Paper ID: 64696
oral
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics (2) (9)

Author: Mr. Adrian Fried
Technische Universität Berlin, Germany, a.fried@campus.tu-berlin.de

Dr. Sebastian Grau
Germany, grau.sebastian@frech.com

APPROACHES TO OPTIMAL CONTROL OF FLUID-DYNAMIC ACTUATED SMALL SATELLITES

Abstract

In the wake of the development of picosatellite fluid-dynamic actuators, novel modes of operation have been proposed for small satellites recently. In order to be able to execute these novel operational modes, optimal control approaches and refined control allocation methods are researched and presented in this paper.

First, the latest state of the development in picosatellite fluid-dynamic actuators is presented. The paper will presenet the BEESAT-9 mission which supports a combination of three orthognally mount reaction wheel and a single fluid-dynamic actuator. Then the dynamic properties of the fluid-dynamic actuators that were developed for the TUPEX-7 experiment will be discussed. TUPEX-7 combines a set of three orthogonally mount fluid-dynamic actuators with a set of three orthogonally mount magnetic coils. This pseudo-CubeSat will be launched in the scope of the REXUS cycle 12 in March 2021.

Based on previous work, an improved implementation of control allocation between reaction wheels and fluid-dynamic actuators is presented first. The allocation is based on the momentarily available pFDA torque.

Next, optimal control approaches for a spacecraft with three orthogonally mount reaction wheels in combinaion with a single fluid-dynamic actuator are presented. Linear-quadratic regulator and model-predictive control approaches are employed to simulate the execution of novel small satellite modes of operation; namely artificial swath increase and single-spacecraft stereo-imaging.

To highlight the benefits of a pFDA-only attitude control system, similar control approaches are applied to a setup that consists of three orthogonal pFDAs instead. Benefits of such a system are the quasi-instantaneous availability of large angular rates which allow for a highly agile reorientation in all three spacecraft axes. The same novel modes of operations are simulated and the results are compared to the combination of reaction wheels and pFDAs.