*THESIS ABSTRACT*

# “CONTRIBUTIONS TO SPACE VEHICLE ATTITUDE CONTROL USING HYBRID OR ELECTRIC SYSTEMS”

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The agile attitude control is relevant both for civilian and military spacecraft and it is needed when the relative velocities are high and the required reaction times are small.

An attitude control system contains sensors, actuators and an autopilot represented by the onboard computer. There is a large variety of sensors that can be used for agile attitude control and they are used in the process of attitude determination.

The algorithm running on the autopilot generates control signals based on attitude information provided by the sensors. The control signals are sent to the actuators which can be moment wheels or jet based devices. The entire control loop needs to be executed with a high enough frequency in order to ensure a smooth and fast spacecraft attitude control.

The main characteristics of sensors are: reliability, cost and technological characteristics. Within the current research we analyze solar, magnetic and gyroscopic sensors.

The main characteristics of actuators are: reaction time, possibility to generate a wide range of correction torques (from small to large values), precision and reliability.

In order to ensure an agile attitude control a combined system is proposed containing both electrical and hybrid systems. Hybrid systems are represented by the jet actuators while the electrical systems are represented by the momentum wheels. Both hybrid and electrical systems ensure a fast and smooth attitude control and the choice of one or another system is done based on the operational requirements of the given spacecraft.

Chapter 1 contains the state of the art in the area of spacecraft attitude determination and control systems. It also contains several examples of civilian and military space missions and their respective attitude control systems.

Chapter 2 contains an analysis of main mathematical methods used for the attitude determination and control of a spacecraft. Euler angles are compared with quaternion formulation outlining the advantages of quaternion formulation. Also within this chapter the main sensors are analysed together with the methods used for agile attitude determination.

Chapter 3 contains main numerical models for the actuators used for the agile attitude control. These numerical models are presented both for jet actuators and for the momentum wheels.

Chapter 4 presents numerical models used for the simulation of attitude determination and control and the comparison with the experimental results. Several theoretical aspects related to the actual implementation of the numerical models on a computer are presented within the current chapter.

Chapter 5 presents a comparison between the numerical simulation results and experimental results using 4 experimental cases.

Chapter 6 presents conclusions, personal contributions and future research development directions.