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VULCAIN: A SMALLSAT FORMATION FLYING MISSION FOR VOLCANOES SURVEY AND
MONITORING WITH MULTISPECTRAL OBSERVATIONS

Abstract

The paper reports about the VULCAIN mission study, funded by ESA-ASI to develop a highly performant Earth Observation mission implemented by means of a two 12U Cubesats flying in train formation. The mission aims answering both scientific and technological goals. The former include: 1) IR observations on Volcanoes to detect surface temperature changes related to their activity 2) SO₂ emissions detection from degassing plumes of active volcanoes; 3) surface temperature in the range 300-400 (TIR channels) measurements; 4) VIS-TIR data fusion to enhance the observation on volcanic areas by adding morphological analysis (includes 3D images). VIS-IR measurements are provided by two miniaturized cameras mounted on each space asset: while the VIS is a COTS, the IR cameras is customized by the VULCAIN consortium. The mission technological goals, strictly derived by the scientific needs, focus on the in orbit assessment of three complementary on board measurements for autonomous relative navigation: 1) differential GPS; 2) inter-satellite RF ranging; 3) optical ranging. The formation flying need is dictated by the scientific requirement to get data for the volcanoes digital elevation model (DEM)

reconstruction: two satellites, identically equipped, flying in train formation with instruments on ground footprints overlapping ensure the stereoscopic measurements acquisition. To satisfy the swath and resolution scientific requirements and the in light in shadow thermal data acquisition, the train formation flies on a very low altitude orbit- 400 km – largely perturbed, LTAN 9.30 am. Co-pointing requirements coupled with very perturbed orbits necessarily call for attention in the guidance navigation and control on board strategy. To this end a suite composed by GPS receiver, RF transceiver and corner cube reflectors for relative state reconstruction, and continuous low thrust engine is assumed as baseline. In particular, the sensor suite is undergoing the settling of a testing campaign to assess that architecture performance to run during the incoming phase B. Aside the hardware suite, adaptive control law has been implemented to ensure the system the proper timeliness to the strongly perturbed environment the space asset is flying in . Results obtained so far demonstrated the VULCAIN mission to be a promising performant solution, low cost quick time to market for science needs answering and miniaturized technology pushing.