SPACE EDUCATION AND OUTREACH SYMPOSIUM (E1)
Lift Off - Secondary Space Education (2)

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ATTITUDE CONTROL ON THE "MAX VALIER" STUDENT SATELLITE: A PROJECT BY HIGH SCHOOL STUDENTS

Abstract

The "Max Valier" student satellite is being developed by two High Schools in South Tyrol, Italy, with the support of OHB System AG in Bremen, Germany. The satellite is equipped with solar cells on only one side, thus requiring an active attitude control.

To this end, the satellite employs four sensors (a coarse sun sensor, a fine sun sensor, a magnetic field sensor, and a star camera), and four actuators (three magnetic torquers and one momentum wheel).

In this paper, we present sensor interface circuits and actuator drive electronics developed by High School teachers and students. In addition, we present an ADCS strategy developed at Max Valier High School which performs the following tasks: calculation of the sun and magnetic field vectors, sun acquisition, inertial stabilization of sun pointing using the momentum wheel, and a slow rotation of the satellite about the inertial axis.

To keep the algorithms simple, within the reach of High School students, the torques to control the sun pointing attitude are generated using only the magnetic torquers and all control algorithms are of ON-OFF type. With these simplifications, it is not possible to generate torques in arbitrary direction. Rather, out of the 26 nonzero possible torques which can be generated with three torquers in ON-OFF mode, we choose the one with the smallest angular deviation from the required torque. The angular rate about the inertially stabilized axis is controlled by varying the momentum wheel's speed at high deviations from the setpoint value. Otherwise, only the magnetic torquers are used.

The performance of these algorithms is tested via numerical simulations. It turns out that this attitude control strategy, in spite of being simple, is fast and precise enough for our student satellite.

The novelty of the presented results is given by the fact that the algorithms can be understood and implemented by High School students who have successfully mastered their Physics curriculum, thus providing an introduction to an important field of space technology at a young age.