Simulation Studies Using Multibody Dynamics Code DART

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Abstract

DART is a multibody dynamics code developed by Photon Research Associates for the Air Force Astronautics Laboratory (AFAL). The code is intended primarily to simulate the dynamics of large space structures, particularly during the deployment phase of their missions. DART integrates nonlinear equations of motion numerically. The number of bodies in the system being simulated is arbitrary. The bodies' interconnection joints can have an arbitrary number of degrees of freedom between 0 and 6. Motions across the joints can be large. Provision for simulating on-board control systems is provided. Conservation of energy and momentum, when applicable, are used to evaluate DART's performance.

After a brief description of DART, the paper describes studies made to test the program prior to its delivery to AFAL. Three studies are described. The first is a large angle reorientating of a flexible spacecraft consisting of a rigid central hub and four flexible booms. Reorientation was accomplished by a single-cycle sine wave shape torque input. In the second study, an appendage, mounted on a spacecraft, was slewed through a large angle. Four closed-loop control systems provided control of this appendage and of the spacecraft's attitude. The third study simulated the deployment of the rim of a bicycle wheel configuration large space structure. This system contained 18 bodies. An interesting and unexpected feature of the dynamics was a pulsing phenomena experienced by the stays whose playout was used to control the deployment.

The paper concludes with a short description of the current status of DART.