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SIMPLE ADAPTIVE CONTROL OF A SATELLITE WITH LARGE FLEXIBLE APPENDAGES

Abstract

Previous research into the development and testing of on-board software for a satellite Attitude and Orbit Control System (AOCS) has yielded a combination of an engineering design and analysis tool and an environment that allows for real-time simulations. This simulation model has been extensively validated related to the orbital and attitude dynamics and Earth aerospace environment and has led to an accepted method for Generic AOCS (GAOCS) design and analysis. The use of the validated environment has been illustrated for the development of a complex attitude control system based on a Simple Adaptive Control (SAC) algorithm.

The previous instances of the SAC system utilised simplified satellite geometries including rigid body modes only. However, the effect of flexible bodies, such as solar panels and antennae, can greatly affect the efficacy and accuracy of an on-board almost strictly passive (ASP) controller and lead to undesired deviations from the commanded attitude and orbital path. Therefore, the inclusion of elastic body deformation modes of the satellite appendages in the real-time controller has been implemented in a MATLAB/SIMULINK simulation environment.

The rigid body-elastic body coupling in simulation has been investigated using a finite element description with Lagrange multipliers as force constraints. The coupled dynamics increases the controller effort and showed effect of the elastic bodies on the controller system by the deviations from the previously verified MATLAB/SIMULINK GAOCS. Since the primary system condition to apply SAC is that the non-linear plant is ASP, the influence of the elastic-body modes on the passivity conditions is studied. Finally, because one of the key advantages of SAC is that the concept is based on output tracking, a proper tuning of the adaptive controller and its reference model should lead to a rigid-body behaviour of the satellite with flexible appendages.