Open Internship in the ESA Advanced Concepts Team in 2016
on

Low-Thrust Targeting

Topic description

A common problem in mission design is the targeting of an object in space. Low-thrust propulsion is a relatively cheap and efficient method in which a spacecraft is propelled continuously by a small force acting on it. Traditional "kick" approximations used in classical impulsive manoeuvers do not apply here as the change in orbit is gradual and the spacecraft "spirals out". Depending on the steering law applied, the direction and magnitude of the thrust can vary leading to different orbit shapes. For certain simple steering laws (e.g. radial thrust), it is possible to obtain analytical solutions for the motion. However for more realistic steering laws the resulting trajectory must be computed numerically. The problem of low thrust targeting is to identify the correct thrust level and starting time for arriving at a final object, e.g. to go from a parking orbit around earth to the moon.

Candidate's tasks

The successful candidate will work on the mathematical and numerical implementation of targeting strategies for various real world thrust laws. Besides simple linear predictor-corrector methods used as a base line, more advanced high-order targeting methods will be implemented. These will be applied to various dynamical systems to assess their relative strengths and weaknesses. Time permitting, the high order transfer map method (HOTM) [1] can be used for propagation of the spacecraft state instead of numerical integration.

In detail, the candidate will be asked to:

- implement the relevant dynamics for the targeting as well as different steering laws;
- get familiar with high order methods (e.g. differential algebra techniques);
- develop and implement various numerical techniques to solve the targeting problem;
- validate and compare the performance of the various targeting techniques.

The ideal candidate

Mandatory:

- Excellent programming skills (C/C++/C#, Java, Python, or similar)
- Interest in orbital dynamics and applied mathematics

Desirable:

- Knowledge of numerical methods
- Background in orbital dynamics

References

[1] Wittig, A. and Armellin, R. High order transfer maps for perturbed Keplerian motion. Celestial Mechanics and Dynamical Astronomy 122, 2015, pp 333-358