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SPACE TETHER SYSTEM TEST AS AN ENABLER FOR AN ARTIFICIAL GRAVITY TESTBED IN LOW EARTH ORBIT

Abstract

This paper is a continuation of previous investigations on a testbed for an artificial gravity platform in low Earth orbit. The vision of the initial design proposal is to address a knowledge gap in our understanding of the long-term effects of partial gravity on physiological and psychological human capabilities. Because human centrifuges on Earth cannot recreate effects of partial gravity on human physiology and parabolic flights fail to provide long enough exposures to generate feasible data, novel research platforms to investigate partial gravity effects on humans and systems are needed. The proposed 3-body testbed comprises two customized crewed-Dragons docked to a Central Hub, which in turn docks to the Zvezda module of the International Space Station. To execute operations, the testbed will undock, retreat 2000m aft of the ISS and initiate rotation by firing its augmented thrusters. Then, the crewed-Dragons will tether out to the desired radius of rotation to begin test operations. Upon completion, the testbed will de-spin, retract its tethers and re-dock to the ISS. The sequence repeats as needed. This paper proposes a small-sat precursor enabling mission to the testbed. The primary design objective is to develop the tether system integral to the testbed and develop confidence in the deployment and retraction of tethers in low Earth orbit. The design consists of two small-sats bound together by a tether system in the middle. Each small-sat consists of a spin and de-spin system (thrusters/RCS and inertial measurement sub-system), a video monitoring system and a ground communication system. The tether system consists of a spool, the tether, braking sub-system to control the rate and length of deployment of the tether, motors for winding/unwinding the tether, and a levelling system to ensure proper rewinding of the tether on the spool. This design is derived from a previously flown space tether system, The Oedipus C tether deployer by Tethers in Space, and from the Space Tether Automatic Retrieval (STAR) experiments done by DLR ESA. Although the testbed will have two independent tether systems, one for each Crew Dragon, this small-sat precursor is proposed with a single tether system in order to minimize cost and complexity. The tether has been preliminarily proposed to be made from a High Modulus Polyethylene (HMPE) product manufactured by Cortland and will be in the order of 10 m long.