A peek into our robotic future

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Dinuka Abeywardena's drone navigates by using a camera, rather than GPS. Credit: Andrew To

In an underground laboratory in central Sydney, a robot and a drone are being put through their paces. From time to time, their young inventors hunch over their respective offspring, fine-tuning movements and adjusting software.

CROC, an autonomous robot inspired by the movement of an inchworm, is edging its way along a customised tunnel in the corner. With its special magnetic foot, CROC can climb vertical steel walls, avoid obstacles and pivot through small spaces inside bridges and other steel structures such as ship hulls, transmission towers and oil rigs. Along the way, it can collect and record inspection data and compare it with data from previous visits.

CROC is an intelligent robot that sees and thinks for itself, answering questions such as "Where am I?", "Where do I want to go now?", "How do I get there?", "What do I want to do now?" and "How do I do that?"

That may sound like something out of science fiction, but it's not. CROC is the world's first autonomous climbing robot for steel bridge inspection, and is the result of several years' collaboration between a team of nine researchers at the University of Technology Sydney (UTS) and many engineers from Roads and Maritime Services (RMS) NSW.

The project is in its fifth year and is one of many industry-related robotics projects instigated by Professor Dikai Liu, the director of the Centre for Autonomous Systems (CAS) at the university.

Peter Ward, team leader for the project's hardware and testing side, has had a passion for robots since he was a kid growing up in Perth. His bedroom was lined with space robot wallpaper; he built robots out of Lego and pulled TVs, radios and computers apart to see how they worked.

Ward says other researchers internationally are developing inspection robots, and some are in commercial use. But "those robots have limited intelligence and face difficulties overcoming challenging obstacles".

CROC is a different beast, he says. "First, it needs sight and an idea of

how far away objects are. Once it has explored its environment and constructed a map, it figures out where to go next and how it's going to get there, all the while making sure it won't collide with anything."

Ward says these processes are called "exploration, mapping, localisation, planning and collision avoidance" – challenges the researchers have solved by developing sophisticated algorithms, with this robot and other projects at CAS.

Associate Professor Jaime Valls Miro says industry involvement is what sets CROC apart, with the Australian Research Council project receiving funding and support from Roads and Maritime Services.

"Many other similar projects are just confined to a lab whereas CROC is a deployable solution to a real-world problem," he says. "It is an industry-driven project that is actually achieving something from the data it collects, including high-definition photos of the current status of the Sydney Harbour Bridge."

On the other side of the basement lab, researcher Dr Dinuka Abeywardena is calibrating a tiny camera as part of his project to develop an intelligent drone. Most drones rely on GPS for navigation, Dr Abeywardena says, but those signals can be disrupted, especially in urban or indoor environments, reducing the drone's effectiveness.

"What we are doing differently is improving the perception capabilities of the drone," he says. "We're using a camera as its eye, so that it can explore its environment and collect data around it.

"The images from the camera get processed by an on-board computer, to estimate how it moves and flies, its speed and tilt and the direction of the wind."

Dr Abeywardena's team is seeking industry partners to help field-test the drones and navigational algorithms that have been successfully tested in the lab.

"Our drone eventually could be used inside a warehouse, working closely and safely with human employees," he says. "It could also be used outside, measuring wind speed and monitoring the effectiveness of wind turbines, for example."

While CROC inspects the inside of bridges, the drone could inspect the outside. It could also monitor tree growth along power lines and conduct bushfire inspections, saving time and money for companies that now use manned helicopters.

Provided by University of Technology, Sydney