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Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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SHAPE CHANGE ANALYSIS OF MODULAR TENSEGRITY STRUCTURES FOR PARABOLIC REFLECTORS

Abstract

Tensegrity structures, comprised of struts suspended in a network of tensioned cables, are light-weight alternatives to classical truss structures with a wide variety of aerospace application. This research investigates the use of tensegrity structures as the backbone of a deployable, shape-changing parabolic reflector. The tensegrity structures are designed with a very large-scale reflector in mind, such that the tensegrity structure may be used as a module, multiple of which may be sent in different launches, where they would be deployed and assembled in space.

Completed research has investigated the ability of two types of modules to achieve a prescribed paraboloid shape on one surface of the tensegrity. The first module is comprised of 6 triplexes, and the second is comprised of 4 quadruplexes. These modules are assumed to start in a parallel shape (where the top and bottom surfaces of the tensegrities are parallel), and then change member lengths to adjust one surface to fit a prescribed paraboloid. For each module, a localized search for achievable shapes near the starting configuration for a single sub-tensegrity (i.e. triplex or quadruplex) is conducted. This localized search provides a large variety of achievable shapes within the specified, nearby bounds on the nodes. The resulting data set is then searched for the best fitting shape to the prescribed surface, and used as a starting point for a particle swarm optimization search of a nearby shape that the best possible fit to the prescribed surface.

Near future research will investigate the achievable shapes of the module on the whole. The shapes the entire module can achieve will be characterized using the same methods applied to sub-tensegrities in the modules, but with a broader scope to encompass more types of shapes, and applied to the entire module (either at once, or else via combining results of a single sub-tensegrity to consider the require module connectives between sub-tensegrities). This broader characterization of achievable shapes for each module will be used not only to fit the module to a prescribed paraboloid surface, but also for deployment considerations. The solution space can be searched for shapes which have a small total volume to use as the stowed state, with the deployed state being the fit to the desired paraboloid surface. Previous research in searching for paths amongst a known set of equilibrated shapes will be used to evaluate the ability of the module to move only through equilibrated shapes between the stowed and deployed states, with consideration of member interference. As a result, this research will present a broad picture of the types of shapes the proposed tensegrity modules can achieve, including a variety of paraboloid surfaces, as well as shapes between stowed and deployed states.