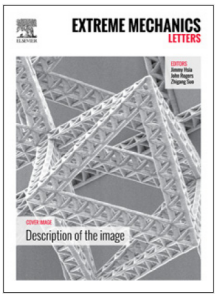
Accepted Manuscript



Designing novel structures with hierarchically synchronized deformations

Dingjie Lu, Yang Fan Li, Hamed Seifi, Shiwei Zhou, Zi-Long Zhao, Yi Min Xie

PII: S2352-4316(17)30179-7
DOI: https://doi.org/10.1016/j.eml.2017.11.006
Reference: EML 328

To appear in: *Extreme Mechanics Letters*

Received date : 18 October 2017
Revised date : 28 November 2017
Accepted date : 29 November 2017

Please cite this article as: D. Lu, Y.F. Li, H. Seifi, S. Zhou, Z. Zhao, Y.M. Xie, Designing novel structures with hierarchically synchronized deformations, *Extreme Mechanics Letters* (2017), https://doi.org/10.1016/j.eml.2017.11.006

Designing novel structures with hierarchically synchronized deformations

Dingjie Lu[a], Yang Fan Li[a], Hamed Seifi[a], Shiwei Zhou[a], Zi-Long Zhao[a], Yi Min Xie[a,b,*]

[a] *Centre for Innovative Structures and Materials, School of Engineering, RMIT University, Melbourne 3001, Australia*
[b] *XIE Archi-Structure Design (Shanghai) Co. Ltd, Shanghai 200092, China*

Abstract

In this paper, we propose a general mechanism to realize a uniform global motion of an n-level hierarchical structure constructed by base components of various shapes, which has only n degrees of freedom. The uniform global motion of the components at the same level of hierarchy is synchronized and independent of movements at other levels. The significantly reduced number of degrees of freedom is achieved by introducing a parallelogram linkage loop to the structure while the hierarchy is obtained from the similarity between the structure and its representative components at different levels. Theoretical analysis reveals the kinematic equations that govern the expansion and retraction of the deployable devices. Numerical simulation and physical prototyping verify the theoretical prediction. This study paves a way towards designing deployable and easily controllable devices and structures for many applications in aeronautics, electronics, optics, and MEMS.

Keywords: synchronized deformation, hierarchical structure, deployable structure, fractal cut

*Corresponding author
Email address: mike.xie@rmit.edu.au (Yi Min Xie)