Robotic ants building homes on Mars?

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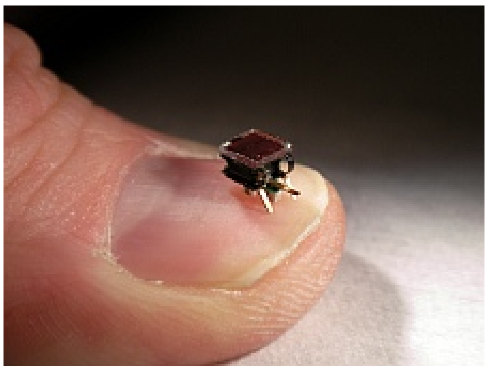

Tiny bots smaller than a thumbnail. © I-SWARM project

(PhysOrg.com) -- Recent discoveries of water and Earth-like soil on Mars have set imaginations running wild that human beings may one day colonise the Red Planet. However, the first inhabitants might not be human in form at all, but rather swarms of tiny robots.

“Small robots that are able to work together could explore the planet. We now know there is water and dust so all they would need is some sort of glue to start building structures, such as homes for human scientists,” says Marc Szymanski, a robotics researcher at the University of Karlsruhe in Germany.

Szymanski is part of a team of European researchers developing tiny autonomous robots that can co-operate to perform different tasks, much like termites, ants or bees forage collaboratively for food, build nests and work together for the greater good of the colony.

Working in the EU-funded I-SWARM project, the team created a 100-strong posse of centimetre-scale robots and made considerable progress toward building swarms of ant-sized micro-bots. Several of the researchers have since gone on to work on creating swarms of robots that are able to reconfigure themselves and assemble autonomously into larger robots in order to perform different tasks. Their work is being continued in the Symbrion and Replicator projects that are funded under the EU's Seventh Framework Programme.

Planet exploration and colonisation are just some of a seemingly endless range of potential applications for robots that can work together, adjusting their duties depending on the obstacles they face, changes in their environment and the swarm's needs.

"Robot swarms are particularly useful in situations where you need high redundancy. If one robot malfunctions or is damaged it does not cause the mission to fail because another robot simply steps in to fill its place," Szymanski explains.

That is not only useful in space or in deep-water environments, but also while carrying out repairs inside machinery, cleaning up pollution or even carrying out tests and applying treatments inside the human body – just some of the potential applications envisioned for miniature robotics technology.

Creating collective perception
Putting swarming robots to use in a real-world environment is still, like the vision of colonising Mars, some way off. Nonetheless, the I-SWARM team did forge ahead in building robots that come close to resembling a programmable ant.

Just as ants may observe what other ants nearby are doing, follow a specific individual, or leave behind a chemical trail in order to transmit information to the colony, the I-SWARM team's robots are able to communicate with each other and sense their environment. The result is a kind of collective perception.

The robots use infrared to communicate, with each signalling another close by until the entire swarm is informed. When one encounters an obstacle, for example, it would signal others to encircle it and help move it out of the way.

A group of robots that the project team called Jasmine, which are a little bigger than a two-euro coin, use wheels to move around, while the smallest I-SWARM robots, measuring just three millimetres in length, move by vibration. The I-SWARM robots draw power from a tiny solar cell, and the Jasmine machines have a battery.

"Power is a big issue. The more complex the task, the more energy is required. A robot that needs to lift something [uses] powerful motors and these need lots of energy," Szymanski notes, pointing to one of several challenges the team have encountered.

Processing power is another issue. The project had to develop special algorithms to control the millimetre-scale robots, taking into account the limited capabilities of the tiny machine's onboard processor: just eight kilobytes of program memory and two kilobytes of RAM, around a million times less than most PCs.

Tests proved that the diminutive robots were able to interact, though the project partners were unable to meet their goal of producing a thousand of them in what would have constituted the largest swarm of the smallest autonomous robots ever created anywhere in the world.

Nonetheless, Szymanski is confident that the team is close to being able to mass produce the tiny robots, which can be made much like computer chips out of flexible printed circuit boards and then folded into shape.

“They’re kind of like miniature origami,” he says.

Simple, mass production would ensure that the robots are relatively cheap to manufacture. Researchers would therefore not have to worry if one gets lost in the Martian soil.

The I-SWARM project received funding under the EU’s Sixth Framework Programme for research.

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