SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 2 (3B)

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DESIGN AND CONTROL OF MONO TILT-ROTOR (MTR) AEROBOT ("HYPERION") AS A MARS SCOUT

Abstract

Surrey Space Centre has been working on an autonomous fixed-wing all-electric vertical take-off and landing (VTOL) aerobot for the exploration of Mars for some years. In previous papers, we have reported on a design which incorperates separate lift rotors and "pusher" motors for forward propulsion. In this paper, we report on a modification to the design which utilises a novel mono tilt-rotor (MTR). The baseline mission of the "Hyperion" aerobot is to investigate Isidis Planitia region on Mars using airborne optical sensors, and a surface science package when landed. The aerobot would take-off vertically, transition to horizontal flight, fly for an hour and land vertically. Each flight would occur around local noon and all power is provided by solar cells and a rechargable battery. The crusing speed is around 60m/s, giving a range of around 200km. The aerobot could cross Isidi planitia in 7 Mars days - but we propose to spend 3-4 days at each landing site to carry out scientific investigations - giving a total mission time of around a month. The aerobot is an all-wing design, similar to the "Zagi" model aircraft. The central section is occupied by a pair of coaxial tilt-rotors, with two auxiliary lift rotors at the wing-tips. The auxiliary rotors are used to to control the attitude in VTOL and transition stages. Wing flaps are used in cruising. A total mass of 24kg (about 3kg for science instruments) is achievable with current technology. The power system is comprised of thin film solar cells covering the wing surface, with rechargeable batteries to provide peak power and power during the hours of darkness. All the rotors of the aerobot are designed using the Free Vortex Method (FVM), verified by Computational Fluid Dynamics (CFD). The Vortex Lattice Method (VLM) is used to obtain the performance of the wing and flaps. For autonomous guidance and control, a Sliding Mode Controller is proposed for the VTOL and transition stages, and a PID controller is proposed for cruising. A 6 Degree of Freedom (DoF) flight simulation indicates that aerobot can accomplish the proposed mission profile.