AUGMENTED AWARENESS

TECHNOLOGY TUNED TO THE WORLD AROUND US

For many years, researchers have been using sensors that detect visual and electromagnetic energy, sound, texture, odour, and taste to explore areas that are hidden from our natural senses of sight, hearing, touch, smell and taste. Many are even biomimetic – copying the sensory capabilities of other organisms. Research ecologist **Richard Mankin**, who has spent decades working on developing acoustic detection methods for insect control, explains.

SPIDER SILK SENSORS


Golden orb-weaver
Photo: Craig Jewell

Spider silk is a biopolymer and can be used as an efficient, cost-effective fibre-optic chemical sensor to detect chemicals at a nanoscale level. Silica has conventionally been used as a sensor for strain, pressure or temperature, but it is impervious to biological and chemical compounds. Spider silk is comprised of millions of repeating protein sequences, so it is very sensitive to other proteins and nucleic acids. In 2015, Hey Tow et al. gathered dragline silk fibre from a golden orb-weaver (*Nephila edulis*), injected linearly polarised light into it, and examined its optical characteristics when exposed to polar molecules such as acids, bases and water. They found it could transmit visible light. Exposure to polar molecules weakens the hydrogen-bonding holding spider silk together, altering the state of polarisation of the light transmitted, thus acting as a sensor to detect compounds. This unique molecular make-up enhances silk's responsivity compared to existing chemical sensing tools. Inserting specific dyes into a single thread will enable customised use as a fibre-optic chemical sensor. Spider's silk is also robust, biodegradable, and able to be produced in a laboratory.

Hey Tow K, et al. 2015. DOI: 10.1117/12.2192427. Vollrath F, Knight DP. 2011.*Nature DOI: 10.1038/35069000*

I've spent much of my career working with sensors to detect infestations of insects hidden in soil, trees, or food products. The sounds insects make as they move and feed can be amplified 100–1000x by vibration sensor systems, which makes them easily detectable with headphones. In 2008, I visited Mackay and Bundaberg in Queensland to search for greyback canegrub (*Dermolepida albohirtum*) and other insect pests in sugarcane fields. It is easier to poke a sensor into the ground and listen to grubs chewing roots than to dig up a set of cane stools and shake off the dirt to check whether root systems are infested, particularly because populations are clustered together near where the mother laid her eggs. You can spend a lot of time digging holes and filling them in again later. Unsurprisingly, farmers prefer to use the headphones!

Modern sensor technology is rapidly improving, driving down the costs of using acoustic systems. Twenty years from now, greyback infestations in sugarcane or hardwood stump borer infestations in avocado groves might be identified by videos recorded by overhead drones, with machines analysing the signals to detect slight differences between light frequencies reflected from leaves of water-stressed or unstressed sugarcane stalks.

Broadening horizons

As a near-sighted codger with leg disabilities, I appreciate the capability of modern sensors and mechanical devices to provide sensory and locomotory accommodations for those with disabilities. Computer screens and iPads that enable those in the field to adjust text size; ever-more effective hearing aids; spectacles, braille maps and publications; and 'read-aloud' systems that convert from text to sound, and vice versa, can help the disabled adapt and thrive in the modern age and enjoy a rewarding career in the sciences. Such systems have greatly improved during my lifetime, and I expect further improvements in the future.

'It is easier to drill into a tree and use sensors to hear hardwood stump borer larvae eating inside the trunk than to cut the tree down and dissect the pieces.'

Although unable to walk unassisted, **RICHARD MANKIN**, president of the US Foundation for Science and Disability, doesn't consider himself disabled. As a research ecologist, he uses touch and hearing to study the vibrations of insects. The foundation sponsors the research of students with disabilities, helping others use augmented awareness to enjoy careers that Richard says 'benefit humanity'. ■

MAPPING THE DEPTHS

Affordable, remote sensing technology, including aerial and satellite surveillance, has facilitated greater understanding of terrestrial ecosystems. However, applying such techniques to marine ecosystem management has its limitations. Poor light penetration in seawater limits the ability to monitor the seabed from the air. Instead, advancements in acoustic survey techniques such as sidescan sonar systems (SSS, right), single-beam acoustic ground discrimination systems (SB-AGDS), and multi-beam echo sounders (MBES) generate accurate images of the seabed that, coupled with *in situ* sampling of substrate, allow for spatial representations of submerged terrain. However, this technology may also affect marine species, particularly cetaceans (see p. 31).

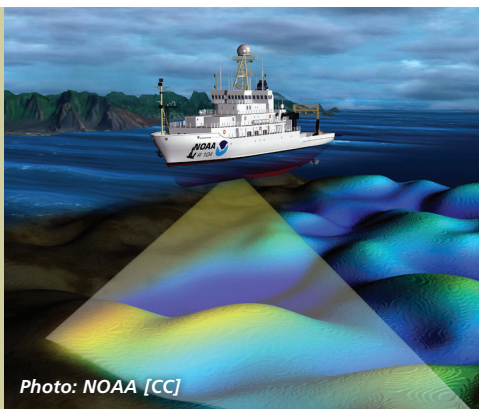
Photo: NOAA [CC]