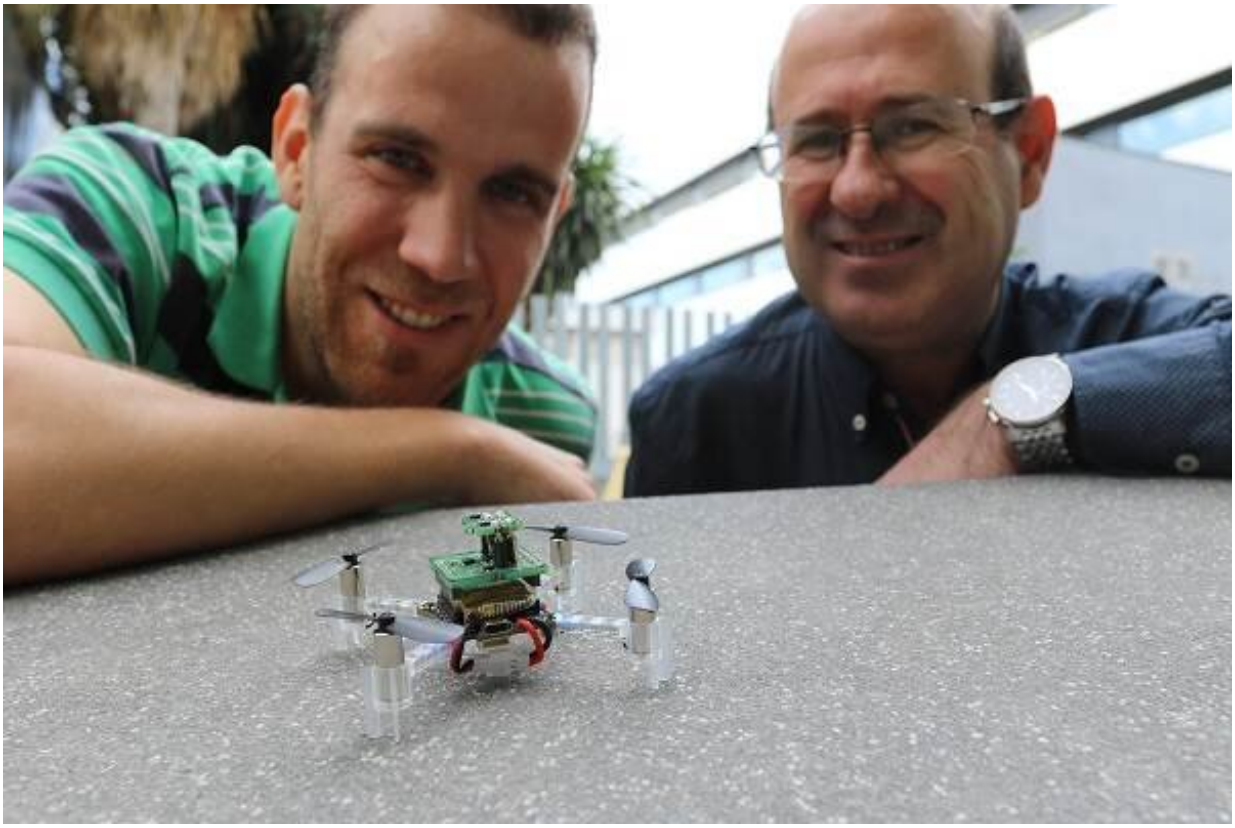
A nanodrone able to detect toxic gases in emergencies

July 24 2019



The experts Javier Burgués and Santiago Marco, from the Faculty of Physics of the University of Barcelona and the Institute for Bioengineering of Catalonia. Credit: IBEC

Detecting dangerous gases in collapsed buildings due earthquakes or

explosions and locating victims in hard-to-access places are among use scenarios of the Smelling Nano Aerial Vehicle (SNAV), a nanodrone designed and created by the researchers Santiago Marco and Javier Burgués from the Faculty of Physics of the University of Barcelona and the Institute for Bioengineering of Catalonia (IBEC).

A drone is an aircraft piloted by remote control. Nanodrones are operational platforms weighing less than 250 grams.

The SNAV nanodrone, described for the first time in an article in the journal *Sensors*, weighs 35 grams and is designed to fly and identify gases in scenarios that other remote vehicles cannot navigate. It has nanometric MOX gas sensors that can respond to gases such as carbon monoxide (CO) or methane (CH_4) and other organic volatile compounds (ethanol, acetone, benzene, etc.), with a detection threshold on the order of a part per million in volume (ppmv).

Different from other larger gadgets, SNAV is able to work in interior spaces and can work in large areas where the chemical emission source is difficult to access (false ceilings, air duct systems, etc.).

SNAV: from detecting toxic gases to rescuing victims

This new device would be especially useful in "rescue operations in collapsed buildings due earthquakes and explosions. SNAV can detect toxic gases and even the compounds unconscious victims exhale, and search for drugs or explosives in places that are hard to enter," says Santiago Marco, principal researcher at IBEC and member of the Department of Electronic and Biomedical Engineering of the UB, who led the new research study.

In these situations after an earthquake or explosion, rescue teams usually have trained dogs to find victims. The possibility of using autonomous

robots in these tasks represents a new option.

"Terrestrial robots used to focus the searching on the field of chemical signaling-based localization. Today, the option of using nanodrones broadens the ability and quickness of the robots to move within an interior space and overcome obstacles such as stairs," says Marco, head of Intelligent Signaling for Sensor Systems in Bioengineering, UB-IBEC.

Overcoming the effects of turbulence and navigation problems

Limitations regarding weight and use of the nanodrone and the negative effects of turbulence of the rotor on the sensor signals are great inflection points for the design and technical development of nanodrones like SNAV. To beat the negative effect of turbulence, which affects the data obtention process, the UB-IBEC team applied signal procedure techniques that obtain useful information from the sensors in the SNAV.

Another critical point is the self-localization of the nanodrone in action scenarios. In general, the control mechanism of drones that fly large distances in open spaces is based on a GPS navigation system. However, this is not a viable option for devices that fly within interior spaces.

"The new nanodrone has accelometers and gyroscopes that help navigation, but without the expected precision for localization. Therefore, this function is based in a series of six radio frequency transceivers located in known positions, and a transceiver on the same drone. This system allows us to fly the nanodrone to the position we want," says Javier Burgués (UB-IBEC), first author of the study.

New algorithms inspired by animal behaviour

As part of the study, the UB-IBEC team of experts worked on the SNAV platform, calibrating the sensors and checking its functions as well as programing the algorithms for data processing, communication and robotic navigation. All robotic navigation trials from SNAV were carried out at Örebro University (Sweden) in collaboration with the experts Víctor Hernández and Achim J. Lilienthal.

The researchers intend to explore bio-inspired navigation algorithms based, for instance, on the behaviour of insects such as mosquitoes or moths. "Another line we want to work on is the merger of data from multiple gas sensors to increase selectivity toward certain compounds of interest. In this case, researchers would work on experiments in complex scenarios and with chemical interferences," says Santiago Marco.

More information: Javier Burgués et al. Smelling Nano Aerial Vehicle for Gas Source Localization and Mapping, *Sensors* (2019). DOI: 10.3390/s19030478

Provided by University of Barcelona