**SOLVING CLASSICAL ASTRODYNAMICS PROBLEMS BY MEANS OF MACHINE LEARNING APPROACHES**

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**1. Introduction**

The main goal of this master’s thesis is to explore the utility of Machine Learning techniques applied to solving two classical problems in Astrodynamics and Celestial Mechanics: the *Spacecraft Attitude Control Problem* and the *Aproximation of periodic orbits of a dynamical system*.

**2. Problem definition and Methodology**

The Spacecraft Attitude Control Problem is the problem of finding the sequence of movements that allow a spacecraft to reach a desired orientation and angular velocity. In the first section of this thesis, we built a control agent (consisting of a multi-layer neural network) and a simulation enviroment that emulates the behaviour of a satellite when a torque is applied. Using the *Proximal-Policy Optmization* algorithm, and by interacting with the simulator, the agent learns the optimal attitude control strategy.

The second focus of this thesis is the approximation of periodic orbits of a dynamical system (such as the one seen in the Restricted Three Body Problem). Current methods for solving this problem usually consist on numerically calculating the intersection of this orbit with a predefined Poincaré Section.

In the second half of this thesis, we will begin by generating a large dataset of initial points and the intersections of their respective orbits with a Poincaré Section. We will initially work with the dynamical system of the CP problem, for it is more well-behaved than the RTBP. This dataset will then be used to train a regressor with the goal of being able to approximate the intersection of new initial conditions not seen in the dataset.

**4. Results and discussion**

Results obtained during the first part of the tesis show that our control agent is capable of stabilizing the attitude and angular velocity of a microsatellite (5-20Kg) with an absolute error ≤10-3 in both orientation (radians) and angular velocity (rad/s), starting from an arbitrary orientation and a maximum angular velocity of ±4.5 rad/s in all axis. Future experiments will be concerned with obtaining a general controller capable of working with a wide range of inertia matrix configurations.

Regarding the second part of this thesis, we expect that the experiments done in the following months allow us to train a regressor that, given an initial condition, is capable of finding the first intersection of its corresponding periodic orbit and the predefined Poincaré Section, with an absolute error < 10-6.

**6. Conclusions**

The results obtained in the first half of this thesis show that reinforcment learning techniques allow us to obtain adequate attitude controllers that could potentially be used in real applications. In the following months we expect to polish this controller, and to train the regressor and successfully approximate the Poincaré Map of the CP problem.

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