23rd IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Satellite Operations (3)

Author: Dr. Stefania Tonetti
Deimos Space SLU, Spain

Ms. Stefania Cornara
Deimos Space S.L., Spain
Mr. Gonzalo Vicario de Miguel
Deimos Space SLU, Spain

FULLY AUTOMATED MISSION PLANNING AND CAPACITY ANALYSIS TOOL FOR THE DEIMOS-2 AGILE SATELLITE

Abstract

The DEIMOS-2 mission, launched in June 2014, operates an agile small satellite for high-resolution Earth Observation applications. The spacecraft can be steered to accurately point the payload up to 45 deg off-nadir, exploiting both roll and pitch agility. It provides 75-cm pan-sharp and 4-m multi-spectral images with a 12-km swath at an altitude of 620 km. Platform agility brings to the fore the need to choose one target amongst various, simultaneously observable ones. When the workload grows, this combinatorial task becomes rapidly cumbersome for human operators and automation emerges as a key enabler for the mission planning and exploitation process. This paper presents the Mission Planning and Capacity Analysis Tool developed by DEIMOS to produce feasible acquisition sequences from a set of user areas of interest. By feasible, we mean they do not overlap and they fulfil the platform constraints: attitude manoeuvring agility and stability requirements, on-board memory and downlink, power production and battery capacity. To deal with various types of image requests, such as pin-point targets and extended mapping areas, an analysis of the best way to sample the ground surface has been performed, leading to a country-based composite grid aligned on the satellite ground track. It optimises the mission observation return while allowing efficient management of the image catalogue. All user-requested areas of interest are translated into sets of grid scenes, which are gathered into along-track stripes called targets. They are assigned a priority level reflecting their urgency/profitability and then fed into a greedy scheduler building a feasible acquisition sequence step-by-step. It schedules the observation of each target so as to fulfil the priority criterion and the system constraints. Attitude, power and dataflow models balance accuracy and speed so that small margins are needed to guarantee feasibility and the scheduling process is fast enough. Besides the significant workflow enhancement obtained by the full automation of mission planning, the tool is also able to optimise the mission return by repeating the scheduling exercise and selecting the best-performing mission timeline. A sequencer reorders the targets within their priority groups, thus letting the scheduler generate different feasible timelines. Their goodness is evaluated by a function reflecting the mission commercial objectives and driving this optimisation iteration. Several approaches, including evolutionary algorithms, have been assessed and have provided promising results for realistic planning timeframes. Constraints models including cloud forecast and acquisition outages have also been enabled to lead to a fully operational facility.