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Research: Robotics & Disaster Response

Pair of EU-funded robotics projects edging toward multi-mode detection and surveillance for disasters, but problems persist

BRUSSELS – Can robots be used to reliably detect and save victims of fires, explosions and other disasters? Two EU-funded projects involving dense networks of academic and corporate research teams are exploring the possibilities. The theoretical and applied research results so far are encouraging, but there remain several critical technical challenges to overcome before either individual or grouped robots can be sent into such missions.

Disaster response robots are the focus of two interesting and related research projects known as VIEW-FINDER ("Vision and Chemi-resistor equipped Web-connected finding Robots") and GUARDIANS ("Group of unmanned assistant robots deployed in aggregative navigation supported by scent detection").

Both are financed from the EU's previous 2002-2006 research budget), meaning they are not part of its new Security Research programme, though their results have obvious security implications. The projects' progress – including prototype demonstrations – was reviewed during a three-day workshop sponsored here in early January hosted by Belgium's Royal Military Academy (RMA), a member of the VIEW-FINDER team.

EU-funded at EUR 2.23 million and ending in September 2009, VIEW-FINDER's consortium of academic, public and private sector researchers is integrating a wide array of optical and chemical sensors with off-the-shelf, wheeled robots to test the feasibility of sending data and images from a fire incident site to a base station for processing and merging with geographical information. The fused data would then be transmitted to an operational command point and to first-responders.

The consortium has developed a prototype, though some technical problems still persist. For example, RMA researchers have been working on algorithms to give a stereo-vision based ability to a robot to analyse its surrounding terrain and thus move across it. They're also trying to enable robots to accurately identify an incident's human victims.

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"Fire and rescue services will not enter a hazardous site if they think no one is there. The challenge is: how to know this?" said Geert De Cubber, RMA researcher.

Yet for a robot to do this, it must handle a daunting array of 'recognition' parameters linked to voice, temperature, scent, skin colour, movement, face and body shape characteristics that humans easily recognize. "A combined approach is the best solution," said De Cubber, adding that the so-called Viola-Jones Algorithm

"works best for facial recognition." The latter analyses image pixels within rectangular areas and is the basis for many of today's visual technologies, from surveillance cameras to computer screens.

The more intriguing project, however, is GUARDIANS, which aims to enable a multitude of identical robots to 'swarm' or move collectively toward an object in order to identify, contain or gather information about it.

The ability of swarming robots to use two-way "pinging", or messaging to stay in contact with each other in order to shuffle toward a target, or beacon, has been proven. Leading-edge robots, known as taxis, directly sense the presence and direction of the beacon, while the other robots behind them are occluded: their perception of the beacon is blocked. As the taxis zig-zag toward the beacon, the others are pulled toward them via triangulated bi-directional 'pinging' between a robot and its neighbours. Result: the swarm jags its way eventually toward the beacon and surrounds it.

The algorithm-based concept is based on statistical analysis of ant and bee colonies where even if a minority of the swarming insects is off-track or immobilised, the swarm's decentralised communications still enable most members to reach the goal.

"There is no single point of failure with swarming: that's a very attractive proposition from a safety-critical point of view," Alan Winfield, engineer and associate dean at the University of the West of England, told the conference. "It means many can fail and the swarm will still work. What's the potential? Scalability. You can go from 10 to 10,000 robots, without having to change your control algorithms."

A prime goal of GUARDIANS is to use swarmed robots to detect and collect data on toxic plumes in a building and communicate with human operators to define safe passages for fire squad-leaders. Asked if swarm robots could learn to learn, Winfield said: "We're still in a new era of swarm robotics. It's still early to impose machine-learning imperatives on them. But we're only at the beginning of this. It will come."

***The upshot**: Both projects hold exciting applications for civil security, but each has its challenges. As De Cubber reported, his team's experimentation with Viola-Jones "mostly achieves the goal of detecting victims in difficult outdoor conditions, but the detection rate is still low: only a 65-percent detection rate and a false alarm rate of 12 percent. That's not so good but we expect this will improve," he said.*

As for GUARDIANS, one of the obstacles to efficient swarming is partial robot failure where its mobility may freeze but its pinging continues. "This is much more serious than a total systems failure because they 'anchor' the swarm to one spot. A completely dead robot is simply regarded by the swarm as an object to be avoided and does not impede its progress, whereas a pinging one prevents the others from advancing," said Winfield.

With EU funding of EURO 2.72 million, the 38-month GUARDIANS project ends in January 2010. Both it and VIEW-FINDER are coordinated by the UK's Sheffield Hallam University. SE

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