

Hoverfly brains mapped to detect sound of distant drones

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UniSA Professor Anthony Finn pictured with A DJI Matrice 600 drone with a payload capable of emitting or receiving acoustic signals. Credit: University of South Australia

For the first time, Australian researchers have reverse engineered the visual systems of hoverflies to detect drones' acoustic signatures from

almost four kilometers away.

Autonomous systems experts from the University of South Australia (UniSA), Flinders University and defense company Midspar Systems say that trials using bio-inspired signal processing techniques show up to a 50% better detection rate than existing methods.

The findings, which could help combat the growing global threat posed by IED-carrying drones, including in Ukraine, have been reported in *The Journal of the Acoustical Society of America*.

UniSA Professor of Autonomous Systems, Anthony Finn, says that insect vision systems have been mapped for some time now to improve camera-based detections, but this is the first time that bio-vision has been applied to acoustic data.

"Bio-vision processing has been shown to greatly increase the detection range of drones in both visual and infrared data. However, we have now shown we can pick up clear and crisp acoustic signatures of drones, including very small and quiet ones, using an algorithm based on the hoverfly's visual system," Prof Finn says.

The hoverfly's superior visual and tracking skills have been successfully modeled to detect drones in busy, complex and obscure landscapes, both for civilian and military purposes.

"Unauthorized drones pose distinctive threats to airports, individuals and [military bases](#). It is therefore becoming ever-more critical for us to be able to detect specific locations of drones at long distances, using techniques that can pick up even the weakest signals. Our trials using the hoverfly-based algorithms show we can now do this," Prof Finn says.

Associate Professor in Autonomous Systems at Flinders University, Dr.

Russell Brinkworth, says the ability to both see and hear small drones at greater distances could be hugely beneficial for aviation regulators, safety authorities and the wider public seeking to monitor ever increasing numbers of autonomous aircraft in sensitive airspace.

"We've witnessed drones entering airspace where [commercial airlines](#) are landing and taking off in recent years, so developing the capacity to actually monitor [small drones](#) when they're active near our airports or in our skies could be extremely beneficial towards improving safety.

"The impact of UAVs in modern warfare is also becoming evident during the war in Ukraine, so keeping on top of their location is actually in the national interest. Our research aims to extend the detection range considerably as the [use of drones](#) increases in the civilian and military space."

Compared with traditional techniques, bio-inspired processing improved detection ranges by between 30 and 49%, depending on the type of [drone](#) and the conditions.

Researchers look for specific patterns (narrowband) and/or general signals (broadband) to pick up drone acoustics at short to medium distances, but at longer distance the signal is weaker and both techniques struggle to achieve reliable results.

Similar conditions exist in the natural world. Dark lit regions are very noisy but insects such as the hoverfly have a very powerful visual system that can capture visual signals, researchers say.

"We worked under the assumption that the same processes which allow small visual targets to be seen amongst visual clutter could be redeployed to extract low volume acoustic signatures from drones buried in noise," Dr. Brinkworth says.

By converting acoustic signals into two-dimensional "images" (called spectrograms), researchers used the neural pathway of the hoverfly brain to improve and suppress unrelated signals and noise, increasing the detection range for the sounds they wanted to detect.



UniSA Professor Anthony Finn pictured with a DJI Matrice 600 drone with a tetrahedral acoustic antenna array for the directional location of signals. Credit: University of South Australia

Using their image-processing skills and sensing expertise, the researchers made this bio-inspired [acoustic data](#) breakthrough. Their effort could support technological solutions to address the weaponization of drones, which are now among the deadliest weapons in [modern warfare](#), killing

or injuring more than 3,000 enemy combatants in Afghanistan and being deployed in the current war in Ukraine.

"Acoustic detection of unmanned aerial vehicles using biologically inspired vision processing" has been published in the *Journal of the Acoustical Society of America*.

More information: Jian Fang et al, Acoustic detection of unmanned aerial vehicles using biologically inspired vision processing, *The Journal of the Acoustical Society of America* (2022). [DOI: 10.1121/10.0009350](https://doi.org/10.1121/10.0009350)

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