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FORMATION RECONFIGURATION AND SCIENCE PLANNING ARCHITECTURE FOR THE IRASSI SPACE INTERFEROMETER

Abstract

IRASSI is an astronomy mission (Phase B) aimed at observing stellar disks and protoplanetary regions using a constellation of five free-flying telescopes operating around the Sun-Earth/Moon L2 point. In these regions of the cosmos, important chemical/physical phenomena can be observed in the far-infrared, advancing our current understanding of how pre-biotic conditions in Earth-like planets are formed.

The distinguishing aspect of the IRASSI interferometer, however, is its free-flying concept. Rather than relying on a fixed formation configuration and relative position control, IRASSI relies on continuously drifting baselines (e.g., inter-satellite distances) and the knowledge of these baselines during the science observations.

However, not all IRASSI targets require the same formation strategy and therefore the planning of the reconfiguration and science maneuvers has been investigated. The manuscript provides an overview of the planning architecture devised for IRASSI, composed of different modules: 1) Target Planner Module (TPM), 2) Reconfiguration Module (ReM), 3) Collision Avoidance Module (CAM), 4) Baseline Pattern Module (BPM).

The first module (TPM), generates an optimized sequence of targets within a specified window period, taking into account variables such as visibility of the targets at each time step, re-targeting time based on the current state, target priority, target type, science task duration and number of previously observed targets of the same type.

The second module, ReM, assigns positions to the telescopes based on the target sequence generated by the TPM. Each translation maneuver is optimized to achieve a specified initial formation configuration, which is both perpendicular to the target direction and three-dimensional. Parameters such as fuel use, fuel balance and delta-V are used for optimizing the reconfiguration of the formation. The translation maneuvers follow straight trajectories.

The third module, CAM, ensures that the telescopes following the ReM trajectories do not violate relative proximity restrictions. In such an event, the CAM computes a new path in order to avoid collisions.

The last module, BPM, calculates the drifting trajectories that achieve the required patterns in the UV-plane during the science observations. UV-plane projection metrics and target type are used for the optimization of the trajectories.

Each module has been individually optimized and the paper describes the main outcomes thereof. Thereafter, end-to-end simulation results are presented, whereby the overall performance of the tool is

evaluated. The paper concludes with the lessons learned and main challenges identified during the mission study in a formation-flying context and points to future steps for investigation.