Modelling and Control of Attitude Dynamics applied to the CubeSat Project "NanoBob"

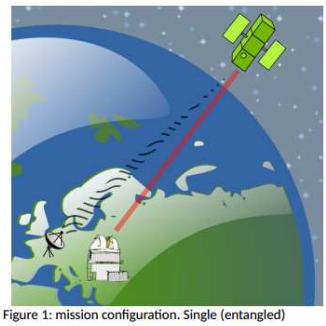

Figure 1: mission configuration. Single (entangled) photons are sent from the Vienna telescope to the receiver on board of the NanoBob cubesat. Satellite control and data transmission is done by conventional radio communication.

Context: This internship is a part of the second satellite project of the Grenoble University Space Center (CSUG) that starts its Phase-0 study in September 2016. The "NanoBob quantum cubesat" or NanoBob Cubesat mission presented here wants to demonstrate the experimental feasibility of a free space full quantum communication link over a distance greater than 500 km. The project assumes collaboration on an equal basis between "Grenoble" and the Austrian Academy of Sciences. Quantum communication is a strategic scientific domain that is expected to become in the near future the preferred method to transmit encrypted data by exchanging single photons between two stations. On the Grenoble side, the project is led by CSUG (https://www.csug.fr/). One of the main partners of the project is GIPSA-Lab (http://www.gipsa-lab.fr/), whose mission is to study the Attitude Determination and Control System (ADCS) of NanoBob.

Project: The first goal in this project is to deal with the attitude dynamics of a CubeSat. The internship student needs to study the state-of-the-art and elaborate the mathematical modeling of satellite attitude dynamics for 3 degrees of freedom based on the rigid body kinetics, kinematics, environmental torques, and actuator dynamics. The proposed attitude model needs to be readjusted according to the specification of NanoBob. At this time, Phase-0 or Phase-1, the student should mainly understand the attitude coordinate systems, the attitude representations and the main sensors/actuators that sometimes need to be used in such problem. Some simulations under Matlab (or Simulink) should be achieved to evaluate the proposed model and its limitations.

In a second part of this work, the student should study the attitude controller schemas in literature. A detailed study on main controllers proposed in literature should be established and tested in simulations in order to understand the limitations and what will be the best approach of control for our proposed CubeSat model. A discussion and (if possible) a first proposition of controller will be appreciated.

Bibliography and links to related works:

- https://web.wpi.edu/Pubs/E-project/Available/E-project-030113-141835/unrestricted/2013_ADC_Report_Final.pdf
- http://citeseerx.ist.psu.edu/viewdoc/download?rep=rep1&type=pdf&doi=10.1.1.208.3894
- http://www.dept.aoe.vt.edu/~cdhall/courses/aoe4140/intro2adcs.pdf
- http://ktb.engin.umich.edu/RSG/pubs_files/AeroConf-2015_Fritz-etalCYGNSS-ADCS.pdf
- http://www.space.aau.dk/cubesat/dokumenter/ADC-report.pdf

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Candidate profile: We search for a student in Engineering School Final Project (PFE) or second year Master with a training in Automatic Control, Signals and Systems. High motivation and personal interest in the subject is highly appreciated.