



Multifunctional Automated Repair System (MARS)

Penn State Applied Research Laboratory

Under sponsorship from and in collaboration with NAVSEA 05, The Applied Research Laboratory of the Pennsylvania State University has developed and demonstrated the Multifunctional Automated Repair System (MARS) for use in emergent facilities, including forward operating bases, ships, and shipyards. This turn-key system is easily transportable for in-situ repairs, multifunctional, quickly reconfigurable, interfaces with different robots, and has a user-friendly interface, control system, and tutorials for each operation.

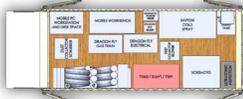
The MARS features a number of different end-effectors for performing inspection, surface preparation and repair operations. The system uses commercial-off-the-shelf and custom designed interfaces to reduce cost, complexity and development time. The suite of end effectors—or tools that have been developed and demonstrated—include a grinder and plasmablast for surface preparation, cold spray and laser wire for repair, and ultrasonic and eddy current non-destructive evaluation for inspection. LIDAR, thermal imaging, gas sensing, laser ablation, welding, laser deposition, paint touch-up, and x-ray fluorescence end effectors are in development.

The system is configurable for a variety of repair applications from in-theatre battle damage repair to shipyard maintenance. Also, the system is designed to be expandable so that additional end effectors can be easily accommodated. Built-in videos and an augmented reality (AR) are being incorporated into the platform

for quick and effective training and fielding. The MARS system allows one operator to perform a number of different operations, which reduces setup and operating time, greatly improving productivity. The system will be used to remove personnel from hazardous and stressing environments where possible.

The first iteration of the MARS was fielded six months after development began and the overall design and fielding will be complete within eighteen months from the start of the project. The first iterative fielding demonstration at the Naval Surface Warfare Port Hueneme Division (NSWC PHD) provided essential feedback from end users during the initial design phase. The design was refined and the requested capabilities were added prior to the second fielding demonstration at Norfolk Naval Shipyard (NNSY). The first ever shipboard cold spray repair was completed using the MARS at NNSY. A power distribution panel has been designed to interface with different power sources including shipboard power.

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<p style="text-align: center;">Problem Statement</p> <ul style="list-style-type: none"> Asset maintenance and sustainment is a major challenge across the DOD for asset readiness and availability What's needed is the rapid development and fielding of a portable, integrated, automated system that is adaptable to a variety of maintenance environments and repair/inspection operations 	<p style="text-align: center;">Benefits</p> <ul style="list-style-type: none"> System has 30 second change-out of end effectors Operators become competent on MARS in less than 1 hour with built-in video trainings and intuitive software/controls System configurable for depot, intermediate, and expeditionary maintenance settings – robot agnostic with switch-able bases MARS performs operations hazardous to personnel Has simple programming for use on flat or curved surfaces
<p style="text-align: center;">Technology Solution</p> <ul style="list-style-type: none"> The Multifunctional Automated Repair System (MARS) provides an automated, turn-key, fully portable preparation, repair, and inspection capability for emergent facilities: forward operating bases, ships, submarines and shipyards MARS is configurable for a variety of operations from shipyard maintenance to in-theatre battle damage assessment and repair System designed and built in a dev-ops construct with fielding trials and user input cycles as a template for rapid development 	<div style="display: flex; flex-wrap: wrap; justify-content: space-around;"> <div style="text-align: center;">  <p>Sailors Using MARS</p> </div> <div style="text-align: center;">  <p>MARS Paint Removal with Magnetic Base</p> </div> <div style="text-align: center;">  <p>Intuitive Robot/End Effector Controller</p> </div> <div style="text-align: center;">  <p>20' Conex Solution</p> </div> </div>