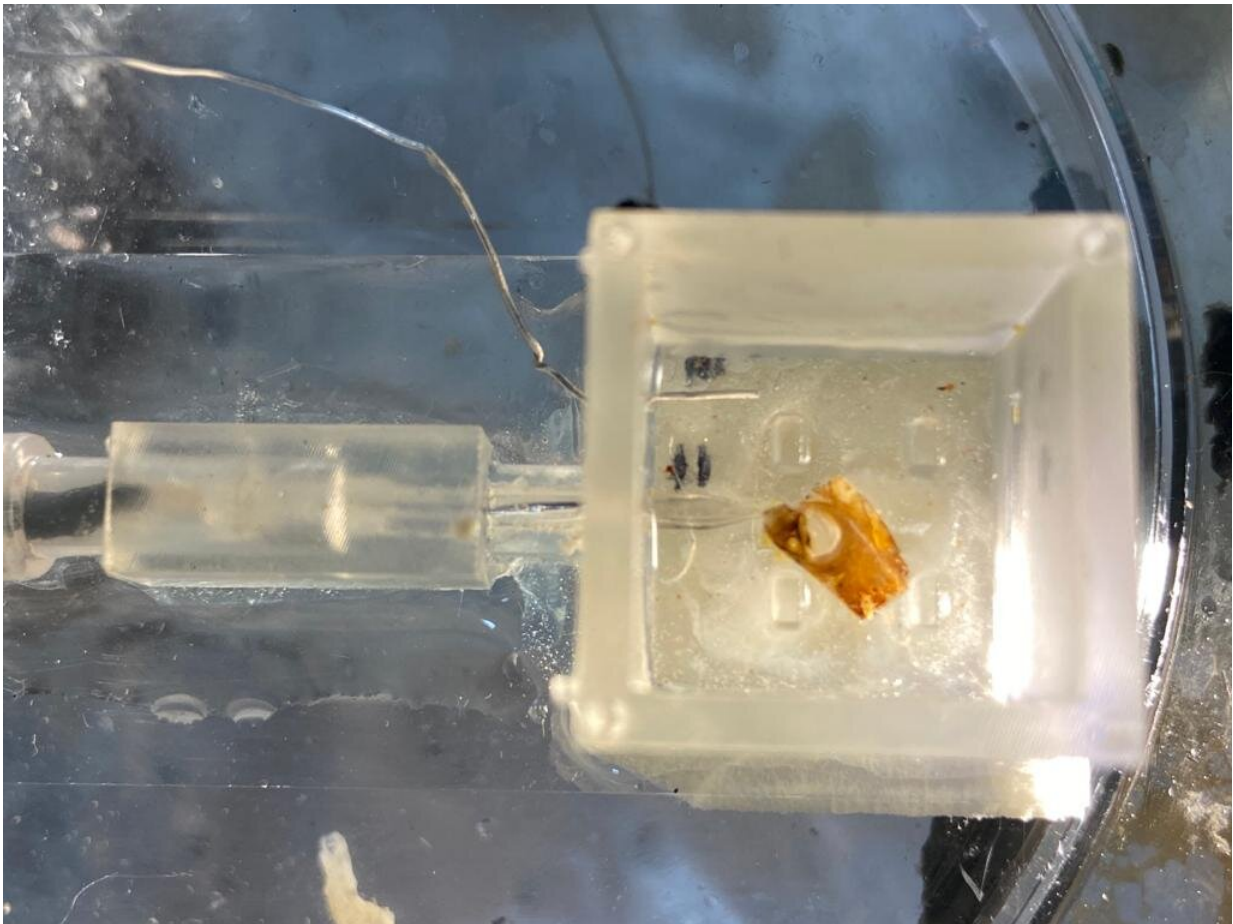


A world first: A robot able to 'hear' through the ear of a locust

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The locust ear inside the chip. Credit: Tel Aviv University

A technological and biological development that is unprecedented in

Israel and the world has been achieved at Tel Aviv University. For the first time, the ear of a dead locust has been connected to a robot that receives the ear's electrical signals and responds accordingly. The result is extraordinary: When the researchers clap once, the locust's ear hears the sound and the robot moves forward; when the researchers clap twice, the robot moves backwards.

The [interdisciplinary study](#) was led by Idan Fishel, a joint master student under the joint supervision of Dr. Ben M. Maoz of the Iby and Aladar Fleischman Faculty of Engineering and the Sagol School of Neuroscience, Prof. Yossi Yovel and Prof. Amir Ayali, experts from the School of Zoology and the Sagol School of Neuroscience together with -, Dr. Anton Sheinin, Idan, Yoni Amit, and Neta Shavil. The results of the study were published in the prestigious journal *Sensors*.

The researchers explain that at the beginning of the study, they sought to examine how the advantages of biological systems could be integrated into [technological systems](#), and how the senses of dead locust could be used as sensors for a robot. "We chose the sense of hearing, because it can be easily compared to existing technologies, in contrast to the sense of smell, for example, where the challenge is much greater," says Dr. Maoz. "Our task was to replace the robot's electronic microphone with a dead insect's ear, use the ear's ability to detect the electrical signals from the environment, in this case vibrations in the air, and, using a special chip, convert the insect input to that of the robot."

To carry out this unique and unconventional task, the interdisciplinary team (Maoz, Yovel and Ayali) faced number of challenged. In the first stage the researchers built a robot capable of responding to signals it receives from the environment. Then, in a multidisciplinary collaboration, the researchers were able to isolate and characterize the dead locust ear and keep it alive, that is, functional, long enough to successfully connect it to the robot. In the final stage, the researchers

succeeded in finding a way to pick up the signals received by the locust's ear in a way that could be used by the robot. At the end of the process, the robot was able to "hear" the sounds and respond accordingly.

"Prof. Ayali's laboratory has extensive experience working with locusts, and they have developed the skills to isolate and characterize the ear," explains Dr. Maoz. "Prof. Yovel's laboratory built the robot and developed code that enables the robot to respond to electrical auditory signals. And my laboratory has developed a special device—Ear-on-a-Chip—that allows the ear to be kept alive throughout the experiment by supplying oxygen and food to the organ, while allowing the electrical signals to be taken out of the locust's ear and amplified and transmitted to the robot.



The Robot with the chip. Credit: Tel Aviv University

"In general, biological systems have a huge advantage over technological systems—both in terms of sensitivity and in terms of energy consumption. This initiative of Tel Aviv University researchers opens the door to sensory integrations between robots and insects—and may make much more cumbersome and expensive developments in the field of robotics redundant.

"It should be understood that [biological systems](#) expend negligible energy compared to electronic systems. They are miniature, and therefore also extremely economical and efficient. For the sake of comparison, a laptop consumes about 100 watts per hour, while the human brain consumes about 20 watts a day. Nature is much more advanced than we are, so we should use it. The principle we have demonstrated can be used and applied to other senses, such as smell, sight and touch. For example, some animals have amazing abilities to detect explosives or drugs; the creation of a [robot](#) with a biological nose could help us preserve human life and identify criminals in a way that is not possible today. Some animals know how to detect diseases. Others can sense earthquakes. The sky is the limit."

More information: Idan Fishel et al, Ear-Bot: Locust Ear-on-a-Chip Bio-Hybrid Platform, *Sensors* (2021). [DOI: 10.3390/s21010228](https://doi.org/10.3390/s21010228)

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