Under the sea, the louder the better

NUS's underwater camera takes images by harnessing sound, to study reef health

Dr Mandar Chitre, head of the institute’s Acoustics Research Laboratory, which built the camera, said that, in water, sound waves can travel up to half a kilometer away.

"The sound in the frequency band that Romans uses could potentially be detected over a few kilometers, depending on the loudness of the sound," he added.

The $2.5 million camera converts sounds – including those made by snapping shrimp – into images by using mathematical formulas.

The 300kg device, which needs to be lowered onto the seafloor with a crane, was used to survey the reefs off the southern coast of the island last year. The data collected is still being analyzed. Its work complements the most common type of reef survey, where scuba divers or snorkelers swim around to inspect a reef and identify species, said experts.

And, if successful, the information Romans collects could be a key part of Singapore’s efforts to save local reefs.

In 2009, academics and conservationists came up with a MoU Plan calling on the Government to conserve the Republic’s coral reefs, conduct a biodiversity survey of reef and review laws and management practices, among others.

Since then, the long-overlooked sea area around the island has received a boost, with conservation efforts being ramped up and the country’s first designated marine park around the Sulphur Islands.

Sound is another matter – sound passes far and fast through water, five times faster than through air.

The snapping shrimp is just 4cm long, but it can produce a noise as loud as the sperm whale's song.

These crustaceans can be found in most waves around the world, and are particularly abundant in coral reefs, said University of Essex marine biologist Julian Piercy, who led a recent study on noise produced by reefs and how it is associated with the ecosystem's health.

Healthy reefs have a higher density of marine creatures producing noise, which makes them "louder," he explained.

"Because snapping shrimp species are so abundant, the snapping sounds they produce have been found to be associated with reef health as a number of recent studies" has added. In essence, more squads equate to a healthier reef.

The shrimp are a good source of sound for the underwater camera dubbed Romans, built by researchers at the National University of Singapore’s Tropical Marine Science Institute (TMS).

By tuning how the sound wave is detected by the camera's various sensors, and how hard the water particles strike them, scientists can discern where the sound comes from.

Reef fish usually spawn away from their homes to protect their eggs from being eaten by other fish, but the larvae use the sound of the reef as their compass to find their way back.

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The snapping shrimp may unlock key to reef survival

Healthy reefs are more densely packed with noise-making marine creatures like the snapping shrimp.

The camera uses sensors to detect changes in water pressure caused by sound waves. When its 5MHz seismic sensors detect such vibrations, they produce an electric signal, which is sent in real time to a computer on land via fiber-optic cables.

By timing how the sound wave is detected by the camera's various sensors, and how hard the water particles strike them, scientists can discern where the sound comes from.

The Singapore researchers have found a way to use the sound collected to produce images, which can then be used to check for changes in the reef. The snapping shrimp spits out an image-making cloud to hunt and communicate, and as a show of aggression.

But the sound it makes is not actually produced by the snapping of its claws.

When the shrimp contracts muscles to activate the claw, it forms a jet of water from the socket at high speed, which forms tiny bubbles.

As each bubble collapses, the temperature inside momentarily reaches the surface temperature of the sun, and produces – for an instant – a loud blast, said Dr Mandar Chitre, who heads the institute's Acoustics Research Lab.

Dr Piercy added: "Romans can detect these sounds and also identify their location, which could be useful for identifying which parts of a reef are the most productive."

Noted the university: "With less sound being produced at impacted reefs, the distance over which larvae can detect habitat is 10 times less, impacting the replenishment of future generations needed to build up and maintain healthy population levels."

The Singapore trial last August saw Romans deployed in the waters surrounding St John's Island. It was funded by the Acoustics Research Lab and the Singapore-MIT Alliance for Research and Technology (SMART).

More than four terabytes of data was collected and is being analyzed. A Smart spokesman said that the images taken by Romans can be used to identify changes in geomorphology and structural conditions.

"In the case of a reef, both these features could be used to gauge its health," he said.

This would give conservationists a better idea of what areas to protect or pump resources into.

While acknowledging the potential of Romans, Dr Piercy pointed out that its use requires expensive equipment, such as drones, and prior knowledge of the sound to work reliably.

"However, the technology and algorithms behind the Romans system are where its real potential lies," he said.

"These advances could be transferred to more simple and less costly systems in the future to monitor reef health."

Audrey Tan

Note: Audrey Tan was a former journalist at The Straits Times. She has written about science, technology, environment and culture for various publications and websites. She is currently a freelance writer and researcher based in Singapore.