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SPACE SYSTEMS SYMPOSIUM (D1)
Enabling Technologies for Space Systems (2)

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STARARM: PERSONAL ROBOTIC ARM

Abstract

STARARM is seven degrees of freedom smaller robotic-arm prototype with advanced end effectors, software and control systems to assist astronauts in on-orbit servicing and low gravity exploratory efforts. Outfitted with specialized tools, it can perform a variety of intricate tasks including: removing and installing components, providing tooling assistance during maintenance EVAs, and semi-autonomous assistance to astronauts in human-machine integrated tasks on planetary and asteroid surface missions. The arm incorporates innovative technologies such as machine vision and force feedback to handle delicate work such as replacing components and working on the Space Station's electrical connections. The Space Station Remote Manipulator System (SSRMS) end effector grapple fixture requires accurate positioning and is prone to mechanical failures. The grapple cable system requires periodic servicing due to mechanical stresses. The systems joint also suffers from mechanical wear requiring expensive EVA servicing missions. Additionally, the SSRMS lacks the ability to detach from the Station, grab malfunctioning or non-cooperative orbital bodies and return them to the ISS. Leveraging the significant power generation capabilities of ISS in addition to the microgravity environment, STARARM utilizes magnetic end effectors and joints coupled with cold gas propulsion. The distributed STARARM system maintains coupling using controlled magnetic fields, which enables separation into smaller autonomous units when needed. Joints and end effectors are cross compatible as they utilize the same flexible magnetic coupling design. Should a section fail it is easily exchanged with a spare. The ability to shorten itself at the joint and remain functional enables increased maintenance efficiencies and enhanced mission capabilities. The STARARM will be able to separate into smaller systems to act independently or in conjunction when required. Implementing use of a magnetic conveyor and unique end-effector tool sets, STARARM translates tools and hardware to astronauts or experiments requiring new batteries or arrays for example. Habitable structures without restrictive mechanical attach fittings will use STARARMs propulsion capabilities. Essentially the STARARM can create a thrust vector environment through independent attachments by positioning their nozzles. STARARM couples magnetic links with cold gas propulsion to increase the range of interactivity and spectrum of targets. The magnetic feature of STARARM increases safety as the gripper remains attached even during blackout. Moreover, there is no possibility of generating sparks during production since no electric current is required. The magnetic end effectors only need one surface to grab the object. The grasping speed is fast and flexible. Most importantly, it requires minimal maintenance.