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ENABLING ROBOTIC GRASPING IN SPACE: PRELIMINARY PERFORMANCE EVALUATION IN SPACE-LIKE ENVIRONMENT OF ADAPTRONICS' ELECTRO-ADHESIVE TECHNOLOGY

Abstract

The strong increase in space activity calls for improved robotic capabilities to enable In-Orbit Servicing and Active Debris Removal operations.
Existing robotic grasping strategies encounter various limitations, impacted by the challenges of establishing physical interfaces with satellites or non-cooperative objects in the harsh space environment, prompting the exploration of novel approaches.
Adaptronics enables innovative grasping solutions to overcome current challenges through its technology based on electro-adhesion with embedded sensing capabilities for proximity and contact force exchange. It can be integrated in the end-effector of a robotic arm for berthing and in docking mechanisms, promising radical improvement in in-orbit operations.
This paper presents a comprehensive investigation structured around dynamic simulations and experimental testing to evaluate the performance of Adaptronics' technology in space-like conditions, laying the foundation for its potential application in future commercial and space sustainability missions.
Preliminary sizing was addressed through dynamic multi-body simulations of the contact phase between the device and an uncooperative object to determine the electro-adhesive force requirements in specific docking/berthing scenarios, including available surface areas and target object materials.
With the objective of evaluating the performance of Adaptronics' electro-adhesive technology in exerting the required force density, space-like environment testing was carried out in vacuum conditions adhering to European Cooperation for Space Standardization (ECSS) guidelines. The thermal-vacuum chamber setup is described, together with testing procedure and results. Static tests to assess materials and manufacturing process suitability were conducted. Also, dynamic traction tests were performed to determine the electro-adhesive force exerted on materials representative of the intended use-case, and results also allowed to evaluate sensing capabilities related to proximity and contact force exchange.
Results here reported represent a significant step forward in the integration of Adaptronics' electro-adhesive technology into commercial missions and sustainable space initiatives, to improve Active Debris Removal capabilities and In-Orbit Servicing operations.
Future developments envisage experimental tests in simulated microgravity environments, with the aim

of further validating and refining Adaptronics' electro-adhesive solutions towards in-orbit demonstration and commercial deployment.