Robots manipulating animal behaviour

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A pet dog sits on command, but nobody expects an insect to follow human instructions. So it may come as a surprise to learn that researchers recently succeeded in controlling cockroaches with tiny mobile robots. The results hint at a future where we can interact and communicate with many different kinds of animal.

Little larger than a thumbnail, the cubic insect-like robots or 'insbots' are technological marvels. Developed under the European Commission's Future and Emerging Technologies (FET) initiative of the IST programme as the project Leurre, the insbots are fitted with two motors, wheels, a rechargeable battery, several computer processors, a light-sensing camera and an array of infrared proximity sensors.

When dropped into a small experimental area with a maze of curved walls, the robots move, turn and stop. They can navigate their way safely

by avoiding the walls, obstacles or each other, follow the walls, congregate around a lamp beam or even line up. When placed in the same area with cockroaches, the robots quickly adapt their behaviour by mimicking the animals' movements. Coated with pheromones taken from roaches, the infiltrator robots even fool the insects into thinking they are real creatures.

The roach pheromones – a blend of molecules developed by the project partner from the Université de Rennes I, France – enable various forms of communication, including recognition and attraction. For example, when a roach detects another roach, it may approach it, move away or stop. Cockroaches were chosen here because their pheromones are better understood than those found on other gregarious insects, such as ants.

Artificial agents meet natural agents

According to coordinator Jean-Louis Deneubourg, from the Université Libre de Bruxelles, the project had its origins in collective intelligence and behaviour in animal society, as well as the tradition of using artificial agents to test theories about animals. "Robots have already been used to interact with some animals, such as bees. But they cannot react to the animals' response," he says. "In our project, the autonomous insbots call on specially developed algorithms to react to signals and responses from individual insects. This results in a chain action or reaction between the artificial and natural agents – a two-way interaction that is unique and very promising for sciences such as biology and robotics."

Not only did the insbots act like and interact with the insects, they even succeeded in changing the roaches' behaviour. For example, the darkness-loving insects followed their artificial cousins towards bright beams of light and congregated there. This process took up to two hours, but it showed how humans might soon be able to manipulate the behaviour of a whole colony of insects. A trick that would delight pest-controllers the

world over!

Two side-projects under Leurre also looked at sheep and chickens, animals that are happy to follow their 'leaders' – unlike the cockroaches, whose collective behaviour is essentially 'democratic'. The researchers collected data and developed mathematical models describing the collective behaviour of sheep, such as clustering together in a field. These models have yet to be taken up in a follow-on project, but are scientifically valuable. Adds Deneubourg, "They are a great way of exploring the importance of leadership or collective behaviour in animals, paving the way for people to control animals and even colonies of robots."

Why influence behaviour?

Asked why people would want to influence animal behaviour, Deneubourg offers several answers. Firstly, by changing the way animals behave or inducing collective behaviour, scientists can learn much about animal communications and information processing. Secondly, the ability to create 'mixed systems', where artificial agents interact with natural ones, is a long-held dream for many in the scientific community – including those working on nanotechnology. Moreover, these systems are in keeping with emerging European research such as collective robotics and FET-funded projects such as Swarmbots. "We believe farming in Europe can only survive if is associated with high technology," he adds, pointing to a potential increase in competitiveness and a decrease in costs. "A robot interacting with animals, even if it is not mobile, could be used for numerous tasks, such as herding or milking. Our project demonstrates that the fields of biology and IT can work together more closely in future."

Though the project has officially ended, some of the partners are continuing to refine the behaviour models they developed. The main

research results are also being published in leading IT and biology journals. “Time constraints prevented us from exploring all the new and interesting research paths that opened during the project,” says the project coordinator. “But we succeeded in our main goal – showing that an artificial agent such as a robot can modify the collective behaviour of natural agents, in this case cockroaches, in a mixed community.”

Source: IST Results