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PREPARING FOR BEYOND-LEO NANO-SATELLITE MISSIONS: BENEFITS OF NEW GNC STRATEGIES

Abstract

Until very recently, CubeSat class small satellite missions were restricted to Low Earth Orbit (LEO) applications. The launch and success of Mars Cube One (MarCO) twin CubeSats in 2018 opened a new paradigm of planetary exploration using these low-cost platforms. Consequently, there are over 50 beyond LEO small satellite missions that have been planned over the next 5 years.

The primary objective of this paper is to investigate the current Guidance Navigation Control (GNC) capabilities of CubeSat class satellites specifically in the context of planetary exploration and identify techniques and strategies that could potentially improve the utilisation of existing hardware as part of an ongoing research project at Luleå University of Technology in preparation for upcoming beyond LEO nano-satellite missions.

Traditional GNC techniques such as ballistic propulsion and ground-based navigation do not scale well for small satellites as the former requires prohibitively large amounts of chemical propellant and the latter requires extensive ground-based infrastructure which increases the operational cost drastically. Fortunately, recent advances in electric propulsion and autonomous navigation techniques such as optical and crosslink radiometric navigation broadened the feasibility of deep space CubeSat missions. The current paper discusses the state-of-the-art of each of the above GNC techniques while proposing architectures that could benefit from the above techniques. The paper also provides an overview of various GNC strategies that are being considered for the planned beyond-LEO small satellite missions.