SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
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DESIGN AND DEVELOPMENT OF A SATELLITE ON-BOARD COMMUNICATION SYSTEM WITH NAVIGATION CAPABILITIES

Abstract

With ESA's formation flying mission Proba-3 being scheduled to be launched in 2018, and with the Asteroid Impact Mission (AIM) currently undergoing preliminary design, substantial efforts are made from the scientific community to develop high accuracy autonomous navigation systems and to improve space and ground communication systems. The purpose of this paper is to present the design and development of a hybrid communication-navigation system together with the preliminary outputs obtained within the HybridNAVCOM activity where a consortium formed by CEOSpaceTech and GMV-Romania has been tasked with the design, breadboard development and testing of an inter-satellite link with advanced ranging and clock synchronization capabilities. The system shall provide relative navigation, telemetry and telecommand between two formation flying spacecrafts and shall also assure space-to-space scientific data exchange using the communication link. The state-of-the-art analysis has been focused on the Proba-3 mission, where two satellites are flying in formation into a highly elliptical orbit (apogee at 66000 km and perigee at 600 km). Between the perigee and the apogee, the orbit crosses the superior region of Earth's ionosphere and the transition stage to the interplanetary space. The radio signal (both scientific data and navigation) exchanged between the spacecraft is affected by channel effects as group delay, Doppler deviation, Faraday rotation, dispersion, multipath and scintillation. During the preliminary design an OFDM architecture has been chosen for the communication system of HybridNAVCOM. The navigation algorithm uses directly the measurements model to derive the estimated range and attitude from raw measurements (PRN codes and phase measurements from two S-band channels). In order to support the HybridNAVCOM design multiple analysis campaigns are necessary. These analyses are being run on HybridNAVCOM Functional Engineering Simulator (FES). The FES is implemented on a Matlab/Simulink infrastructure, which allows for the communication channel characteristics emulation. The validation of the chosen navigation algorithms and communication system architecture within the proposed mission scenarios will be performed through both simulations and breadboard functional testing. In conclusion, the study will provide a comprehensive and critical analysis on how radiofrequency navigation and communication for satellite formation flying can be resolved in a common low-cost and efficient framework.