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Search-and-Rescue Robots Needed, But Market Has Yet to Develop

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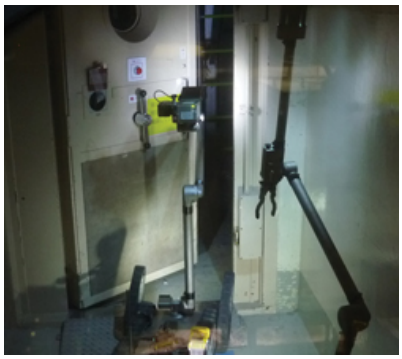
By Stew Magnuson



There are "Doctors Without Borders," "Engineers Without Borders" and "Teachers Without Borders."

Now there are "Roboticists Without Borders."

Robin Murphy, the director of the Center for Robot-Assisted Search and Rescue at Texas A&M University, has kickstarted an organization that will find teams of engineers willing to travel to disaster zones with their ground-, air- or sea-based machines.

She describes the missions as "participatory research."

"Every disaster is different, so we always walk away smarter," she said at the Association for Unmanned Vehicle Systems International conference in Washington, D.C.

The problem is that there are virtually no robots specially designed for disaster response.

"The market is just not there to drive the investment and to drive the production and sustainment of those systems," said Tim Trainer, vice president of operations at iRobot's government and industrial division.

Bob Quinn, vice president for unmanned systems for QinetiQ North America, agreed. "There isn't a market for search-and-rescue robots."

Mike Knopp, president of Romotec Inc., at a briefing introducing the company's new line of bomb disposal robots, was asked if there was any demand for robots that could search rubble piles after a bombing, earthquake or hurricane. He asked his sales manager if they had had any inquiries.

"Nope. Not one."

But that isn't to say that robots — even if designed for other purposes — can't be employed in disaster scenarios.

A case in point is the Tohoku earthquake and tsunami in Japan on March 11, and the subsequent crisis at the Fukushima II nuclear power plant.

Three U.S. companies — QinetiQ North America, iRobot and Honeywell — all sent robotic systems and teams to the plant where they helped Tokyo Electric Power Co. employees understand what was occurring in highly radioactive areas where it was dangerous to send in personnel.

In addition, Murphy brought a submersible robot to help authorities recover the bodies of victims in ports and clear waterways.

Japan is a world leader in manufacturing robots. Companies there regularly make headlines for producing human like machines that can play trumpets and dance. A lifelike female robot that talks was a YouTube sensation.

But the nation did not have a large number of robots that could go into a danger zone and perform dirty, dangerous tasks.

Adjoining the Texas A&M campus is Disaster City, a state-run facility where search-and-rescue crews hone their skills on collapsed buildings, rubble piles, derailed trains and other scenarios. Once or twice a year, Murphy's center brings in robot-makers to test their machines in the series of destroyed buildings.

One of the only Japanese organizations developing search-and-rescue robots was wrapping up a week of testing there when the earthquake and tsunami struck.

Satoshi Tadokoro, director of the International Rescue Systems Institute, and his team already had tickets to return to Japan, and made it onto one of the last flights.

Every disaster is different, as Murphy said. And this was no exception. For example, in an earthquake, robots can be used to go into damaged buildings ahead of human teams to determine if the structures are stable enough to send in firefighters. Or they could take the

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place of traditional dog rescue teams when rubble piles are deemed too dangerous to climb.

It was determined early on that there wouldn't be a need for these kinds of missions. Most of the destroyed structures were one- or two-story wooden homes.

Instead, Murphy brought in remotely operated underwater vehicles to help authorities clear fishing ports and recover the bodies of victims.

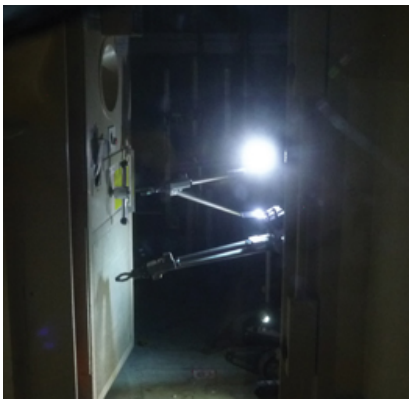
The tsunami created massive islands of floating debris. There were more than 20,000 missing after the giant wave struck the coast, and it was feared that many of the bodies were underneath the flotsam. The Japanese coast guard also wanted to ensure that the lanes in ports were free of underwater obstructions. It was deemed unsafe for human divers in both missions.

"We were able to go to places where the Japanese coast guard could not," she said.

The team ultimately did not find any bodies underneath the floating debris, but it at least gave the Japanese some peace of mind that the victims were not there, she said.

Coast guard officials told her that they had tried ROVs a decade ago, but they didn't work well. However, just like the high-tech consumer electronics found in Tokyo's famous Akihabara district, robots have made great leaps in the past 10 years, she told them.

"We have to educate the community that it is not like buying a fuselage for a KC-130 that we use for 60 years. Robots are going to continue to change as we use them more," Murphy said.



As the days wore on, it became apparent that there was a third disaster in the making following the earthquake and tsunami. The Fukushima power plant was leaking radiation and it was growing hazardous for engineers to go inside, even with protective suits.

Meanwhile, iRobot and QinetiQ teams separately were preparing to respond with their machines any way they could.

iRobot chose to bring its workhorse Packbot, famous for its employment by explosive ordnance disposal teams in Iraq and Afghanistan. It also brought a larger prototype called the 710 Warrior, which has an arm that can lift 150 to 200 pounds, Trainer said.

QinetiQ brought Talon robots, also well known for bomb disposal missions, as well as Bobcat compact loaders that have an appliqué that allows them to be operated remotely.

Both companies trained Tokyo Electric employees how to use the system. Executives stressed the importance of having easy to understand menus and controllers based on Xbox gaming systems.

The U.S.-based engineers were able to teach the Japanese employees how to operate the robots within hours. That is crucial in disaster scenarios where responders don't have days and weeks to train.

"The manuals were not used," Quinn said. At first senior employees came to the training sessions, but they grew younger as each group came in. It was the 20-something workers who did best, Quinn said.

In a hierarchical society where seniority is key, it was a chance for the younger employees, particularly those in their 20s, to shine, he said.

The QinetiQ and iRobot machines were used to go into highly radioactive sections of the reactor to take readings, and visually inspect for cracks. Later, the Bobcats were used to remove radioactive debris. The smaller robots were used to vacuum up contaminated dust.

Tadokoro's center also contributed by sending in some of its robots. Although they are laboratory models, they performed well, he said. He refuted claims in the Japanese press that one had failed and had to be recovered by a worker.

Along with the sea- and land-based robots, unmanned aerial vehicles also played a role.

The Defense Department requested that Honeywell bring its T-Hawk hovering UAV from operations in Afghanistan and redeploy it at Fukushima, said Prabha Gopinath, director of unmanned aerial systems strategic campaigns.

"T-Hawk has fundamentally been designed as a military tactical vehicle. That's all it's been designed to do. That's all it does well. And that's all we have experience with," he said. "We had absolutely no idea whether it would perform in a high radiation environment."

After completing a theoretical report speculating on how long it could survive in such an environment, Honeywell sent in a team of pilots and two aircraft.

Unlike the ground robots, UAV pilots cannot be trained in a few hours, he said. The Honeywell employees would have to do all the operations. U.S. citizens were not permitted to be within 50 miles of the plant, so all missions were flown from a makeshift hilltop base at that distance.

There were other complications. They had to obtain an export license for the technology, particularly the chip that contains U.S. military GPS codes. It was assumed that the UAVs would be so contaminated that they would not come back. Honeywell had to come up with a plan to destroy the chip once the mission was over. It also had to work with the Japanese bureaucracy to ensure that it could operate in the radio spectrum. Signals could not interfere with operations at the plant.

Once those hurdles were cleared, the UAVs flew outside the reactors to inspect damage. They also collected air samples.

The collection kits and radiation sensors had to be strapped on, Gopinath said.

The lesson for rescue robots is that they have to accommodate all kinds of sensors. Sometimes plug-and-play capabilities allow operators to integrate a device into the system. In the case of the air samplers, it was duct tape, he said.

Engineers also purchased small high-definition cameras — the same brands skiers mount on their helmets — to capture video. They had wide-angle and narrow-angle options and could provide an hour of high-resolution images.

"You really need an open platform because you can't go in anticipating what a critical disaster operation will require from you. You have to be willing to essentially strap-on, zip-tie and duct-tape whatever makes the most sense in that context," Gopinath said.

Since every disaster is different, and it is impossible to design a robot for every scenario, the lesson taken away from the Japan disaster is to have adaptable, rugged systems that are easy to use, and won't break down in difficult terrain.

Even the next tsunami may not have the same characteristics as the March 11 disaster, Gopinath noted.

Much of the research at the Texas A&M center revolves around mobility — especially the ability to move on rubble piles.

Murphy said: "One of the common threads is that these are all small. If it doesn't fit in the back of an SUV, it just doesn't get used or can't be transported to the disaster site."

As for the market, research and development dollars for some capabilities will have to come from governments, Quinn said. At Fukushima, they could have used an underwater robot with the ability to turn dials.

That scenario may come up every 100 years or so, Trainer added. There isn't an incentive for robot manufacturers to develop capabilities such as that on their own dime.

"There is technology in the military world that gives the robustness to operate in those environments," he added.

Murphy said there was no market for domestic bomb disposal robots in the United States at one time. Then federal regulations changed and stated that every EOD team had to have a robot to get certified. Then, the domestic market took off.

That could happen for search-and-rescue robots as well, but there is currently a regulation stating that federal grants for firefighters can't be spent on robots. States can go their own way, but most fall into line with federal regulations. Only one state, New Jersey, has ignored the regulation, and purchased search-and-rescue robots, she said.