SPACE EXPLORATION SYMPOSIUM (A3)
Small Bodies Missions and Technologies (Part 2) (4B)

Author: Mr. Francisco da Silva Pais Cabral
G.M.V. Space and Defence, S.A., Spain

Ms. Mariella Graziano
GMV Aerospace & Defence SAU, Spain
Mr. Andrea Pellacani
G.M.V. Space and Defence, S.A., Spain
Mr. Matteo Suatoni
G.M.V. Space and Defence, S.A., Spain
Dr. Jesus Gil-Fernandez
ESA, Spain

SCORPION: A LOW-COST MULTI-PHASE AND MULTI-OBJECTIVE ASTEROID MISSION

Abstract

Planetary Defence is one of the medium-term goals of most space agencies together with NEA Characterization, Human Spaceflight, Small Bodies Sample Collection, and Asteroid Mining, to name a few. However, the technology readiness level (TRL) of some of the required technologies to perform such missions is not yet at the necessary level. In particular, these missions require agile and precise navigation and guidance techniques that only autonomous on-board GNC systems can achieve.

This paper presents the results of a GMV internal study proposing a low-cost multi-phase and multi-objective small body mission, SCORPION, suitable to raise the TRL of such technologies (not limited to GNC but also other relevant technologies) with an emphasis on the test and flight validation of autonomous GNC systems based on optical measurements to achieve scientific as well as commercial and planetary defence purposes.

Besides its natural science and planetary defence return values, and as a technology demonstration mission, SCORPION is designed to be low cost. This is achieved by adapting existing platforms, re-using systems previously flown on past missions, reduced ground operations, both in terms of life time and ground operations requirements, and reduced technical complexity. In order to test as many technologies and mission scenarios as possible the mission is comprised of several phases, that present different validation conditions, science return, and technical challenges: (1) low-cost Earth escape, (2) interplanetary cruise, (3) autonomous NEO(s) fly-by('s), (4) autonomous NEA 1 impact rehearsal, and (5) autonomous NEA 2 impact with terminal-phase guidance. The inclusion of fly-by and impact scenarios along the nominal path is important as it allows the test, under very different dynamical conditions, of different autonomous GNC, image-processing (IP) techniques and satellite operations procedures that are required in the diverse mission scenarios previously described as potential objectives.

GMV has been playing a major role in the development of GNC systems in the European context. In order to propose a low-cost approach the available development and lessons learned from current and past activities are traced together with their applicability to the SCORPION mission. These experience comprise the design and development of autonomous navigation and guidance techniques (CLEON, CHILON, CHILON2, NEOGNC, IANT), the study and development of autonomous GNC and FDIR systems for different missions (Marco-POLO-R, Phobos-SR, AIM, JUICE, NEOSHIELD2), the study and development of different IP algorithms (centroiding, shape matching, and others) and their validation within the GMV's robotic testbed ***platform-art***©.