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INVESTIGATION OF REDUNDANCY STRATEGIES IN FLUID-DYNAMIC ATTITUDE CONTROL

Abstract

The ongoing research of fluid-dynamic actuators (FDAs) at Technische Universität Berlin (TU Berlin) has culminated with the launch of the TechnoSat nanosatellite mission in 2017, which carried the first ever FDA to orbit. To enable this novel and promising technology for CubeSat missions, picosatellite fluid-dynamic actuators (pFDAs) are researched at TU Berlin.

The 3D-printed fluid conduits of the pFDAs allow for great flexibility in conduit geometry. This enables design of mass efficient conduits that can be mounted to CubeSat solar panels. Benefits of this design are a highly increased available payload volume and improved attitude control torque in comparison to miniaturized reaction wheels (RWs).

Owing to the shape of CubeSats, a set of three solar panels equipped with pFDAs enable full 3-axis attitude control. With increased mission complexity on current and future CubeSats, the requirement for redundancy of the actuators will arise. Using panel-mount actuators, this requirement may only be met mounting a second actuator on every one of the body-fix axes. Increasing the number of actuators to six, the attitude control system mass and power consumption will exceed the available resources.

Reaction wheels are employed in sets of four to enable full redundancy. On CubeSat missions a large quantity of available volume, mass, and power would be invested in such systems. This paper shows, how careful design of three-dimensional conduits enables the formation of a redundant set of four pFDAs. Maximum angular momentum capacity available for a single three-dimensional actuator is discussed. The authors present the results for developing said attitude control system which will be used in the scope of a student-lead sounding rocket project to demonstrate a payload capacity of about 30

The present work numerically demonstrates the stability of the system and shows results of the angular momentum measurements performed on a laboratory gas bearing environment.