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Cable-actuation of pill bug-inspired adaptive origami structure using computer vision

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The ancient art of origami can be harnessed for the development of adaptive structures, including those at civil-engineering scale. This can be enhanced with biomimetics, the study and development of synthetic mechanisms that mimic the structure or functionality of biological organisms in nature. The origami pill bug (OPB) structure is inspired by the morphological characteristics of the pill bug (Armadillidiidae), a species of woodlice. Pill bugs can roll their body into a ball shape in a process called conglobation, when triggered by an external stimulus. This ability to roll into a ball serves as the basis for the design of the adaptive origami-enabled pill bug structure. The panel type origami pill bug structure is modelled as bars, hinges, and active elements for actuation [1]. Computer vision is the field of study that deals with automated extraction of useful information from visual inputs, analysis of the data and meaningful interpretation of the results [2].

This paper provides a comparison between the analytical and the experimental model of the origami pill bug structure. The analytical study of the structure involves a dynamic relaxation method along with a finite element model for dynamic analysis of the structure. An experimental model comprising of hard polymer panels and flexible rubber hinges is used for the experimental study of the cable-actuated structure. A computer vision algorithm is used to track displacements and used to accurately track displacements in the experimental investigation.

Results of experimental tests using computer vision program are in agreement with the simulation using the novel module within dynamic relaxation method of the origami pill bug structure. This validates that the new dynamic relaxation module is an effective method for quasi-static form-finding of the origami pill bug structure. The image-based object tracking using computer vision is successful in identifying and tracking key features of the 3D-printed model to accurately determine the change in length of the structure throughout the rolling process.

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