U.S.NAVAL RESEARCH LABORATORY

NRL Satellite Servicing Technologies

AT A GLANCE

NRL has spent nearly two decades working to transition unmanned space robotic satellite servicing from an R&D concept to a fielded national capability. Robotic servicing promises to bring in a new era of increasingly resilient on-orbit operations by providing the ability to finely inspect, reposition, repair, and upgrade existing spacecraft. NRL has developed safe autonomous robotics controls and has focused development on understanding the interactions between all of the unique elements that must work together to make satellite servicing a reality.



NRL Proximity Operations Laboratory: Allows engineers to simulate the rendezvous and proximity operations of spacecraft docking and robotic grappling of satellites. The testbed encompasses the entire 45 ft by 100 ft Space Robotics Laboratory, providing a large area to perform spacecraft maneuvers on two motion simulation platforms.



NRL Gravity Offset Table: Allows engineers to float models of spacecraft on air bearings (similar to an inverse air hockey table) so that the frictionless motion of zero-gravity operations can be simulated precisely. The NRL Gravity Offset Table is a 20 ft by 15 ft solid slab of granite, ground to a precision flatness within 0.0018 inches across its surface.



NRL Space Machine Vision Laboratory: Allows engineers to simulate the harsh lighting environment of space so that prototype and flight-qualified cameras can obtain imagery representative of what will occur on-orbit. Camera and lighting position can be measured precisely to ensure that automated machine vision processing returns valid results.



NRL Robotic Simulation Environment: Allows engineers to perform software simulations, testing full end-to-end robotic operations before performing hardware-in-the-loop testing. This simulation environment includes high-fidelity contact dynamics and the ability to incorporate flight software, running many more test cases than can ever be simulated on hardware in the lab.

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Nearly two decades of R&D in satellite servicing



Early testing validated autonomous grapple approach



Flight prototype FREND Arm supports system validation



Multi-arm dexterous manipulation IR&D supports advanced concepts



Environmental testing of prototype robotics leads to flight qualification



Advanced assembly concepts



Proof of concept of small lightweight robotics to enable novel missions



RSGS flight Robotic Arm System #1 prepared for thermal vacuum testing



RSGS contact dynamics testing in the robotics test bed