has 5 DOF and the grippers are attached to the end of the manipulator. Position control is applied to the manipulator and the tests are done by moving between two fixed points. Actuation is done by pulling with a servo motor.

(a) (b)

Fig. 1 Two grippers that have different sizes (a) and the corresponding designs (b).



(b)

Fig. 2 The large scale gripper (a) and the small scale gripper (b) that grasping various shaped objects.

Fig. 2 shows the grippers that grasp irregularly shaped objects. The small gripper is grasping electronic parts such as a connector. The large one is grasping various objects in real life.

IV. Conclusion

We designed, fabricated, and tested the two different underactuated adaptive grippers based on flexural buckling. We have shown scalability of the mechanism by grasping various shaped objects in two different scales.

References

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