Dshell/DARTS: A Multi-Mission Spacecraft Simulation Framework

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Physics-based simulations play a key role throughout a space mission's life-cycle. Their use spans early design trade studies, flight system development, integration, test, and mission operations. The need for high-fidelity simulation is increasing with the growing complexity of future missions involving precision landing, hazard avoidance, formation flying, surface exploration, and on-board autonomy. The Dshell/DARTS simulation framework has been developed at the Dynamics and Real-Time Simulation (DARTS) Lab with the goal of providing a configurable and reusable spacecraft simulation architecture and toolkit to meet these simulation needs. Dshell includes the DARTS flexible multi-body dynamics computational engine, a modeling framework for developing reusable dynamics and device models and processes for configuring such models at run-time into spacecraft simulations. The Dshell architecture also provides extensive instrumentation for easy usability and for detailed visibility into simulations. Dshell can be used within a workstation environment, as a stand-alone simulation, in closed-loop configurations, and in real-time, hardware-in-the-loop environments. As it has evolved, the Dshell Toolkit has been adapted by several missions over the years, including Galileo, Cassini, Mars Pathfinder, DS-1, Starlight, SIM and others.

In this talk, Dr. Jain will discuss recent developments focusing on extending the Dshell framework to newer mission domains. These include the development of the DSENDS entry, descent and landing simulator, the ROAMS planetary rover simulator, distributed simulations for formation-flying missions, simulations for autonomy technology development, and rendezvous and sample capture testbeds. He will also describe Dshell's architectural elements, as well as some of the unique challenges associated with the development of such reusable software.

Dr. Abhinandan Jain is a Principal Technologist in the Mobility Systems Concept Development Section (348) at JPL. He is leading tasks towards the development of the Dshell simulation framework and the ROAMS planetary rover simulator. Jain's research work has included the development of the Spatial Operator Algebra computational multi-body dynamics methodology that formed the basis of the DARTS development. He received a NASA Space Act Award in 1995 for the Spatial Algebra research, and the NASA Software of the Year award for DARTS in 1997. Jain was also a Co-Principal Investigator on an NSF Grand Challenge Project for large-scale molecular dynamics simulations. He authored the NEIMO constrained molecular dynamics simulation software, which is in active use by computational chemistry researchers at Caltech. Jain received another NASA Space Act Award for this research in the year 2000. He has authored over 20 peer-reviewed journal papers, and 40 conference publications.

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