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EXTREMELY LOW EARTH ORBIT IMAGING AND TECHNOLOGY EXPLORER (ELITE): PUSHING EARTH OBSERVATION BOUNDARIES

Abstract

Extremely Low earth orbit Imaging and Technology Explorer (ELITE) is micro-satellite on a mission to demonstrate the very low earth orbit (VLEO) flight and achieve imaging GSD of 0.5 m from 250 km altitude. The camera sensor used in the mission is commercial off-the shelf (COTS) which reduces the cost of development significantly. The spacecraft will be launched at an altitude of 550 km, and it will gradually manoeuvre its orbit in VLEO to approximately 320 km. The operational altitude will be maintained at 320 km for roughly a year and the spacecraft will push to further conduct imaging operations at 250 km. Besides the primary imaging mission, the spacecraft also carries: 1) an ionospheric probe for in-situ plasma density and drift velocities, and 2) atomic oxygen (AO) detector for characterising the changing AO field in the region of flight. To support the orbit manoeuvres and drag compensation, the spacecraft is equipped with a propulsion system which can produce 3 mN of thrust. There are numerous challenges to overcome to sustain a flight in VLEO which do not occur in LEO. This mission is designed for micro-satellite weighing approximately 170 kg. The atmospheric density increases exponentially with altitude, i.e. the drag increases exponentially as the orbit altitude is lowered to 320 km. The propulsion system has to be sized with adequate margin for sustained operations in VLEO. The increased drag also applies additional stress on to the attitude control system, compromising the stability of the spacecraft. The power generation and ground contact will also be affected as the spacecraft shall maintain minimum drag and high stability orientation instead performing sun-tracking or ground tracking. Besides the ambient environmental challenges, the spacecraft is also subjected to surges in atmospheric density due to solar storms. The storms can increase the density by 10 or 100 times which can be catastrophic for the spacecraft. This paper discusses the mission design for ELITE mission considering the estimated launch time. Analytic results are shown for altitude profile, drag analysis, structure optimisation, power generation and communication. The objective is to highlight the mission design process considering the limitations and considerations of sub-systems. ELITE mission is fully funded by Singapore government and developed by Nanyang Technological University.