9 Robotic Projects for Mitigating Future Pandemics

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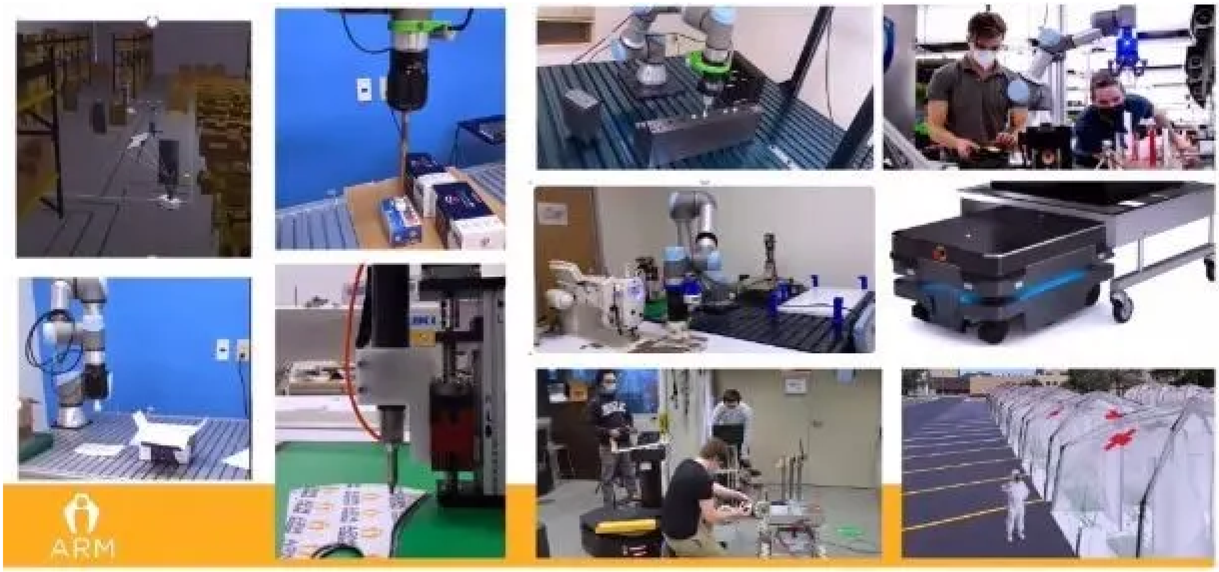


(Image courtesy of ARM Institute.)

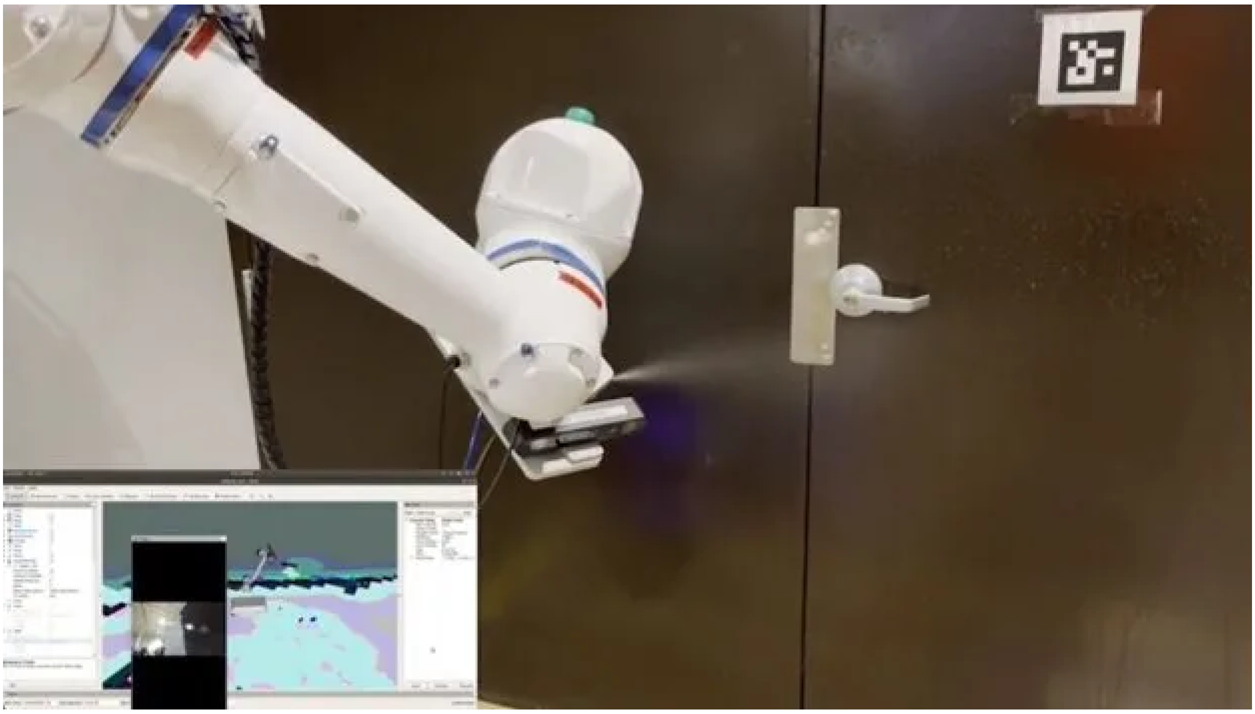
On August 30 th , the Advanced Robotics for Manufacturing (ARM) Institute hosted a technical summit to present robotic solutions that prepare industry for pandemics of the future. Funded by entities such as the U.S. Department of Defense, the ARM Institute facilitates the collaboration of industry, academia and government to make robotics and artificial intelligence (AI) accessible to U.S. manufacturers.

During the virtual event, nine COVID-19 remediation projects were highlighted.

Autonomous Disinfecting Robots

The first three projects were related to spraying and disinfection systems in manufacturing facilities.

One solution used camera sensors and NVIDIA Jetson Xavier AGX's AI-based visual perception module to map out floor plans and autonomously navigate through areas to disinfect heavily touched surfaces (such as doorknobs). The scalable platform had a modular design that leveraged both open-source and commercially available software.



(Image courtesy of ARM Institute.)

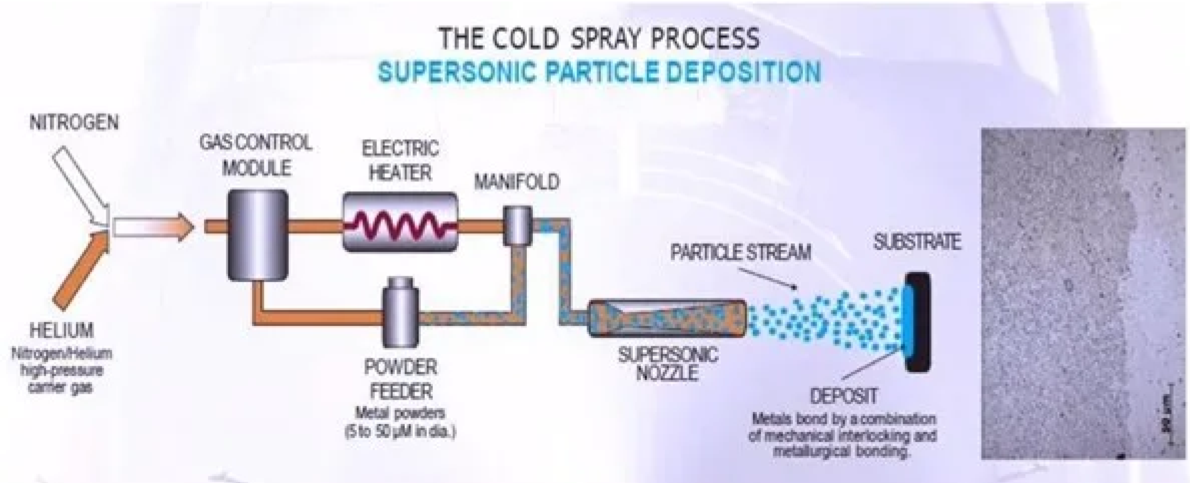
Another project developed an autonomous mobile robot with a mounted collaborative multi-axis robotic arm capable of manipulating both a disinfection system and a sensor suite. One of the benefits of the system included the ability to determine under-treated areas through 3D sensors and analysis of areas that could be occluded, with ensuing secondary disinfectant treatment. The robot used intensity, shape and distance of the light source—as well as the angle of incidence to surfaces—to estimate the amount of disinfectant reaching surfaces, and then proceeded to compare the data against a minimum threshold.

The third project added mobile autonomous capabilities to the existing Decon–X (DX1) disinfection system to automate the consecutive treatment of multiple rooms. The solution featured a QinetiQ SPUR arm with four degrees of freedom (4DOF) for opening doors, enabling the robot to move from room to room. A built-in spatial sensing suite monitored hydrogen peroxide levels in the air for human safety, and a ROS-enabled platform allowed for multi-terrain operation.

(Image courtesy of ARM Institute.)

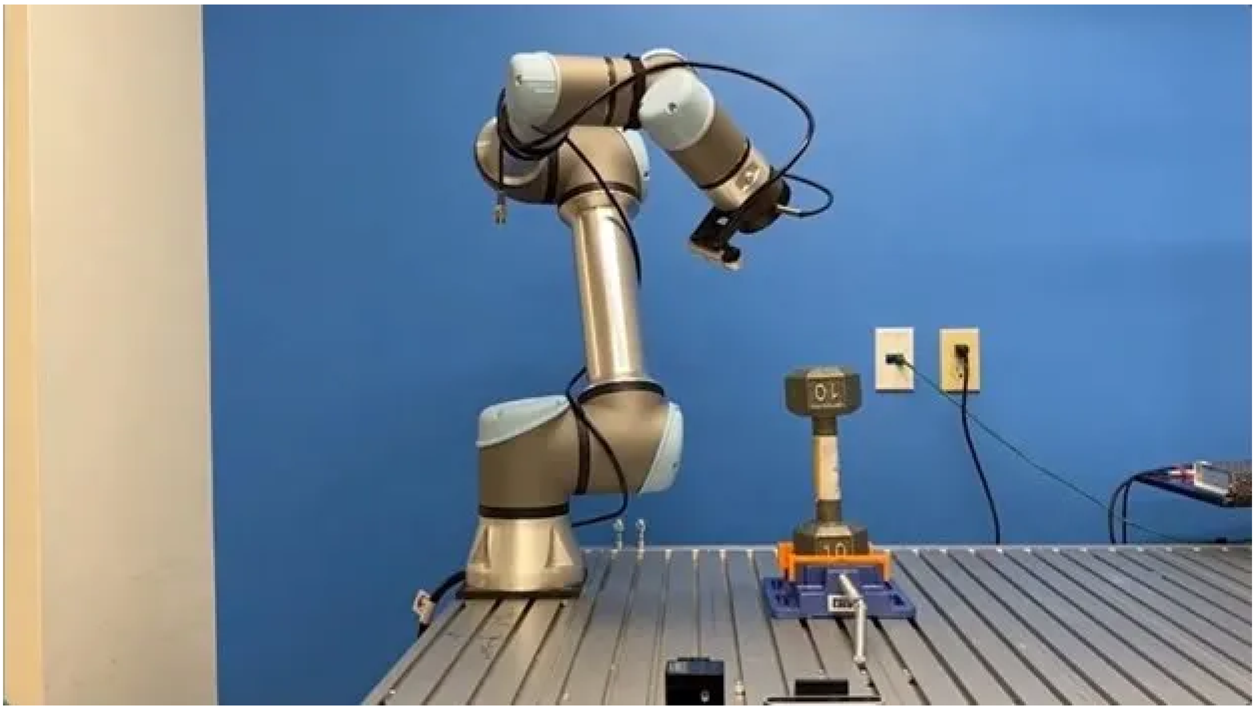
Robotic Anti-Microbial Copper Application System

The fourth exhibit involved the robotic cold spraying of copper coating for rapidly tackling coronaviruses like COVID-19 without the need for frequent cleaning. The manufacturing of copper-coated surfaces allows for high-touch surfaces that are self-disinfecting.



The cold spray process. (Image courtesy of ARM Institute.)

Along with developing a robotic anti-microbial copper application system, Siemens Digital Industry Software partnered with VRC Metal Systems to integrate a scanner and create automated paths for applying copper coating to various components. The customizable setup involved mounting a powder feeder, heater and applicator on the robot. Siemens NX CAM Robotics software was used to drive the six-degrees-of-freedom (6DOF) robots, and create both additive and coating toolpaths for spraying parts. The team also built a digital twin for detecting collisions, avoiding singularities, experimenting with layouts and toolpaths, and generating robotic movements.



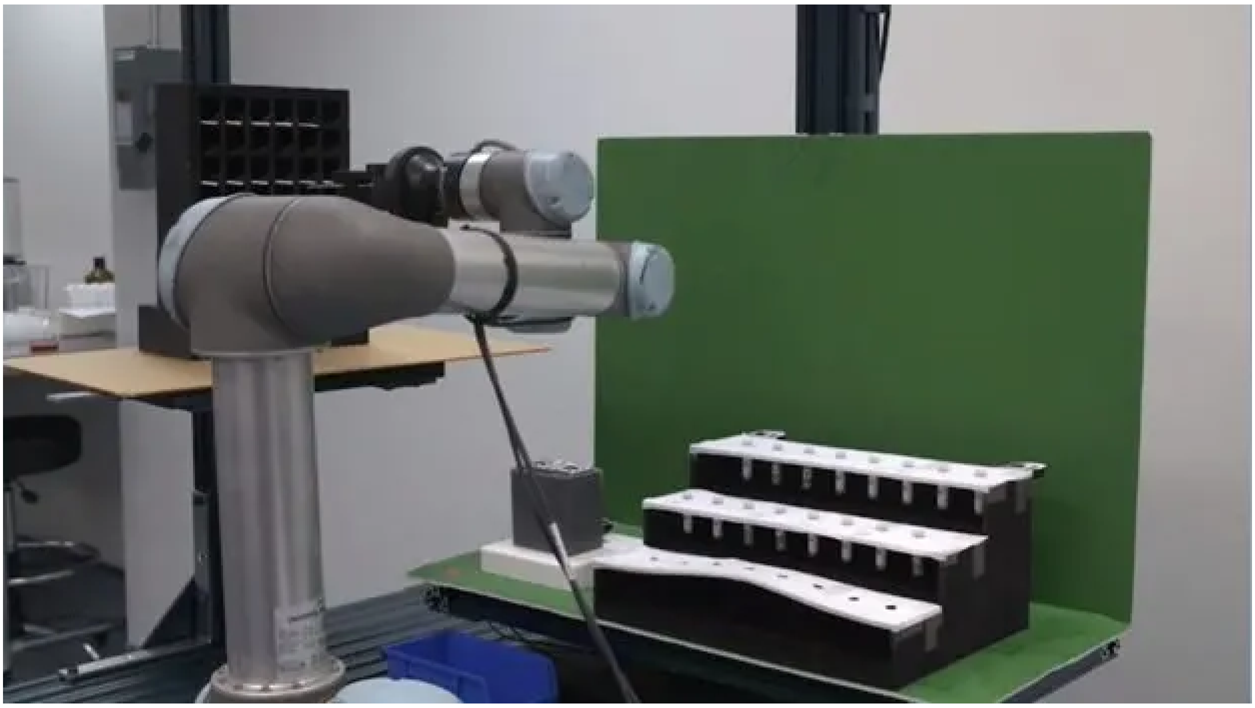
Applying copper coating on a dumbbell. (Image courtesy of ARM Institute.)

As a result of the copper spray, a 99.999 percent reduction was found for both Staphylococcus aureus and Pseudomonas aeruginosa.

Rapid Robotic Diagnostic Testing

This project aimed to accelerate large-scale infectious disease testing by utilizing advanced vision systems and flexible robots for the development and evaluation of Lateral Flow Assay (LFA) tests.

Traditionally, at least two technicians are required for the testing process—where one runs the assay, and the other interprets results using analyzers for imaging and quantifying individual test strips. Siemens Healthineers and Maxim Biomedical got together to develop a robotic automation solution that could accelerate the development of diagnostic kits by two to three magnitudes.



The robot transfers a strip to a sample tube, after which it transfers the strip from the tube to the test bed. (Image courtesy of ARM Institute.)

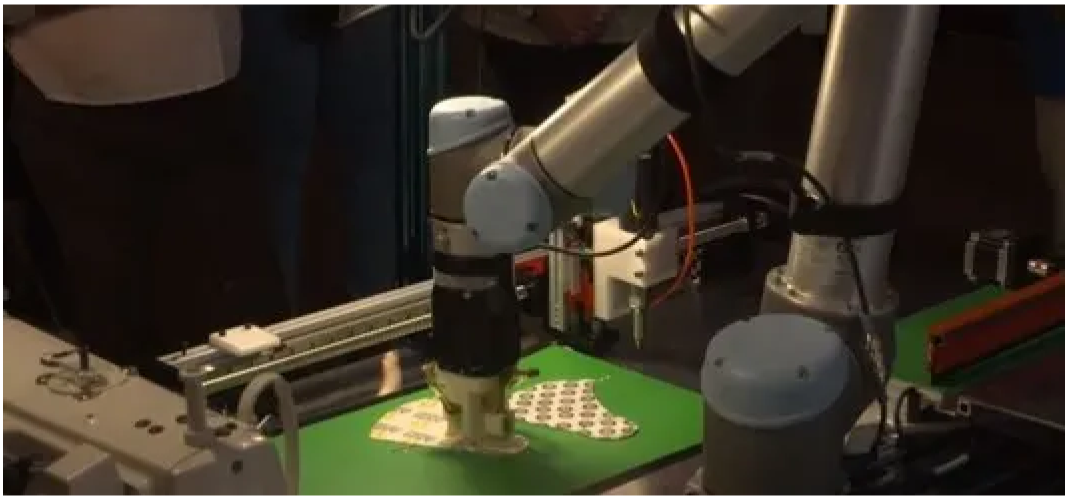
The system comprised a robot with an end effector, an assay surveillance vision system for strip monitoring, a test strip evaluation system that used machine learning (ML) and AI, and a robotic system for automated path planning. The following benefits were observed:

- An increase in throughput from 45 to 75 tests per hour.
- A reduction in test strip evaluation time from 60 seconds to five seconds.
- A reduction in defect rate from eight percent to four percent.

The setup time remained constant at 10 minutes.

Automated Mask Production

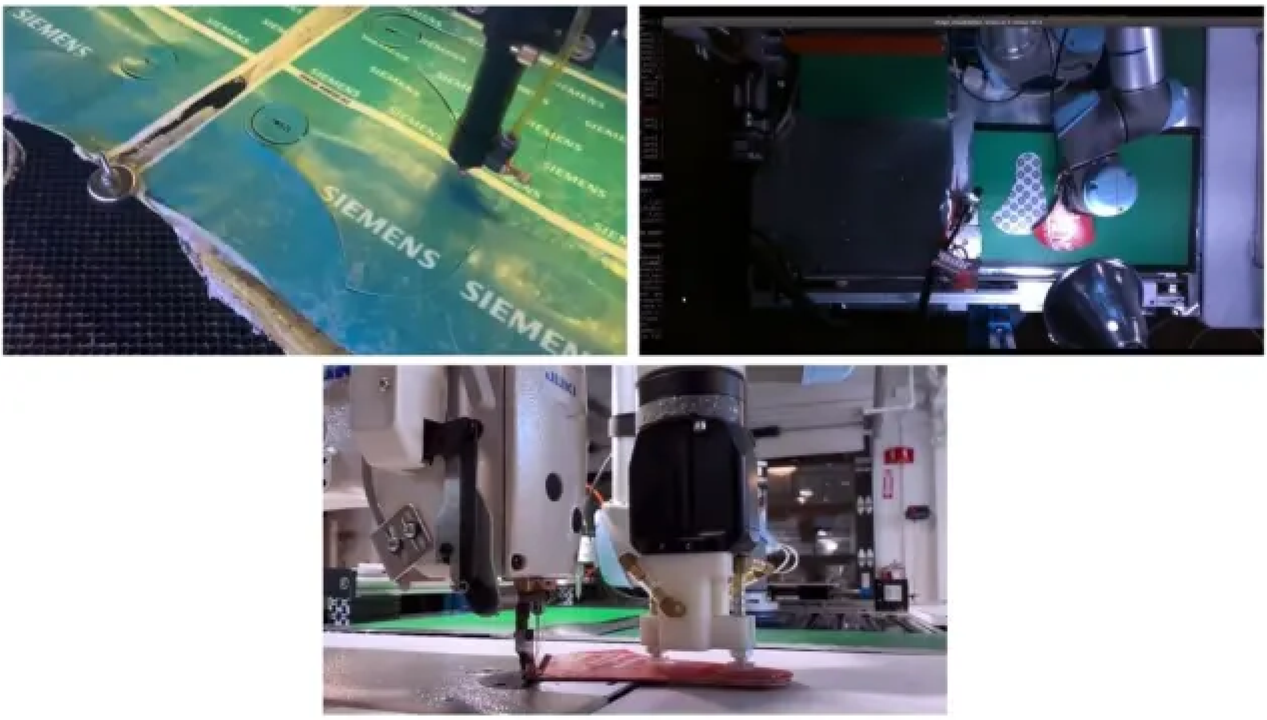
ARM's next two exhibits were related to the production of personal protective equipment (PPE), which has demonstrated critical vulnerabilities during the COVID-19 pandemic.



(Image courtesy of ARM Institute.)

The first of the two PPE projects improved the production of disposable face masks through robotic automatic visual inspection, picking-and-sorting, and end-of-line packing and palletizing. The end-to-end agile manufacturing system was led by Siemens in conjunction with Henderson Sewing and Yaskawa. The process involved manipulating raw materials into mask shapes, adding a wire nose bridge, inspecting and stacking the masks, placing them in a box, and loading the boxes into a larger box suitable for shipping. Edge AI and visual quality inspection contributed to robotic autonomy, enabling synchronized and remote operation.

The second PPE project was similar, except that it built upon other ARM projects to automate the production of cloth face masks through robotic sewing—which requires the manipulation of flexible materials, fine motor control and precise part recognition.

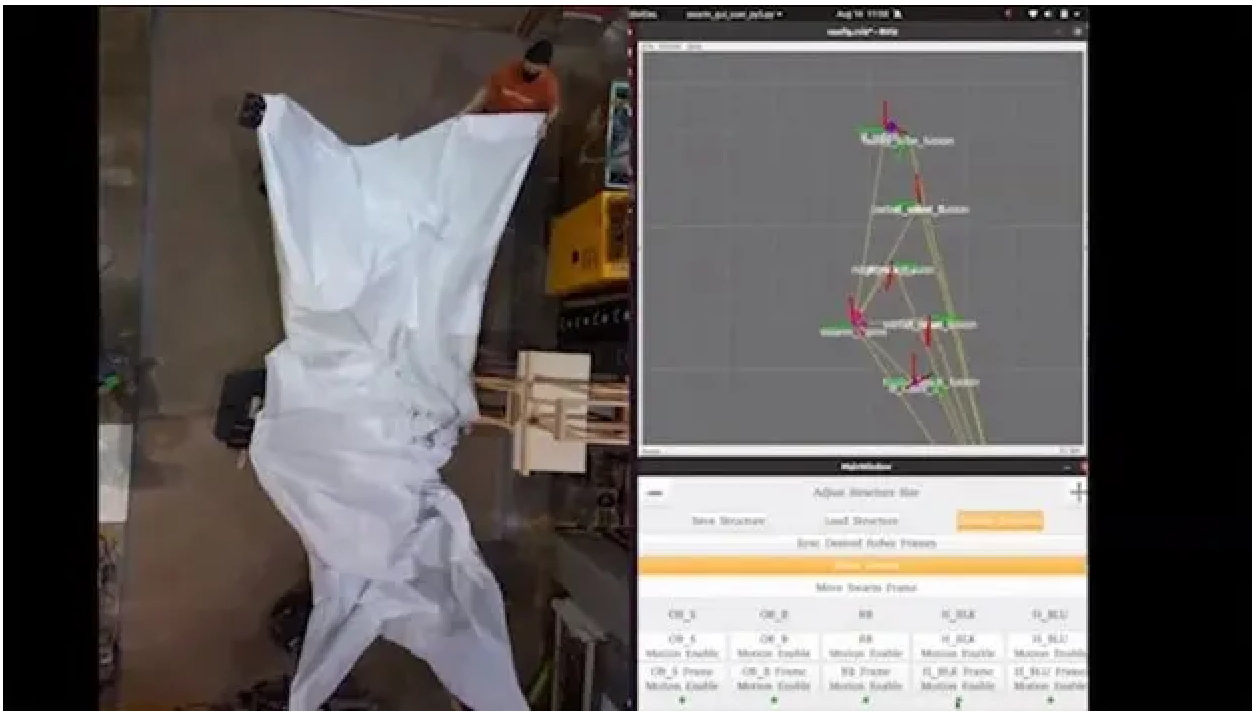


(Image courtesy of ARM Institute.)

Swarm Robotics for Medical Facilities

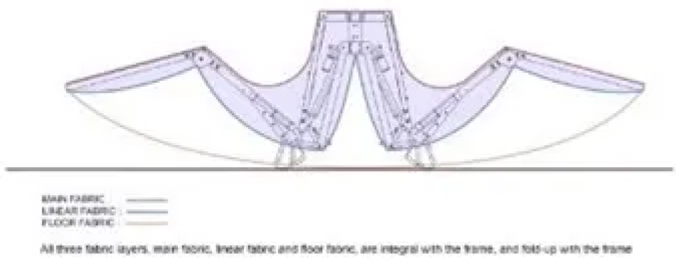
(Image courtesy of ARM Institute.)

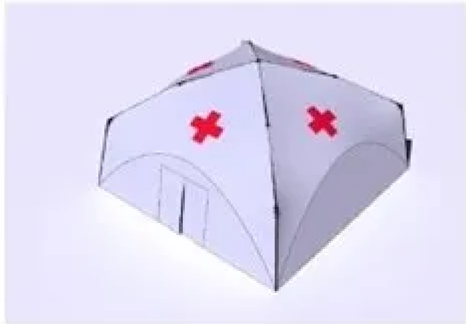
This project by Rensselaer and Pvilion Technologies addressed the rapid deployment of large tent structures for expeditionary hospitals, quarantine facilities, housing, and other emergency applications. Through the development of a fleet of self-aware, human-directed mobile robots that could work together, the technology alleviated the hard work of moving heavy, flexible tent material around the production floor.



The ROS-based robot swarm controller utilized sensor fusion, hierarchical control, and a Kalman filter. (Image courtesy of ARM Institute.)

Another part of the project involved a prototype of a self-erecting medical facility.





(Image courtesy of ARM Institute.)

Automation of Quality Assurance in PPE Manufacturing

The final project involved the automation of characterization and evaluation (ACE) in PPE manufacturing. A team from Northeastern University, Merrow Group and Boston Engineering developed a system that integrated robotics and automation into quality assurance processes, circumventing typical lead times of up to 75 days due to backlogs.

The project involved a human-supervised robotics and automation work cell that could perform liquid barrier, fluid penetration and flammability tests. ML and AI techniques enabled a metric-based characterization of PPE, while processes were developed that relied on robust human-robot task factorization.

Readiness for Future Pandemics

This year’s ARM summit demonstrated technologies including high-rate precision robotic production, real-time path planning, multi-agent coordination, and closed-loop process control through digital twins and toolpath generations. By pooling experience through their nation-wide consortium, ARM leveraged the latest developments in robotics and technology to prepare for challenges related to COVID-19 and pandemics of the future.