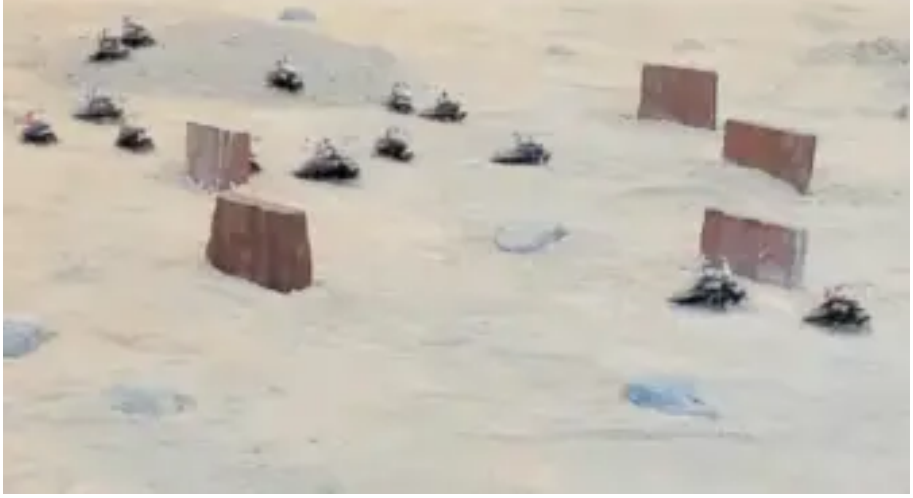
Scientists control swarms of cyborg cockroaches

Controlling several cyborg cockroaches is a difficult undertaking. Researchers have found a solution: They give them more autonomy.



A swarm of cyborg cockroaches crawls on sand and overcomes obstacles. (Image: Nanyang Technological University)

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By Oliver Bünte

Researchers at Hiroshima University and Osaka University have developed an algorithm to control swarms of cyborg cockroaches in difficult terrain without them getting stuck. The real cockroaches, which are equipped with a

small electronic backpack that enables directional control, are to be prepared for disaster relief, search & rescue and inspection missions.

The control of cyborg cockroaches is nothing new. Scientists have been researching the remote control of biological insects for several years. The cockroaches are equipped with small backpacks containing control electronics, batteries, sensors and sometimes cameras. The necessary interventions in the cockroaches are kept to a minimum and are largely limited to connecting the cockroaches' antennae to electronics for stimulation via probes. The cyborg cockroaches are then steered in the desired direction by stimulating the sensors.

So far, however, control has been limited to individual insects, although mass conversion of insects into cyborgs is already possible under laboratory conditions with the help of robot technology. However, entire swarms of insects cannot yet be controlled at the same time. However, this is necessary in order to be able to use as many cyborg cockroaches as possible to track down survivors within a 72-hour time window during search missions in disaster areas, for example.

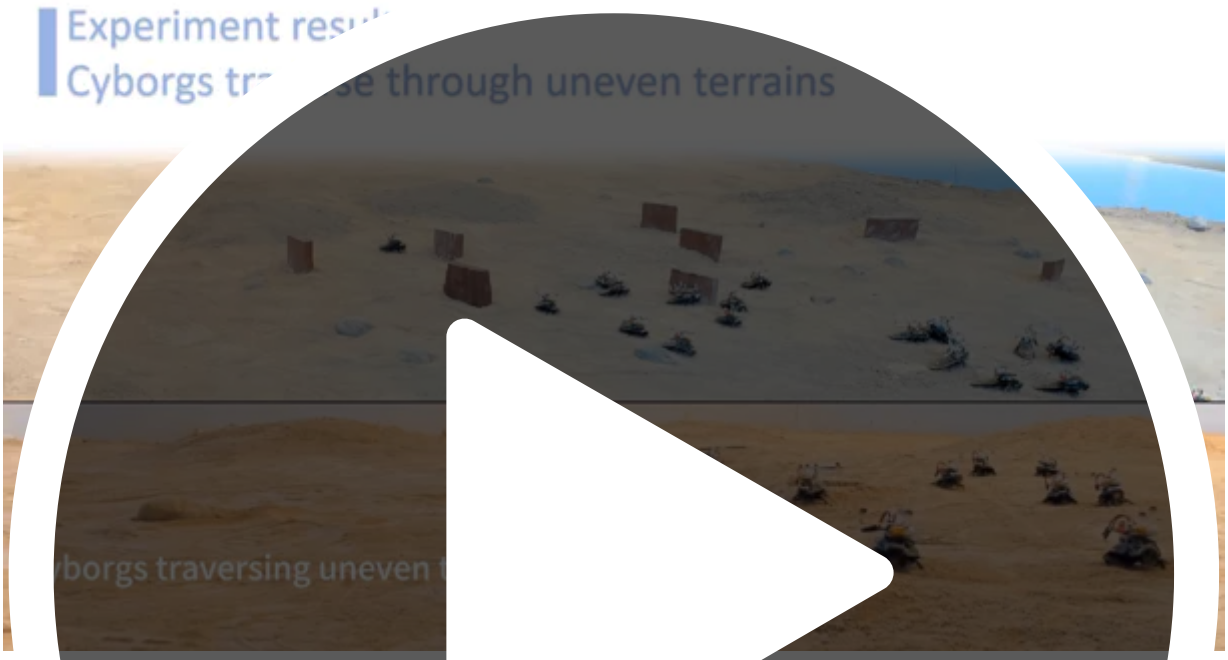
Remote control of the cyborg cockroaches via individual operators is too time-consuming and therefore ineffective. In addition, swarms cannot be coordinated sufficiently well using algorithms that forward detailed instructions for each individual insect.

Independent cyborg insects

In the study "Swarm navigation of cyborg-insects in unknown obstructed soft terrain", published in Nature Communications, researchers from Hiroshima University and Osaka University have found a new approach to the control problem of several cyborg cockroaches. The scientists rely on a leader insect whose control backpack coordinates with the backpacks of the other insects and leads the swarm. The swarm can thus be dynamically controlled and the cyborg cockroaches can help each other, for example to overcome obstacles or if they get stuck.

The algorithm developed by the scientists only controls the direction to the target to which they should move. In complex terrain formations and when

overcoming obstacles, however, the cyborg cockroaches act independently. This allows them to react much faster to changes in their environment based on their instincts than would be possible with purely computer-controlled logic.



D ideo zeigt, wie ein Schwarm Cy gesteuert werden kann. (Source: Nany j Te ological University)

The ientists tested this app ach in practice. They used Madagascar cockr ches that had been prepared with appropriate electronics.

In the exp ments, the researchers were able to prove that the a oach worked. Con e control of the individual insects was not n ssary. The algorithm and the porary transfer of control to the i ts themselves were able to minimize t. te the cyborg cockroaches to move by 50 percent. In addition, problems such as insects getting trapped or stuck could be solved more quickly or even prevented.

"Unlike robots, insects don't behave the way we expect them to. However, instead of trying to control them precisely by force, we found that a relaxed and rough approach not only worked better, but also led to the natural emergence of complex behaviors. Such behaviors include cooperative actions that are difficult to design as algorithms, says Wakamiya Naoki, professor at the Graduate School of Information Science and Technology and co-author of the study.

Cyborgs rather than robots

The scientists involved see the use of cyborg cockroaches for "search and rescue" tasks as having a clear advantage over robots. Cyborgs require significantly less energy than the power-intensive, electric motor-driven drive systems of robots. There is also no need to operate complex control electronics with high computing power.

In a further research project, the scientists now want to develop algorithms that encourage the cyborg insects to perform cooperative actions, such as the joint transportation of loads. In addition, the existing control algorithm is to be tested and improved in various realistic scenarios.