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SEMI-AUTONOMOUS ATTITUDE GUIDANCE USING RELATIVE NAVIGATION BASED ON LINE OF SIGHT MEASUREMENTS – AIM SCENARIO

Abstract

The Asteroid Impact Mission (AIM) is an ESA's small mission of opportunity which intends to travel to the binary asteroid Didymos to assess planetary defence capabilities in the context of the AIDA program, in collaboration with NASA, to demonstrate new technologies for future exploration missions to asteroids and to perform scientific observations. The AIM S/C is described in the paper, together with its vision-based GNC strategy that has significantly evolved during the project and reached a high level of maturity at the end of the Consolidation Phase (post B1). Ground navigation analyses pointed out that for close proximity operations (distances under 20 km) a certain degree of autonomy is required. During the Detailed Characterisation Phase at 10 km, several hyperbolic arcs will be performed. Towards the end of each arc, the ground-predicted S/C relative position will not be precise enough to guarantee that Didymain will remain in the camera's FoV (since the FoV of the Aim Framing Camera -AFC- is small and complex slewing and multiple acquisition strategy should be avoided). To cope with that, a semi-autonomous attitude guidance has been developed. This algorithm will apply a delta quaternion to the

reference attitude profile updated by ground in order to correct the pointing to the body. This technology has been designed to be easily validated and, at the same time, constrained: the delta quaternion can be limited by thresholds which depend on the ground-predicted navigation dispersion; in case the thresholds are crossed or any failure occurs, the ground-based reference attitude profile will be used. A correct pointing towards the body requires an on-board navigation filter which provides an estimated position of the S/C. The GNC prototype was updated to use Line of Sight measurements provided by a centroiding algorithm designed and autocoded in Matlab/Simulink, then validated up to Processor-in-the-loop tests using a flight-representative processor (AT697E LEON2-FT @ 80 MHz). The algorithm is based on the correlation of the image with a Lambertian sphere, taking advantage of the almost spherical shape of Didymain. When relative distance to the binary system is below 8 km, the feature tracking algorithm will be used. Indeed, in this scenario, the entire primary body will be in the FoV, thus the centroiding algorithm cannot be adopted. In this paper a specific case is assessed: the close fly-by for MASCOT-2 delivery (lander included in the payload for AIM's phase B1), tested up to Hardware-in-the-loop with the AFC.