Adapted from the automotive industry, Lasersnake2 is a flexible robotic arm capable of laser cutting and other tasks. (Photos courtesy of Sellafield Ltd.)

The Role of Robotics in U.K. D&D

At the U.K.'s Sellafield nuclear site, robotics research and development is playing an increasing role in addressing complex decommissioning challenges.

The Robotics and Autonomous Systems Network of the United Kingdom held its first U.K. Robotics Week during June 25 to July 1. The event was designed to encourage experts from industry, the government, and academia to discuss possible applications of robotic technologies, as well as help inspire the next generation of scientists and engineers to further push the boundaries of what is possible.

As a supporter of U.K. Robotics Week, Sellafield Ltd., the company responsible for decommissioning the Sellafield site on behalf of the U.K. Nuclear Decommissioning Authority (NDA), highlighted the ability of robots and remote systems to support its cleanup mission by entering buildings and areas that are too radioactive for human entry. According to the company, robotic technology is helping to clean up the Sellafield nuclear site more quickly and safely, ensuring that the risk posed to people and the environment by the site's legacy facilities is being reduced every day.

Technical teams at Sellafield Ltd. are researching, developing, and testing a broad range of robotic technology to help accelerate the site's decommissioning program. The work is being done in close collaboration with technical providers from academia and private industry. What follows are a few examples of the different robotic and remote system technologies the company is developing to fulfill its cleanup mission.

A small underwater ROV, AVEXIS-Mini can be produced through additive manufacturing, which speeds up production and reduces costs.

Lasersnake2

Lasersnake2 is a project co-funded by the NDA, InnovateUK, and the Department of Energy and Climate Change and developed in collaboration with a consortium including OC Robotics Ltd. and Welding Institute Ltd.

A slender, flexible robotic arm adapted from the automotive industry, Lasersnake2 performed its first demonstration at Sellafield's underwater test facility earlier this year. Driven by wire ropes, the snake-arm robot can navigate through small spaces and cluttered environments with the ability to conduct activities such as laser cutting, inspection, fastening, and cleaning.

The technology is highly flexible, spanning up to 4.5 meters in length, and ideal for working in confined and hazardous spaces. Another key feature is that the motors, electronics, and control systems are situated outside of the environment, with only the arm itself being deployed into the work space.

Rhys Roberts, a decommissioning project manager, said the technology has the ability to be deployed within an unprepared area, minimizing the need to make modifications to size-reduce the active inventory. In addition, the lack of contact between the cutting tool and the work piece allows the deployment platform to be much simpler, cheaper, and reliable, he said.

"Normal metal cutting methods such as reciprocating saws or grinders pose a significant challenge to remote deployment platforms, where the lack of 'feel' often taken for granted when operating tools manually, is totally lost," Roberts said. "The engineering solutions can easily become overcomplicated, unreliable, and expensive."

According to Sellafield Ltd., the next stage of the project will see Lasersnake2 tested in its first-generation reprocessing plant, where it will be used to size-reduce a lightly contaminated vessel.

AVEXIS-Mini

Monitoring the radioactive contents of both modern and historic storage ponds presents an important but difficult decommissioning challenge, and a number of remotely operated vehicles (ROVs), each with different characteristics, are now under development for use at Sellafield. One example is the AVEXIS-Mini, an underwater robot designed for mapping and real-time monitoring of pond waste.

Developed through a collaboration between Sellafield Ltd., the University of Manchester, and Forth Engineering, the AVEXIS-Mini addresses a variety of scenarios and can carry different onboard sensors, including onboard camera capabilities. The mini-ROV can be deployed through existing holes of only 15 centimeters in diameter, allowing access to challenging contaminated areas where there is limited information.

The flexibility of the design is facilitated by additive manufacturing, or 3-D printing, which allows a quick, inexpensive way to produce the AVEXIS-Mini on demand. According to Sellafield Ltd., the mini-ROV is easily tailored to specific scenarios, and the reduced cost of equipment provides a cost-effective way to survey difficult-to-access underwater areas.

RISER

To help clean up the U.K.'s nuclear legacy, unmanned aerial vehicles (UAV) are beginning to carry out vital work in hazardous environments at Sellafield where access to workers is precluded. Project RISER (Remote Intelligence Survey Equipment for Radiation) is a collaborative initiative between the small Cumbrian company Createc and a Bedfordshire-based aerial specialist called Blue Bear Systems Research.

RISER is an electrically powered quadcopter UAV that has been specially developed to simultaneously laser-scan an environment and characterize the radiation within it. The UAV

The RISER drone was tested as a characterization tool inside Sellafield's iconic Windscale pile chimney.

generates an accurate 3-D virtual model of the environment and will then overlay that model with accurate radiometric data. The first-ever test of the RISER in a radioactive environment took place this year inside the Windscale pile chimney on the site.

Createc developed the N-Visage radiation mapping software that produces an accurate 3-D, high-definition picture of contamination distribution. Called SNAP autopilot, Blue Bear's flight management system uses simultaneous location mapping, making the UAV completely autonomous. According to Sellafield Ltd., the technical maturity of the technology has the potential to transform the way data relating to radiation and hazard is gathered at the Sellafield site. Driven by a Microsoft Xbox game-type controller, it can provide detailed information about areas where it would be difficult, or even impossible, for humans to access safely.

Latro

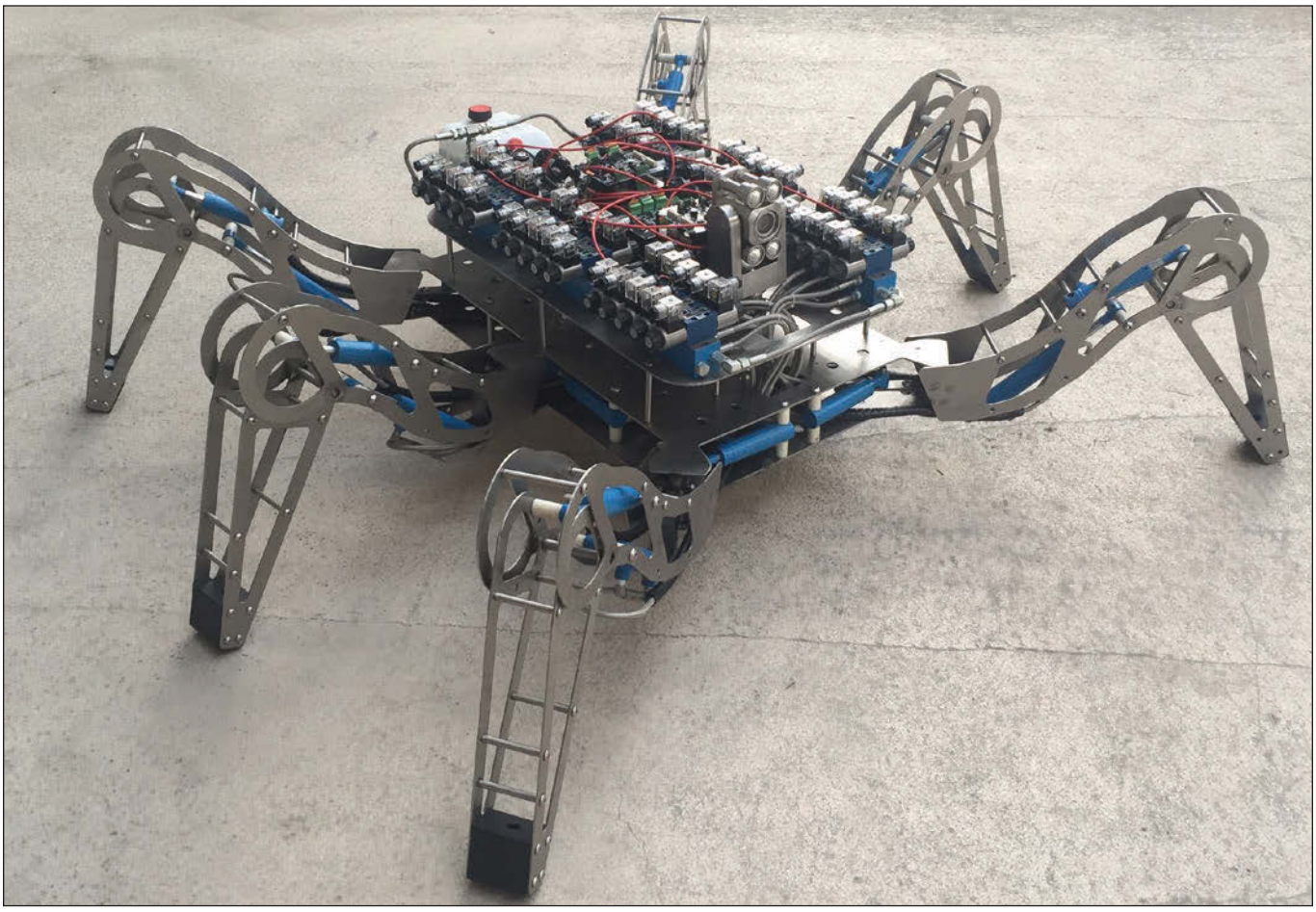
Latro is a spider-like robot that is being developed through a partnership between its creators at Forth Engineering, Sellafield, and the University of Manchester, and is funded through InnovateUK and the NDA via a knowledge transfer partnership. While Latro is still in the development phase, the robot spider is intended to be used to grab waste, chop it up, and drop the remains into a skip loader.

Latro will be equipped with a full range of smart sensors, camera equipment, laser scanner, and smart software. This will allow it to navigate over rough terrain using its own internal sensors, relaying back information to the remote operators via live 3-D imaging. According to the NDA, the robot's stainless steel legs are strong enough to carry a person and are designed to step delicately around obstacles or over them. Eventually, it will walk underwater and retrieve radioactive material from some of Sellafield's most hazardous ponds.

Industrial robots

Sellafield has been leading a collaboration to evaluate robot technology and its potential for use in the site's Box Encapsulation Plant (BEP), which will receive and treat a mixture of solid low-level radioactive waste from a number of legacy waste facilities around the site. The waste must be remotely manipulated and processed to allow grouting into a product suitable for long-term storage and eventual transfer to a more permanent facility.

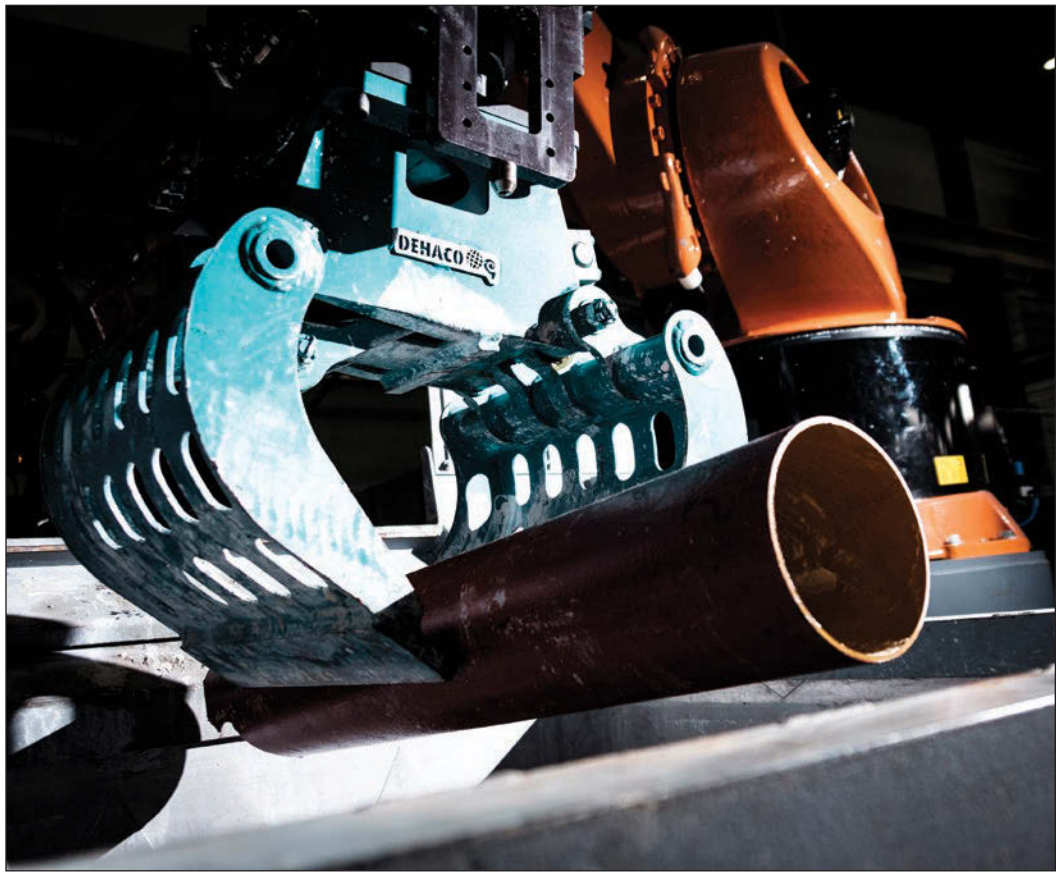
According to the NDA, off-the-shelf robots used in other



A spider-like robot designed to handle radioactive waste, Latro will be able to walk over and around obstacles.

industries have been successfully trialed, demonstrating the full range of waste-handling operations required to ensure the waste can be manipulated and processed into a suitable solidified product. A selection process identified equipment required to test the robotic technology's capabilities at the National Nuclear Laboratory's Workington facility in Cumbria.

The trials demonstrated a range of capabilities, including the sorting of waste from skips, opening packages to break them down into component pieces, and the flexibility to receive and process waste from a range of legacy facilities. The trials also demonstrated the ability to reduce the probability of producing packages that fail to meet specifications for disposal, as the grout is able to flow around the waste to form a suitable product. ■



Industrial robots capable of being used for nuclear decommissioning are being evaluated at the Sellafield site in the U.K.