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DESIGN OF AN AUTONOMOUS Y-4 TILT-ROTOR (Y4TR) AEROBOT FOR FLIGHT ON MARS

Abstract

Surrey Space Centre (SSC) has been working on an autonomous fixed-wing all-electric vertical take-off and landing (VTOL) aerobot for the exploration of Mars for several years. SSC's previous designs have incorporated separate vertical lift and horizontal pusher rotors as well as a mono tilt-rotor configuration. The novel Y-4 tilt-rotor (Y4TR) design is a blend of the two previous designs and a step forward for planetary aerobots. The more robust Y4TR configuration utilizes two large fixed coaxial counter rotating rotors and two small tilt-rotors for vertical take-off. The front tilt-rotors rotate during transition flight into the main horizontal flight configuration. The baseline mission of the Y4TR remains the same as previously reported and will investigate the Isidis Planitia region on Mars over a month long period using optical sensors during flight and a surface science package when landed. The aerobot will take off vertically, transition to horizontal flight, fly for around an hour, and land vertically, with up to one flight per day. The flight missions will take place at local noon to maximize power production via solar cells during flight. The aerobot is a blended wing design with the wings using the "Zagi 10" airfoil blended to a center cover for the coaxial rotors. It will be controlled as a Y4 multi-rotor during vertical flight and as a conventional flying wing during horizontal flight. The open source design and analysis programs XROTOR, CROTOR, XFLR5, and OpenVSP were used to design and model the four rotors and aerobot body. A 6 Degree of Freedom (DoF) flight simulation has been built to model the aerobot during flight. The paper describes the design strategy for this Mars Aerobot, and presents the results of the modelling and simulation work. The concept of operations,science objectives and payload options are also discussed.