A cellular morphogenesis method for 3D tensegrity structures

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ABSTRACT

In architecture and engineering, a tensegrity describes a system in stable self-equilibrated state comprising a discontinuous set of compressed components inside a continuum of tensioned components. In mathematics and rigidity theory, a tensegrity is defined as a self-stressed framework. The topology and form finding of tensegrity structures have been studied extensively since the introduction of the tensegrity concept. However, most of these studies address topology and form separately, where the former represented a research focus of rigidity theory and graph theory, while the latter attracted the attention of structural engineers. In this work, a bio-inspired generative design approach for the combined topology and form finding of spatial tensegrity systems is introduced (see [1] for further details). Tensegrity cells, elementary infinitesimally rigid self-stressed structures that have been proven [2] to compose any tensegrity, are used to generate more complex tensegrity structures through the morphogenesis mechanisms of adhesion and fusion. A methodology for constructing a basis to describe the self-stress space is also provided. Through the definition of self-stress, the cellular morphogenesis method can integrate design considerations, such as a desired shape or number of nodes and members, providing great flexibility and control over the tensegrity structure generated.

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