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Author: Mr. Ahmed E. S. NOSSEIR
Delft University of Technology (TU Delft), The Netherlands, a.e.s.nosseir@student.tudelft.nl

Dr. Angelo Cervone
Delft University of Technology (TU Delft), The Netherlands, a.cervone@tudelft.nl
Prof. Angelo Pasini
University of Pisa, Italy, angelo.pasini@unipi.it

MIMPS-G: MODULAR IMPULSIVE GREEN-MONOPROPELLANT PROPULSION SYSTEM FOR MICRO/NANO SATELLITES HIGH-THRUST DEMANDING ORBITAL MANEUVERS.

Abstract

Innovation in ultra-small satellites space missions and modern applications require propulsion capabilities to enable active operations in orbit, such as formation flying, orbital altitude and inclination changes, orbital transfers, docking and rendezvous operations – generally, operations demanding high-thrust impulsive maneuvers. In addition, Green-monopropellants are current state-of-the-art of modern liquid propellants for small satellites space propulsion due to their safety, stability, storability, simplicity and high performance. MIMPS-G is a *modular propulsion system*, particularly for CubeSats, mainly utilizes *green- monopropellants*, and is a prospect game-changer for micro/nano satellites/spacecrafts demanding *high-thrust* propulsion-systems. The baseline design is a standard 1U that can be expanded depending on the spacecraft size and intended mission requirements.

Design and system analysis of MIMPS-G are discussed and system paradigms are presented – stressing on design modularity. Different *pressurization-systems* are investigated – *conventional* and *unconventional* relative to small-satellites – emphasizing on *autogenous-pressurization* and *self-pressurizing monopropellant systems*, since the choice of the pressurization-system will further affect the propulsion-system overall *performance*, onboard *power-consumption*, and the spacecraft *size-optimization*. A trade-off study with regards to the *performance* and *characteristics* of suitable monopropellants, to be utilized by MIMPS-G, is carried out to give insights for system design and architecture possibilities, as well as future studies concerned with *monopropellant propulsion systems* for various classes of space propulsion.

Throughout the propulsion-system design process *Reliability & Risk* are assessed for various components. Using a *qualitative* approach, the results of the *Failure Modes & Effects Analysis (FMEA)* systems' reliability assessment are presented. A *quantitative* risk assessment is shown on a *Fever chart* and overall *"risk score"* is produced for the studied pressurization-systems and the overall system design.

Finally, candidate system architectures for MIMPS-G utilizing most reliable pressurization-systems as well as highest performance green-monopropellants – focusing on the highly stable Hydroxyl-ammonium nitrate NH_3OHNO_3 (HAN), also known as AF-M315E, due to its greater density (45%) and higher specific-impulse (10%) than Hydrazine – are presented, and comparative results are tabulated including performance criteria, orbital operations capabilities, systems reliability, and design overall risk score.