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Computational modelling methods for pliable structures based on curved-line folding

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Abstract

Curved-line folding, the act of folding paper along a pattern of curved lines to obtain a 3D shape, is an interesting starting-point for the design of innovative pliable structures. There exists a kinematic connection between two surfaces linked through a curved crease that can be used to generate a folding motion. However, due to the interdependency of geometry, forces and material properties the design of pliable structures based on curved-line folding is very complex. To facilitate the design process, adequate computational modelling methods are essential. This paper presents two ways of modelling: a geometric modelling method based on discretisation of the crease pattern and a method based on Finite Element Analysis (FEA). The proposed methods are validated by means of a case study in which a physical model is compared to digital ones. It can be concluded that the method based on FEA corresponds very well with the physical model, proving its potential. The accuracy of the geometric modelling is improved by the introduction of a set of guidelines based on the direction of the principal bending moments in the pliable structure. Furthermore, the case study exposes how the material-dependent behaviour of pliable structures increases the complexity of the design and should certainly be part of future research.