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Author: Mr. Thomas Terzibaschian
DLR, German Aerospace Center, Germany, thomas.terzibaschian@dlr.de

Mr. Wolfgang Baerwald
Astro- und Feinwerktechnik Adlershof GmbH, Germany, w.baerwald@astrofein.com
C. Raschke
Astro- und Feinwerktechnik Adlershof GmbH, Germany, c.raschke@astrofein.com
Mr. Andreas Kotz
German Aerospace Center (DLR), Berlin, Germany, Andreas.Kotz@dlr.de
Mr. Christian Schultz
DLR (German Aerospace Center), Germany, christian.schultz@dlr.de
Mr. Xavier Amigues
DLR (German Aerospace Center), Germany, xavier.amigues@dlr.de
Mr. Andre Choinowski
DLR (German Aerospace Center), Germany, andre.choinowsky@dlr.de
Dr. Winfried Halle
DLR (German Aerospace Center), Germany, winfried.halle@dlr.de

HIGH TORQUE WHEELS FOR AGILE SATELLITE MANEUVERS - IN ORBIT EXPERIENCES AND FUTURE STEPS WITH RECUPERATION OF ENERGY

Abstract

Agility is a necessary skill for several tasks. This applies in particular to remote sensing applications, but is also useful for optical communication from satellite to ground. While discussing a new reconnaissance satellite, the need for suitable actuators for agile maneuvers was identified several years ago. Developments for robotics at DLR (e.g. ROKVIS experiment on board the ISS 2004-2011) gave rise to the option of further developing the reaction wheel principle for the special use case "high torque" for fast accelerations. This was in competition with the widespread use of CMGs. Therefore it was decided to equip the small satellite BIROS (launch 2016)with 3 "High Torque Wheels" (HTW) as additional technological payload. With this down-scaled version of the HTWs, the proof of the concept should be made under real conditions in space. This included various agile satellite maneuvers such as for "in track stereo", scanning up to 5 parallel image strips on ground or switching between different targets on ground. Of course, this required, among other things, modifications to the ACS and the power supply system, which had been taken over from the DLR small satellite TET-1. The ACS uses several "attitude modes" for a comfortable and autonomous attitude control of the satellites in space. This has been extended by a special "Fast Slew Mode", which has been developed for fast maneuvers using HTWs. The standard satellite slew rate used for all reorientation maneuvers is 0.5 degrees per second with a freely selectable slew axis. A fast slewing maneuver is intended to reorient the satellite by up to 30 degrees within 10 seconds. Actually however, the satellite achieved angular speeds of up to 10 degrees per second in space. A fast slew maneuver is finished, when all the HTWs are nearly stopped and the default ACS actuators took over the remaining angular momentum. This process of momentum exchange between the actuator systems was one important aspect of investigations. Another test case was the usage of these 3 experimental HTWs as actuator of the ACS. After successful completion of the first experimental phase in orbit the work will be

continued by improving the fast slew maneuver algorithms and by preparing a second experimental phase in space including active payload cameras in the defined image scenarios. The HTW will be equipped now with an energy recuperation system storing electrical energy instead of kinetic energy within a spinning CMG.