

Crease-loops That Transform 3D Thick Rigid Origami/Kirigami

G. Wei, K. Wohlhart, L. Ren, J. S. Dai

keywords: Crease-loop, transformable 3D thick origami/kirigami, mobility

Abstract

Thick rigid origami/kirigami (1; 2) has recently attracted research interesting due to its great potential applications in space structure (3), domestic furnitures (2), robotic metamorphosis (4) and transforming architectures (5). The folding of thick rigid origami/kirigami lies on the crease loops or equivalent spatial linkage loops that are integrated into the vertices and edges of rigid origami. As pointed out by Chen et al. (1), the commonly used crease loops such as the Miura-ori, square-twist and diamond patterns need to be adapted to their equivalent spatial overconstraint 4R, 5R, 6R or 8R linkages in the cases of foldable thick origami.

This paper aims at identifying single spatial kinematic linkages that can be integrated into the vertices and edges of polyhedral thick rigid origami for the construction of transformable or deployable engineering structures and architectures. A thorough search for crease-loops and their corresponding spatial kinematic loops is presented and mobility of these loops is characterized with screw theory. Various of the proposed crease loops and their corresponding kinematic linkages are then integrated into regular rigid origami polyhedrons and large-scale combined polyhedra complex (see Fig. 1) leading to the construction of 1-DOF transformable/deployable engineering structures and architectures. Mobility and kinematics of these proposed structures and architectures are subsequently investigated and prototype of sample the proposed structures is developed and demonstrated.

References

- [1] Chen, Y., Peng, R. and You, Z., Origami of thick panels, *Science*, **349**(6246): 396 - 400, 2015.
- [2] Morgan, M. R., Lang, R. J., Magleby, S. P. and Howell, L. L., Towards developing product applications of thick origami using the offset panel technique, *Mechanical Sciences*, **7**(1): 69-77, 2016.
- [3] Guest, S. D. and Pellegrino, S., A new class of solid surface deployable antenna, *Acta Astronautica*, **38**(2): 103-113, 1996.

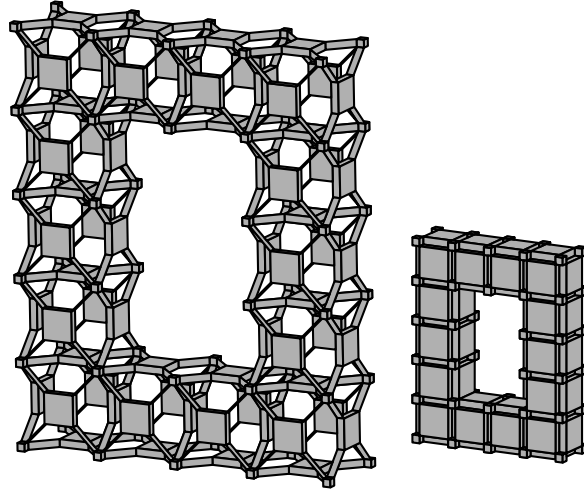


Figure 1: Transformable architecture constructed based on polyhedral complex through 8R over-constraint spatial single-loop linkage (crease loop) (6)

- [4] Miyashita, S., Guitron, S. Li, S. and Rus, D., Robotic metamorphosis by origami exoskeletons, *Science Robotics*, **2**: eaao4369, 2017.
- [5] Reis, P. M., Jiménez, F. L., and Marthelot, J., Transforming architectures inspired by origami, *PNAS*, **112**(40): 12234-12235, 2015.
- [6] Wohlhart, K., Regular polyhedral linkages, *2nd Workshop on Computational Kinematics*, Sophia Antipolis, France, September 4–6, pp. 239-248, 2001.