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Preface: Special issue in origami engineering and physics

This special issue aims to consolidate the latest advancements in origami engineering and physics. Origami, initially a paper craft, has spurred technological innovations and novel engineering designs due to its intrinsic mathematical nature and prevalence in both natural and human-made structures. The concept of origami is quite pervasive.

Applying robust mathematical theories, computational simulations, and experimental characterizations, the papers in this issue delve into recent developments in origami. New modeling approaches for the mechanics of origami structures are unveiled in this special issue. For instance, Tao, Eldeeb, and Li [1] introduced and validated a new origami mechanics model that integrates an Absolute Nodal Coordinate Formulation (ANCF) and Torsional Spring Damper Actuator (TSDA) connectors, demonstrating quantitative agreement with experimental results for examples having complex facet deformation and transient dynamics. Wang and Liu [2] proposed a computational design framework for origami patterns that incorporates non-linear mechanics, particularly elastic stored energy. In their design framework, the stable configuration of the origami structure is determined by minimization of their stored energy under prescribed boundary conditions.

Well-known origami fold patterns, such as the Miura-Ori and the waterbomb, continue to surprise with their utility for future engineering applications and fascinating mechanics. In this context, Lahiri and Pratapa [3] investigated the lattice modes of Miura-Ori tessellations with triangulated faces and internal voids. These tessellations have potential applications in metamaterials and the authors introduced additional loop closure constraints required to model the internal voids. The team composed by Yu, Andrade-Silva, Dias, and Hanna [4] formulated a model for a disk with a single-vertex crease pattern and an inner hole cutout, idealizing it as a wide annular developable strip. The model captures qualitative observations in experiments and numerical simulations. Rodrigues and Savi [5] investigated the non-linear dynamic behavior of a waterbomb unit-cell using a model that employs two degrees-of-freedom. After formulating the governing equations for the kinematics of the waterbomb unit cell and proposing a reduced-order model for the unit cell, numerical simulations were performed to investigate its dynamic behavior to reveal responses such as chaos. Xing and You [6] studied the kinematics of double four-crease origami, which are formed by merging two four-crease single-vertex origami structures. Their findings provided insights in the designs of stackable structures with thick panels that use the double four-crease origami patterns as their basis.

Foldable tubular structures have been explored for several years and there are still multiple aspects of such intriguing structures to unveil. Moshtaghzadeh and Mardanpour [7] investigated how combining different stories in a tubular Kresling structure influences its mechanical characteristics, revealing insights into fatigue, stability, and modal behaviors based on variations in story heights, length ratios, and rotation directions. Sharifmoghaddam, Maleczek, and Nawratil [8] presented a novel method for creating continuous and flexible tubular structures based on the construction of surfaces known as T-hedra (discrete form) and profile-affine surfaces (continuous form), enabling a unified treatment of diverse structures and suggesting potential applications such as foldable bridges. H. Zhang, Q. Zhang, Liang, Yao, Kueh, and Cai [9] studied the rigidity and compression performance of origami tubes known as “flip-flop”, formed by two types of origami tubes arranged in an orthogonal manner. The rigidity of the tubes was assessed using loop-closure equations and the compression characteristics were evaluated using finite element analysis. Turco, Barchiesi, Causin, dell’Isola, and Solci [10] presented a computational study on Kresling tubular origami structures and provided insights on their nonlinear buckling behavior under compression, which is characterized by substantial and abrupt twisting along with large transverse dilation or contraction.

Deployable antennas, an application that is being actively explored by origami researchers, were also covered within the contributions of the special issue. Zhao, Li, Zhou, Liu, Xing, Chen, and Zhang [11] studied the kinematics, deployment, and design of a deployable antenna based on the Miura-Ori fold pattern, where the deployment was achieved using a linkage frame attached to the back of the Miura-Ori structure. Cheng, Xu, Jin, Shen, and Zhang [12] researched bifurcations and mode transitions of buckled ribbons using computational and experimental approaches. Their models are employed to demonstrate a tri-stable mesostructure with a buckled ribbon, which could be used to design morphing antennas capable of tuning their radiation pattern or central frequency.

This summary provides an idea about the scope of each contribution, and the reader is directed to the actual papers for more details. We hope the contributions of this special issue prove highly beneficial to your research and projects that rely upon sound and innovative advances in origami engineering and physics.

Sincerely,
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