Deployable Glider Module for Multimodal Robots

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Multimodal robot which contains gliding and jumping or crawling has increased locomotion capability and it can move energy efficient way. The most important consideration for the integrating glider with the other robot is to minimize drag due to the area of the wing. Here, we present a bio-inspired curved compliant facet origami structure and a deployable glider module based on the origami wing frame.

I. Bio-inspired Origami Structure

The wings must be strong enough to withstand the aerodynamic force during flight. However, to easily fold the wings, the stiffness must be low. These two things conflict with each other, but the deployable wing for multimodal robot must satisfy both.

A variety of insects can fold and unfold their wings. Especially ladybird beetle, which use the tape spring shaped vein to secure the stiffness of the wings to endure the aerodynamic force during flight and make them easier to fold [1]. Inspired by the ladybird beetle, we developed a curved compliant facet origami structure. This structure can be folded completely and can be deployed rapidly through elastic deformation [2].

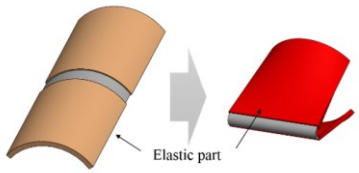

Figure 1. Bio-inspired curved compliant facet origami structure

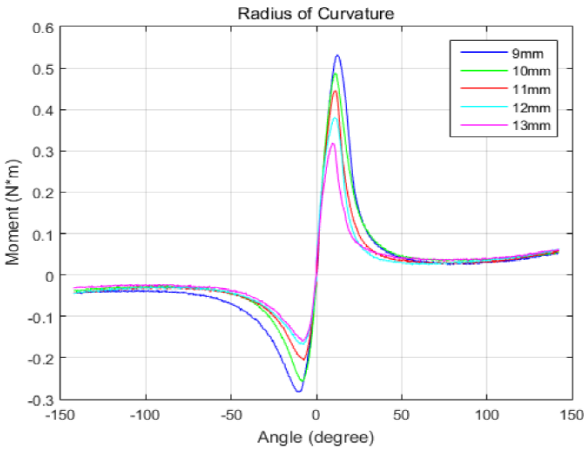

Figure 2. Experimental result of the folding angle v.s. joint torque of the curved compliant facet origami structure

As it folds, its facets are deformed and elastic energy is stored on the facets. Therefore, they can deploy themselves quickly. It is also suitable to withstand aerodynamic force when it is used as a wing due to its notably high stiffness at deployed state.

II. Deployable Glider Module

A. Overview

Based on the curved compliant facet origami structure, we developed a deployable glider module for multimodal robots. The wing span of the glider is 60 cm and weights 28 g including electronics. The glider module can be folded in confined space and it deploys within 350 ms.

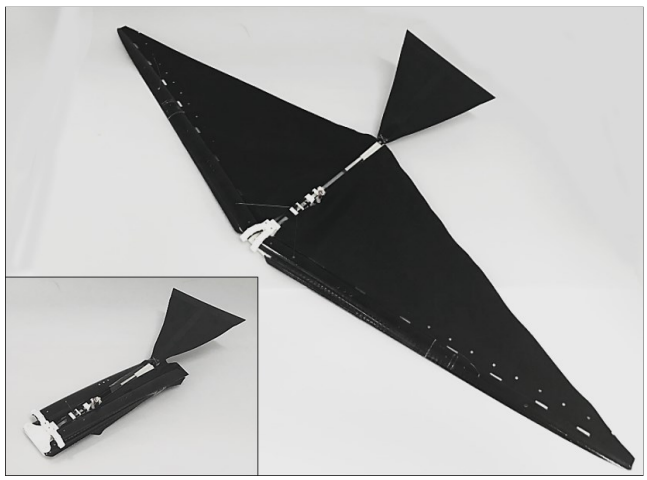

Figure 3. Deployable glider module for multimodal robots

LIVE DEMONSTRATION

The sample of the curved compliant facet origami structure.

References

[1] K. Saito, S. Nomura, S. Yamamoto, R. Niiyama, and Y. Okabe, "Investigation of hindwing folding in ladybird beetles by artificial elytron transplantation and microcomputed tomography," PNAS, vol. 114, no. 22, pp. 5624–5628, May 2017.

[2] S.-M. Baek, D.-Y. Lee, and K.-J. Cho, "Curved compliant facet origami-based self-deployable gliding wing module for jump-gliding," in Proc. ASME Int. Des. Eng. Tech. Conf. Comput. Inf. Eng. Conf. 2016.

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