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What a lot of bots

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An EU-sponsored research programme is to build robots that can successfully adapt to live in buildings.

The 42-month, £1.85m Swarmanoid project is due to commence next month. Led by Dr Marco Dorigo of the Universite Libre de Bruxelles in Belgium, it aims to create a novel distributed robotic system consisting of 60 dynamically connected small autonomous robots.

Known collectively as a Swarmanoid, the robots will consist of three types: eye-bots, hand-bots and foot-bots. The three will act together to form a heterogeneous robotic system that can operate in three dimensions.

As well as constructing the robots, the team will have to develop distributed algorithms to determine the actions of the swarmanoid, and a communications structure that will make it possible to control the system as a whole.

Heterogeneous swarms

'At the moment the main goal of the project is to understand how to control heterogeneous swarms of robots,' said Dorigo. 'In the far future one could imagine such swarms could complete a number of different tasks in human-made environments.

'The name Swarmanoid comes from the idea that this type of robot is intended to take a different approach to the construction of robots, rather than creating humanoid robots. Although they will have a shape that is not reminiscent of human beings, these will be able to act effectively in human-made environments,' added Dorigo.

The eye-bots will observe and analyse the environment while gripping the ceiling, passing information to the hand-bots and foot-bots operating below them. The hand-bots will be able to climb vertical surfaces such as walls while the foot-bots will specialise in moving on rough terrain and transporting either objects or other robots.

'The hand-bots will be capable of climbing — that is, moving in the vertical plane,' said Dorigo. 'They will have simple manipulation capacities. The eye-bots will probably have more sophisticated sensing such as very simple vision and their main purpose will be in helping foot-bots and hand-bots plan their activities.'

The foot-bots are based on robotics developed within a previous EU sponsored Swarm- Bots project.

This ran from October 2001 to 31 March, 2005 and aimed to further research into designing a self-organising and self-assembling robotic system based on studies of swarm intelligence — the self-organising and self-assembling capabilities of insects and animals.

During the project the team created a swarm consisting of a number of simple, insect-like robots, called s-bots, built from relatively cheap components. These were capable of self-assembling and self-organising, changing the shape of the swarm to adapt to their environment.

The swarm-bots were tested by undertaking tasks which could not be accomplished by a single s-bot without co-operative effort, mimicking the types of behaviour that occur in nature in units such as ant colonies.

A long-term aim was for the group of bots to be able to identify and expel the bodies of s-bots that were no longer functioning, something that is still the subject of an ongoing doctoral thesis.

The s-bots created in the Swarm-Bots project were 12cm in diameter, weighed 700g, and had 50 sensors and nine actuators with gripping capabilities. Dorigo says that the foot-bots in the Swarmanoid project will be identical, though modifications will be made as necessary.

By using their sensory and gripping apparatus the s-bots could self-assemble into a larger aggregate robot called a swarm-bot in order to tackle increasingly difficult tasks. Each s-bot was controlled independently and had access only to locally available information. The team built 35 robots and completed experiments using swarms of up to 20 members.

These managed to autonomously self-assemble despite different types of rough terrain. As a collective, the swarm-bots were used to transport heavy objects, cross holes and avoid obstacles that a single s-bot could not have managed.

Self-assembly

The team also managed to make the robots perform functional self-assembly, triggered by environmental clues.

As part of the Swarmanoid project these skills will be developed so that the swarm is able to form certain shapes depending on the problem faced, such as dividing in two, with each half containing s-bots with similar characteristics.

This will also involve configuring the group so that all s-bots with a given set of sensors could stay on the outer perimeter of a formation while all the others remained inside.