IAA Planetary Defence Conference 2019

Autonomous GNC and data fusion for the HERA mission

A. Pellacani (GMV, Spain), C. Prioroc (GMV, Romania), F. Cabral (GMV, Portugal), P. Kicman (GMV, Poland), M. Graziano (GMV, Spain), M. Homeister (OHB), M. Fittock (OHB), J. Gil (ESA), I. Carnelli (ESA)

29th April – 3rd May 2019 Washington DC, USA

Abstract

The HERA mission is based on extensive work done by the European Space Agency and European industry between 2011 and 2016 (AIM studies in the frame of the AIDA joint mission with NASA). The main mission objective is to demonstrate the kinetic impactor concept on a binary asteroid system. This technique is considered to be one of the most promising for planetary defence to deflect asteroids in the order of one hundred meters diameter. In order to be able to detect the slightest change into the system and to estimate the effect of the impact, close operations are baselined in the mission timeline. A highly autonomous system has been designed to allow such operations and it is part of the technologies demonstrators of the mission. As it is the first time that a binary asteroid system will be studied from short distance, it is also important to remark the value of the scientific return of the mission. The autonomous GNC system will allow to navigate safely close to the binary system, and the closer the trajectory will be, the more valuable will be the scientific data collected by the spacecraft.

The level of autonomy expected during the interplanetary cruise is limited to the execution of pre-planned, ground-defined, mission operations on-board. Indeed, during this phase, there is no need for fast and autonomous response. On the contrary, during proximity operations, an autonomous GNC system will allow a precise target pointing for the characterization phase. Furthermore, there will be a continuous safety monitoring of the close fly-bys that in case of a contingency scenario (e.g. unpredicted manoeuvre execution error) might lead the spacecraft into a collision course. A vision based navigation has been designed, developed and tested for the AIM mission and it will be further improved in the frame of HERA, including data fusion with the PALT (laser altimeter) during the closest approach to the binary system. A precise and robust on-board navigation estimation of the spacecraft state is the key to perform autonomous manoeuvres and progressively reduce the pericenter of the fly-bys up to a few hundred meters altitude, also having the possibility to trigger Collision Avoidance Manoeuvres in case of failures.

In the frame of HERA phase B1, the AIM autonomous vision based navigation has been consolidated including new data fusion functionalities and the test campaign, based on incremental validation from Model-In-the-Loop (MIL) to Hardware-In-the-Loop (HIL), will allow the technology to achieve a TRL 6 by the end of 2019.

This paper will include the consolidated strategies of the vision based GNC designed for the HERA mission, together with the justification of the required autonomy and the test campaign results. Also an assessment of the planned/required future work will be given.