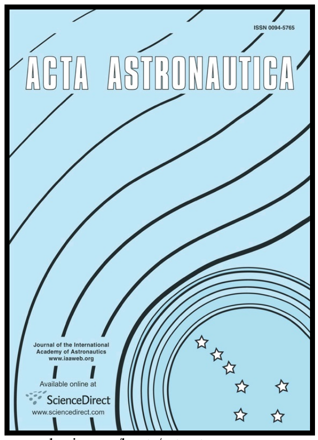
Author's Accepted Manuscript



www.elsevier.com/locate/actaastro

Constrained Spacecraft Reorientation Using Mixed Integer Convex Programming

Margaret Tam, E. Glenn Lightsey

PII: S0094-5765(16)30315-0
DOI: http://dx.doi.org/10.1016/j.actaastro.2016.04.003
Reference: AA5770

To appear in: *Acta Astronautica*

Received date: 31 July 2015
Revised date: 19 January 2016
Accepted date: 4 April 2016

Cite this article as: Margaret Tam and E. Glenn Lightsey, Constrained Spacecraf Reorientation Using Mixed Integer Convex Programming, *Acta Astronautica* http://dx.doi.org/10.1016/j.actaastro.2016.04.003

Constrained Spacecraft Reorientation Using Mixed Integer Convex Programming

Margaret Tam[a,*], E. Glenn Lightsey[b]

[a] Texas Spacecraft Laboratory, The University of Texas at Austin, Austin, TX 78712
[b] Space Systems Design Laboratory, Georgia Institute of Technology, Atlanta, GA 30332

Abstract

A constrained attitude guidance (CAG) system is developed using convex optimization to autonomously achieve spacecraft pointing objectives while meeting the constraints imposed by on-board hardware. These constraints include bounds on the control input and slew rate, as well as pointing constraints imposed by the sensors. The pointing constraints consist of inclusion and exclusion cones that dictate permissible orientations of the spacecraft in order to keep objects in or out of the field of view of the sensors. The optimization scheme drives a body vector towards a target inertial vector along a trajectory that consists solely of permissible orientations in order to achieve the desired attitude for a given mission mode. The non-convex rotational kinematics are handled by discretization, which also ensures that the quaternion stays unity norm. In order to guarantee an admissible path, the pointing constraints are relaxed. Depending on how strict the pointing constraints are, the degree of relaxation is tuneable. The use of binary variables permits the inclusion of logical expressions in the pointing constraints in the case that a set of sensors has redundancies. The resulting mixed integer convex programming (MICP) formulation generates a steering law that can be easily integrated into an attitude determination and control (ADC) system. A sample simulation of the system is performed for the Bevo-2 satellite, including disturbance torques and actuator dynamics which are not modeled by the controller. Simulation results demonstrate the robustness of the system to disturbances while meeting the mission requirements with desirable performance characteristics.

Keywords: convex optimization, spacecraft, attitude, guidance, control, constrained

*Corresponding Author
Email addresses: mtam@utexas.edu (Margaret Tam), glenn.lightsey@gatech.edu (E. Glenn Lightsey)