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MODELLING AND DYNAMICS OF THE DEPLOYMENT OF MESH ANTENNAS

Abstract

Promoted by the rapid development of high-resolution satellites, in recent years, foldable mesh antennas have attracted great research attentions, benefited from their high package ratios and low areal densities. A state-of-art example is the Astromesh antenna. It comprises a deployable truss with several identical parallelogram bays, a pair of mirror cable networks mutually tensioned by tie forces, and a driving cable running over pulleys and across diagonals. At the truss design stage, all of the truss members are assumed to be rigid, and the entire truss owns a single degree-of-freedom. Hence, if motors reel in the two ends of the driving cable, the diagonals of all bays are shortened with the same speed which in turn unfolds the bays in a simultaneously manner. However, during practical deploying process, the flexibility of truss members is indispensable and visible deformation occurs. Moreover, the friction between cable and pulleys makes the bays near the motor deploy faster than the bays far from it, in other words, the bays deploy in an asynchronous manner. As a result, the truss members experience remarkable bending moment that is hard to be predicted from theoretical or measured from experimental point of view. This study is motivated by understanding the deployment dynamics of flexible mesh antennas, and providing an approach for deciding the bending moments for design propose. We first present a flexible multibody model of a mesh antenna, and special attention is paid on formulating the driving cable and the friction within cable-pulley systems. Then, using a 12.25-meter Astromesh antenna as an example, the kinetics and dynamics of the deployment was systematically investigated, focusing mainly on the bending moments of the truss members, the motor driving force and the effect of cable-pulley friction. Furthermore, the energetics of the deployment was addressed to provide a deep view of the nonlinear nature of the deployment of mesh antennas.