Master Thesis: OUFTI-NEXT ADC Subsystem

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OUFTI-Next ADC subsystem

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This Master Thesis is the first part of a deeper work about orbit and attitude dynamics coupled ADCS for high surface-to-mass ratio satellites. Nowadays spacecrafts are designed with complex shapes and large areas in order to accomplish more peculiar mission objectives, maintaining a low mass to reduce the launch cost. As a result, for the Earth observation satellites aerodynamic drag and solar radiation pressure become the main actors, driving and coupling the orbital dynamics with the attitude one. This is the case of ZodiArt, a new mission carried out by Politecnico di Milano and supervised by Prof. Camilla Colombo, whose aim is to launch a fleet of MicroSats each of them equipped with a reflective balloon, to promote space advertisement during night time and to enhance Earth observation during day time. The work done is subdivided as follows:

- Period at ULiège on OUFTI-Next:
  - ADCS design and requirements based on the optical design and performances.
  - Optimization of the image acquisition through slewing maneuvers.
  - Development of an ADCS simulator.
  - Study of the perturbations due to the cryocooler.
  - Trade-off between KUL and Hyperion ADCS units.
  - Emergency strategies simulations.
- Period at Politecnico di Milano:
  - Test of the simulator provided to ULiège with ZodiArt platform.
  - Development of the simulator including a united state model to couple the orbit and attitude dynamics.
  - Sizing of the ADC subsystem of ZodiArt platform in order to exploit perturbations to control the spacecraft.

Thanks to the part of Thesis here presented, it has been possible to simulate the control and determination action of the OUFTI-Next ADC subsystem, providing 3 mission profiles which represent the operative behavior of the CubeSat during its lifetime, both on ISS and Sun synchronous orbit. In chapter 1 an introduction to the OUFTI-Next project has been provided and the structure of the work explained, then in chapter 2 the fundamental nomenclature has been reported and in chapter 3 the main results previously obtained from the team about the other subsystems are presented. In chapter 4 it has been described how the physics of the problem has been modeled, while chapter 5 has been dedicated to explain the logic behind control parameters optimizations, then in chapter 6 the majority of the results has been listed and commented. Additional analysis have been performed in chapters 7, 8, 9 and 10 respectively about the cryocooler disturbances effects, the sensors noises and update rates, the trade-off between *Hyperion* and KUL ADCS units and the emergency strategies in case of one reaction wheel or the star tracker failure.
This Thesis has also an appendix, where the reader can find the results of the second mission profile, both in SSO and ISS orbits, with target following slew maneuvers, and the de-tumbling model made in Simulink™.

Cristiano Contini, 16/08/2018, Liège