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## LOTNAV: A low-thrust Interplanetary Navigation Tool

*Friday, 9 November 2018 10:30 (30 minutes)*

LOTNAV has been for 10 years the ESA reference tool in the design of finite-thrust and ballistic interplanetary spacecraft trajectories and the preliminary assessment of navigation and guidance issues on the computed trajectories. Within DEIMOS Space LOTNAV has recently undergone a considerable update effort to enhance its modularity and flexibility to extend its applicability to new navigation problems. The aim of this paper is then to present LOTNAV capabilities and its most important updated features (i.e. the inclusion of ephemeris data directly from SPICE, new launcher models, the GNSS signal in the navigation analysis, etc.).

The main high-level analyses covered by LOTNAV are:

- Production of a continuous trajectory profile compliant with a set of environmental conditions and thrust hypotheses and also consistent with an ulterior use for navigation and guidance purposes.
- Generation of a number of system observables which shall allow performing an ulterior estimation of the spacecraft state as well as a number of environmental parameters.
- Theoretical assessment of the achievable levels of accuracy in the spacecraft state dispersion and knowledge, as well as on the selected environmental parameters.
- Estimation of the spacecraft state vector and the selected environmental parameters together with the required guidance to meet the system goals over a number of cases. Statistical analysis of the results obtained allows validation of the theoretical results.

LOTNAV provides answers to the above aspects in an efficient, modular and integrated fashion. In line with each of the previous functions, a software module was developed:

- Trajectory Reconstruction
- Measurement Generation
- Covariance Analysis
- Simulation
- Support Tools
- Project Management

The Trajectory Reconstruction Module provides with a consistent trajectory definition meeting the finite-thrust mission goals proposed by the user, which will serve for the purposes of the rest of the modules. Then, to analyse the trajectory estimation process, the observables for the system are established and computed within the Measurements Generation Module. Those observables together with the trajectory definition allow carrying out a theoretical assessment by means of Covariance Analysis. Trajectory determination and guidance are dealt together by the Simulation Module, performing a Monte Carlo simulation over the full navigation process thus obtaining empirical statistics of the system knowledge and dispersion in presence of low-thrust guidance.

## Summary

LOTNAV has been for 10 years the ESA reference tool in the design of finite-thrust and ballistic interplanetary spacecraft trajectories and the preliminary assessment of navigation and guidance issues on the computed trajectories. Within DEIMOS Space LOTNAV has recently undergone a considerable update effort to enhance its modularity and flexibility to extend its applicability to new navigation problems. The aim of this paper is then to present LOTNAV capabilities and its most important updated features (i.e. the inclusion of ephemeris data directly from SPICE, new launcher models, the GNSS signal in the navigation analysis, etc.).

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