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MULTIBODY DYNAMICS ANALYSIS AIMING ON-ORBIT ASSEMBLY OF 30M-CLASS SQUARE LIGHTWEIGHT PLANER ANTENNA

Abstract

JAXA has been working on the research of the on-orbit assembly method of large and lightweight space structures, aiming for the realization of a 30m-class square lightweight planer antenna. DELIGHT (DEployable LIGHtweight planar antenna Technology demonstration) mission, which will be launched next year, is going to demonstrate our proposed assembly method on-orbit. Our proposed assembly method of a lightweight planar antenna consists of two columns of four serially-connected antenna panels, each column has a different deployment mechanism. Panels of the first column are deployed with the thin tape spring inserted between the adjacent panels, and no synchronization mechanism is implemented for simplicity. Panels are deployed as the tape spring force is released and latched when the neighboring panels form the planner surface. After the first column panels are fully deployed, the deployment of the second column is initiated. Prior to deployment, the tip of the second column is attached to the guide rail on the side of the deployed first column. Then the connected tip is towed along the guide rail, and the second column panels are deployed as the tip end extends. The proposed deployment mechanism has three main novelties. Firstly, the synchronous deployment of multiple panels is unnecessary, making the mechanism highly simple and reliable. Secondly, the proposed assembly method can be modularized as multiple panel columns and scalable by appending additional column modules. Thirdly, the proposed assembly method can enhance the surface accuracy of the assembled plane compared to the conventional deployment method, which is important to realize the Ku-band antenna on-orbit. To design such deployable planner space structures, the deployment trajectory of panels has been analyzed with multibody dynamics simulation. Each panel is modeled as a rigid panel with six degrees of freedom. Panels on the first column are interconnected to neighboring panels with tape springs, simulating the deployment with spring force. While panels on the second column are connected with a hinge, and deployment is simulated by providing the position of the tip as a predefined trajectory. Deployment is calculated by solving the equation of motion along with the kinematic constraint equations of panels. The developed simulation realized the deployment analysis of the proposed lightweight planar antenna assembly method.