

Robots to rescue coral reefs

August 27 2012



Underwater coral. Photo: Murray Roberts

Researchers at Heriot-Watt are developing a swarm of intelligent robots to help save coral reefs.

A team of 'coralbots', each individually working to simple rules, will piece together damaged bits of coral, allowing them to regrow.

The approach is inspired by the behaviour of natural swarms of insects such as bees, [wasps](#) and termites which collectively build substantial and complex structures.

The coralbots is a collaborative project led by Dr Lea-Anne Henry from the School of Life Sciences in partnership with Professor David Corne from the School of Mathematical and Computer Science and Dr Neil Robertson and Professor David Lane from the School of Engineering and Physical Sciences. The project provides an innovative solution to restore the function of reefs, both shallow and deep across the globe.

Rebuilding coral reefs

The [deep waters](#) west of Scotland are characterised by the occurrence of large reef-forming corals similar to those in the tropics. Scottish reefs provide homes to thousands of other animals including fish and sharks, and are crucial to supplying coral propagules all the way to the Arctic. But Scottish corals are threatened by adverse impacts of bottom fishing that damages and kills large areas of reef. Luckily, this species can sometimes survive this damage and re-grow, but this can take many decades to centuries.

At present, this process of regrowth is assisted by volunteer scuba divers reassembling coral fragments on the reef framework. But the method has only limited success because they cannot spend long periods underwater nor reach depths of over 200 metres where some of the [deep-sea coral](#) grows.

'Swarm' robotics provides an [innovative solution](#), whereby multiple small [autonomous robots](#) follow a simple set of rules and seek out coral fragments and re-cement them to the reef. But first the robot needs to be driven by a computer 'trained' to recognise coral fragments from other objects such as rocks, litter, [sponges](#) and other sea creatures.

The swarm of autonomous underwater robots will operate according to a simple set of 'micro-rules' to seek out coral fragments and re-cement them to the reef.

Dr Lea-Anne Henry, from the School of Life Sciences, who is leading the project, said: "The biggest most immediate threat to deep-sea corals like the ones we have in waters off western Scotland is the bottom-fishing industry that damages and kills these corals."

Dr Henry has been studying Scottish deep-sea reefs for nearly a decade and says they continue to be at risk from fishing. The annual global contribution of corals to the economy, through supporting fisheries, coastal protection and tourism, is estimated at £40 billion.

Using 'swarm intelligence'

Heriot-Watt's Professor David Corne, from the School of Mathematical and Computer Science, who is in charge of developing the #micro-rules controlling the robot behaviour, said: "This project explores one of the most intriguing and impressive feats of natural 'swarm intelligence', whereby collections of simple-minded individuals collaborate to construct complex and functional structures.

"Exactly how this happens is only partly understood, but scientists have several clues and ideas, and we will exploit these ideas to achieve reef reconstruction."

Using a swarm of coralbots has many benefits including reducing the engineering requirements for the robots and robustness; if one coralbot is damaged then the others will still be able to complete the task. "The most exciting thing about this project is that it offers us the potential to restore the function of reefs, both shallow and deep, across the globe, which we all enjoy and benefit from in some way.

Dr Henry adds, "Swarms of robots could be instantaneously deployed after a hurricane or in a deep area known to be impacted by trawling, and rebuild the reef in days to weeks, instead of years to centuries."

Provided by Heriot-Watt University

Citation: Robots to rescue coral reefs (2012, August 27) retrieved 5 July 2024 from <https://phys.org/news/2012-08-robots-coral-reefs.html>

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