Interreg Sudoe

EUROPEAN UNION

NANOSTAR

European Regional Development Fund

Research and innovation

Attitude Determination and Control System (ADCS) elements

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NANOSTAR consortium

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APPLICABLE AND REFERENCE DOCUMENTS

List of all references used or mentioned in the main text, and may include a list of the acronyms used in the report. A change record table, like the one reported below, should be added in this section.

TABLE 1: Change log record table

Edition/Revision	Date	Description of the change
V0.0.1	18/12/2019	Initial version of the document

INTRODUCTION

In a satellite, the ADCS subsystem is in charge of the control of the attitude (orientation) of the satellite. To maintain requested attitude the 3U-CubeSat developed at CSUM relies on actuators (reaction wheels and magnetorquers) and sensors (Sun sensors, magnetometer, gyroscope).

In order to test the control algorithms implemented on the on-board computer, a test bench has to be developed. This test bench consists of a simulated environment (Matlab/Simulink) that simulates actuators and sensors while the on-board computer runs ADCS algorithms as if it was controlling real actuators and getting data from real sensors.

The objective of this challenge is study, design, and develop such a test bench.

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STATE-OF-THE-ART

This challenge gives student the possibility to learn about the whole ADCS subsystem of a 3U-CubeSat. From the environment model simulating the Sun and satellite positions, the actuators and sensors inputs and outputs, to the on-board controller trying to maintain desired attitude according to simulated sensor data, every aspects of the ADCS loop will be studied during this challenge.

CENTRE SPATIAL UNIVERSITAIRE DE MONTPELLIER

CSUM is an educational platform of Montpellier University for Science and Technology through nanosatellite engineering.

In France, the CSUM is one of the leaders in the development of student nanosatellites. It is also a European center of reference devoted to bring together equipment and skills for the development, production, testing and operation of nanosatellites. These projects involve student interns and encourage regional economic development.

To do this, the CSUM has facilities and equipment dedicated to nanosatellite engineering:

- A control center including a transceiver radio station and antennas in UHF and S-Band;
- A dedicated CIC room (concurrent engineering center);
- AIT facilities (Assembly, Integration and Testing) including a clean room and multiple workshops;

The CSUM develops its own nanosatellite technology producing 1U and 3U CubeSats.

SPECIFIC CHALLENGE OBJECTIVES

The challenge is divided in 3 different objectives:

1. Establish a bibliographic study of CubeSat ADCS control systems. The team will focus their study on control system technics as well as actuators and sensors used in the CubeSat world.

2. Propose several Matlab/Simulink models in order to simulate:
    - Environment (Sun position in satellite reference frame, magnetic field vector in satellite reference frame, satellite position on its orbit). These models will be generic and output results for variable reference inputs (current date, TLE).
    - Actuators (reaction wheels and magnetorquers) and sensors (gyroscope, magnetometer, Sun sensor). These models will be generic and configurable in order to simulate different actuators and sensors according to manufacturer datasheets.
    - ADCS control loop using models developed above. This model will be then converted to a C/C++ program in order to execute it on a microcontroller.

3. Propose and test a hardware architecture to test the ADCS control loop running on a microcontroller while environment, actuators and sensors are simulated by Matlab/Simulink models.

FIGURE 1. ADCS "HARDWARE IN THE LOOP" TEST BENCH

Duration of the challenge: 4 to 6 months

Deliverables: **The developed models (well commented),** a report, in English, describing the activities carried out, the original goals and the achieved ones, with the NanoStar Template and a presentation of the challenge.

Composition of the team: One or more students from the Universities of the NanoStar project. If possible as much women as men and from different countries.

Rewards: A diploma of participation, a visit and goodies from the University Space Center of Montpellier (CSUM), the University of Montpellier (UM) and NanoStar project and others rewards for the most innovative team.

If you are interested in this challenge, contact us at nanostar-projet@umontpellier.fr or on the NanoStar website.