Insects inspire robotics research

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Insects are proving invaluable for one researcher at the University of Alberta, who hopes robots can perform the same types of tasks that ants or bees do.

Dr. Hong Zhang, a professor in the Department of Computing Science, was awarded a 2006 NSERC Discovery grant for his work on collective robotics. The grant will fund Dr. Zhang and his team of graduate students' work on Multi Robot Systems (MRS). The MRS is a group of robots, each smaller than a paint can. They move as independent units but are programmed for collective decision-making and construction tasks.

Zhang hopes his robots will interact like a group of friends going out for the evening.

"Your friends get together to go to the movies. The group has to decide what movie to see from a few selections, using a negotiation process. Then there is a point of consensus reached and you pick a movie. What we are doing with the MRS is similar," said Zhang, an NSERC/iCORE Industrial Research Chair.

However, instead of people, Zhang and his students are using social insects such as ants and bees as their model. The ant species L. albipennis pick a new nest site in three steps: research, communication and commitment. Individual ants head out looking for a suitable nest location, 'tell' the other ants about the site and eventually gain commitment from the majority of the colony that the proposed location

is perfect for the new nest.

Zhang uses algorithms to map this behaviour and recreate it with the MRS. In this "biologically inspired" work, success is based on the ability of the robots to complete various experiments involving group transport and collective construction using the collective decision-making algorithms.

The key, Zhang says, is decentralized control. No one robot is in charge, but a group consensus must be made to complete tasks using only peer-to-peer interactions, an ability that is critical for an MRS to act as a single entity. For Zhang, this is the fascinating part about the research.

"To me, it is more interesting and useful to use MRS instead of a single robot. To gain the power of parallel tasks execution and to increase the robustness of a system, you need multiple robots."

This redundancy involving the simultaneous performance of actions by multiple robots is a key component. If one robot fails, the rest of the robot team can still complete the mission.

The other part of the research is in collective construction. The problem involves constructing a geometric structure using MRS that are only able to sense and communicate locally. Ants and termites have no blueprint to read when constructing new nests and neither will the robots - they will rely on each other for information.

Zhang is using two insect-inspired methods in building a structure. One is the use of past work to stimulate and guide the current activity. Past actions by the robots can be used to repeat a building pattern. The other is the releasing of robotic 'pheromones' in a specific area where other worker robots will be induced to add materials to the structure. Zhang believes it is possible to recreate this local sensing with programming

that instructs robots to be guided by other robots' activities. They will broadcast digital 'pheromones' to signal the other robots where to leave the materials and where to build the structure.

The implications of this research are far reaching. The recent successes of single robot technology with Mars rovers Spirit and Opportunity have opened the doors for MRS. Zhang points out that multiple robot systems could be used to construct lunar or Martian bases for future space missions. Robots that have collective decision-making and collective construction skills can also be used in saving lives in case of terrorist attacks or natural disasters.

These goals are obtainable with help, says Zhang.

"My research is in a way about exploiting the age-old idea that the whole can be greater than the sum of the parts when it comes to the design of a robot system, with robots being the parts and the team the whole. To accomplish this, we have a lot to learn from social insects."

Source: By Tereasa Maillie, University of Alberta