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FEASIBILITY OF AUTONOMOUS ORBIT DETERMINATION (AOD) IN CIS-LUNAR ORBIT

Abstract

The recent steep increase in the amount of space missions is calling for the need of developing reliable and scalable Autonomous Navigation Systems for satellites in outer space travel. Without having the spacecraft to rely on ground communication for keeping its desired orbit and/or perform maneuvering, the operational costs of the mission would get significantly reduced, and its sustainability greatly improved. One of the main challenges, in terms of cost, technology and manpower needed for navigating a satellite in outer (Cis-Lunar, for the scope of this paper) space is determining its orbit. Therefore, this paper aims at outlining and providing a full testbed to prove the feasibility and scalability of an Autonomous Orbit Determination (AOD) software based on the Linked, Autonomous, Interplanetary Satellite Orbit Navigation (LiAISON) method to process simulated, inter-satellite distance radiometric data. The AOD software used within this research builds upon that worked out in the Master's Thesis from Tobias Tanis (Delft University of Technology), in which ideal radio parameters (for applying a LiAISON-based AOD system meeting pre-established mission requirements) were determined, inter-satellite radio measurements were simulated, and orbital determination based on those was performed. To achieve the goal of this research, the AOD algorithm (written in Python) was successfully optimized and its computational requirements (mainly in terms of SRAM consumption) reduced in order to make it possible for it to be run on a low-performance computer such as one which would be mounted on a Small Spacecraft (and not only on a powerful standard personal computer, as it has been done until now). After thorough performance tests, the code was successfully run on an -off the shelf (COTS)- On Board (Highly) Integrated Computer mounting an ARM Cortex-A53 processor, suitable for small satellites missions. This therefore effectively proves the feasibility of fully on-board, AOD for missions in Cis-Lunar space.