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TETHERED SYSTEMS IN ADR: SATLEASH MICROGRAVITY EXPERIMENT AND FUTURE DEVELOPMENTS

Abstract

The attention of the space community towards the concept of towing objects in space is increasing, mainly in the field of Active Debris Removal, LEO satellites disposal, low-to-high energy orbit transfer and asteroids retrieval. Space towing consists in an interconnection through a flexible link, a tether, between a passive orbiting target and an active chaser. The chaser must, not only to reliably perform operations, but also to avoid and damp dangerous vibrations of flexible connection and elements. Moreover, tether entanglement and instabilities have to be avoided. All these requirements define new frontiers and challenges for the Guidance, Navigation Control system. The PoliTethers team, from Politecnico di Milano, Department of Aerospace Science and Technologies (DAER), was selected to fly an experiment on-board Novespace's Zero-G aircraft by the ESA FlyYourThesis! 2016 programme. The flight campaign took place in October 2016. The SatLeash experiment objective was to study the dynamics and control of tow-tethers, for space transportation. A scaled tethered floating test-bed, has been developed for the parabolic flight campaign. During the SatLeash experiment, a control method based on wave-based technique, using tension feedback, has been designed and tested. The results of the experimental validation are satisfactory and proved the efficiency and robustness of the proposed control strategy. This paper wants to summarize and critically discuss the results obtained during the SatLeash experiment. With the know-how acquired during this experience, the team proposes an upgraded version of the SatLeash experiment. In fact, with limited changes in the experiment design, the team plans to add some significant results and outcomes. In particular, the new objectives include the test of the control law with a tether-net system. This would also allow to study how the net influences the global flexibility of the system and if the control law is able to stabilize the system with this configuration. Moreover, it will be possible to modify the initial conditions of the target. In this way, the damping of the motion of the tumbling target due to the pulling phase will be investigated. This phenomenon has been observed only in theory and with numerical simulations. Finally, for the first time, it will be implemented a fiber-optic system to obtain pinpoint tension measurements on the tether with an integrated solution. This paper will present a preliminary design of the upgraded SatLeash and the road-map of the on-going activity on tethers and tether-net systems at Politecnico di Milano, DAER.