SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Mobile Satellite Communications and Navigation Technology (3)

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GNSS/INS/STAR TRACKER INTEGRATION FOR REAL-TIME ON-BOARD AUTONOMOUS ORBIT AND ATTITUDE DETERMINATION IN LEO, MEO, GEO AND BEYOND

Abstract

In our previous studies, we demonstrated that Global Navigation Satellite System (GNSS) signals can be processed, not only in Low Earth Orbit (LEO), but also in higher earth orbits, up to the Moon. In order to maximize the GNSS-based navigation performance, we implemented an adaptive orbital filter, which fuses the GNSS observations with a model of the spacecraft dynamics, achieving a navigation accuracy of approximately 100 meters, at Moon altitude. In this paper, we take a step forward and we investigate the design of an advanced multisensor solution that, in addition to combining GNSS with an orbital forces model, also adds the integration of an Inertial Navigation System (INS) and of a Star Tracker, in order to provide a versatile, real-time, on-board, autonomous orbit and attitude determination in different space mission scenarios, from LEO to GEO and beyond. First, we describe the designed architecture of the integrated system, then its implementation, and finally we report its achieved navigation performance for different representative Earth orbits, showing that the synergistic integration of the different sensors, can overcome their individual drawbacks and provide a higher navigation performance than either could achieve individually.