Three axis Attitude Determination and Control System for a picosatellite: Design and implementation

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The design and implementation of the Attitude Determination and Control System (ADCS) for a Norwegian picosatellite is presented. The satellite, named Ncube, is based on the CubeSat concept. This means that its size is restricted to a cube measuring 10cm on all sides and that its total mass is restricted to 1kg. Meeting these restrictions represents the main technical challenge of the work. The complete cube includes the payload, ADCS with actuators and sensors, deployable antennas, communication systems, OBDH and power system. Miniaturization is a key approach in order to meet the tight mass budget.

The Determination part of the ADCS is solved by integrating measurements from a three-axis magnetometer with current measurements from the solar panels in a Kalman filter. A novel approach is used to employ the solar panes as a crude sun sensor. The Control part is solved by using a combination of magnetic coils and gravity boom. The control system operates in one of two modes: 1) Detumbling and 2) Stabilization. The control laws are derived using Lyapunov theory, and stringent stability proofs are given. The gravity boom is realized using measurement tape, and a boom release policy guaranteeing release in the right direction will be presented. Simulations of both detumbling, boom deployment and stabilization are presented.

The Ncube satellite project is a cooperation between several Norwegian educational, research and indutrial environments. The payload is an automatic identification system, AIS, which is as a mandatory system on all larger ships. It transmits identification and position data messages on the 162 MHz maritime VHF band. The satellite prototype is under construction and launch is planned for the second half of 2003.

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