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Lidar Spots Bomb-Sniffing Honeybees

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Bees aren't busy just for the sake of being busy. The constant foraging for pollen by honeybees enables the hive to exist. This industriousness also has been proposed as a means to locate land mines.

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"We are really hopeful that this work can help with humanitarian de-mining," explained Joseph A. Shaw, an associate professor of electrical and computer engineering at Montana State University-Bozeman, where he is working with colleagues on the lidar project. Others involved in the research effort are at the University of Montana-Missoula and at the National Oceanic and Atmospheric Administration's Environmental Technology Laboratory in Boulder, Colo.

Jerry J. Bromenshenk and his group at the University of Montana have shown that honeybees can sense the chemical plume emitted by land mines and can be taught to respond to it as they would a food source. Bees offer several advantages over dogs in such work. The insects, which can be trained in a few days, do not require handlers and do not set off mines.

However, spotting where bees congregate isn't easy. Visual and video counts can determine bee density and thereby map the position of the mines, but these techniques require walking into a minefield. Several years ago, scientists at Sandia National Laboratories in Albuquerque, N.M., turned to lidar, using reflected laser pulses to locate bees at distances of 1.33 km.

In experiments reported in the July 25 issue of Optics Express, Shaw's team used a frequency-doubled Nd:YAG laser in its lidar setup as a source of 532-nm light, firing 30 pulses per second as the system scanned horizontally across the scene. The investigators collected the backscattered signal using a linear polarizer, a telescope and a nanometerwide bandpass filter, and fed the light into a photomultiplier tube.

What they sought were those points where the bee density was above a threshold. Shaw noted, however, that they were not looking for swarms of insects but rather for those places where numbers of bees tended to visit over time.

They evaluated how the honeybees performed at a control field that was free of mines and at a field that contained defused mines, which could not explode but which still emitted the chemical plume of explosives. Both visual and lidar measurements proved that the bees did indeed detect the mines. The bees even found one that was unknown to the researchers.

Although the results are encouraging, more work needs to be done. One problem is that bees fly close to the ground, so the ideal scanning laser beam would do likewise. Given the unevenness of most terrain, this may mean that multiple lidar stations must be used. Another is that bees aren't the only things in nature that reflect polarized light when hit with a laser pulse. Vegetation does the same. During their investigation, the researchers had to keep the grass on the minefield short enough so that it wouldn't interfere with their measurements.

"Clearly, mowing a minefield isn't going to be the long-term solution," Shaw acknowledged. "We need a sensor system that provides a more unique bee signal."

The researchers may have uncovered a solution. Although a bee's wings don't generate much of a polarized reflection, the beating of the wings does give rise to a rhythmic signal. The group is considering ways to exploit this phenomenon to create a bee-specific measurement.

The hope, Shaw said, is that the system eventually will be sufficiently portable and inexpensive that several lidar stations may be deployed at once.

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