Capitol Graduate Research Summit

NEURAL NETWORK ASSISTED TRAJECTORY PLANNING FOR SPACE MISSIONS

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A critical aspect of space mission analysis is spacecraft trajectory optimization, which is a challenging problem involving nonlinear dynamics, multiple phases, nonconvex objectives, and complex constraints. State-of-the-art trajectory optimization solvers are primarily meant for use by personnel on the ground; however, onboard trajectory planning capability can enhance mission flexibility and responsiveness to uncertain situations. Our research focuses on applying machine learning techniques to improve the performance of our in-house trajectory planning tool on two fronts: (1) accurate prediction of atmospheric density for Mars aerobraking maneuvers, and (2) improvement of quality of orbit-raising trajectories to Geostationary Earth Orbit (GEO). These applications are important for reducing the cost of space missions through significant reduction of fuel expenditure, which in turn allows for stacking multiple satellites in a single launch vehicle and lowering launch costs. Consequently, given new emphasis on GEO applications (GOES-T mission enhancing tornado warning lead time and GeoCarb mission monitoring vegetation stress), the benefits of mission cost reduction are important for Kansas. Additionally, recent years have witnessed an enhanced involvement of private industry (notably SpaceX, Boeing, Lockheed Martin and Blue Origin) in near-Earth and deep space missions. This also means new business opportunities for Kansas companies that already have a strong aeronautical infrastructure. In this context, our research on mission planning for spacecraft with solar-electric propulsion has provided a new platform for engaging Kansas stakeholders (multiple universities) with NASA and private industry.