Life-saving drones use photonics to transform disaster rescue efforts

Directing evacuations, reducing damage and saving lives in the aftermath of major disasters like wildfires, chemical blazes, or volcanic eruptions will all be improved thanks to a new drone that provides critical air quality data to ground-based emergency services in real-time.

Critical air quality information is needed for deploying emergency services, evacuations and survival in the aftermath of a catastrophic event, such as a volcanic eruption, a wildfire or a chemical plant explosion.

Natural disasters like the infamous eruption of Iceland's Eyjafjallajökull in 2010 can severely impact air quality and safety in the short term and are often outside the reach of fixed monitoring station networks.

Similarly, wildfires, which destroyed 700,000 ha of land in the EU this year according to the European Forest Fire Information Service (EFFIS), and 8.8 million acres caused by 52,699 individual fires in the USA in 2017, were estimated to kill up to 339,000 people worldwide per annum.

Rapid Response Drone

Reaching speeds of up to 120 km per hour and covering an 80 kilometre radius, the drone is fitted with a novel photonic sensor that can simultaneously detect dozens of toxic gasses in an instant.

Flying through some of the toughest environments on earth such as dangerous clouds or poisonous plumes, the FLAIR (or 'Flying ultrA-broadband single-shot Infra-Red Sensor') drone aims to provide real-time air quality data used for quick decision-making during evacuations and the deployment of rapid response emergency services.

André Oliveira Project coordinator of TEKEVER AUTONOMOUS SYSTEMS told Photonics PPP:

"For the first time, a drone reaching altitudes of up to 4000 metres will be able to detect fine traces of air molecules that are dangerous to our health with a state-of-the-art laser sensor. The drone can map out areas that are too dangerous for humans to go and can transmit data in real time to a ground processing unit."

Standard gas sensors on ground based stations usually deploy 'light detection and ranging' (LIDAR) or 'differential optical absorption spectroscopy' (DOAS), focusing on one or few specific molecules, such as carbon dioxide and methane, using a narrow spectrum laser.

However, because the FLAIR sensors work in a much wider spectrum, more detailed signatures in the gas mixture can be detected, such as carbon dioxide, methane, sulphur oxides, and nitrogen dioxide.

Sensing Toxic Particles

It works by beaming the sampled air in a ‘multipass cell’ to increase the total optical path length for exposure with a super-continuum laser, allowing the tiniest concentrations of complex, toxic gas mixtures to be detected.

The gas concentrations are measured by reading the unique frequencies, or ‘signatures’ of the air sample, that become absorbed and ‘dimmed’ in the laser light. To improve detection, these unique frequencies of the multiple gasses are separated.

The light then passes through a series of gratings and lenses, illuminating the surface of a multi-pixel detector, a device able to distinguish the toxic particles at the photon level.

From these separated pixels the system can then detect exactly ‘what’ and ‘how much’ of the poisonous gas is present. The drone then relays this microscopic information to the user on the ground in real time

“Immediate detection with such accuracy and precision, without putting lives at risk allows us to visualise vast areas of danger much more effectively. A tailored response can therefore be deployed to disaster situations, reducing damage or even saving lives”, said Mr Oliviera.

“For the first time a gas sensing device has been created from the hybrid of an optical spectrometer and a high-resolution spectroscopy gas sensor. By employing infrared absorption spectroscopy in either the 2-5 microns and 8-12 microns wavelength windows where most of the harmful gasses have absorption signatures, the optical sensors can detect many molecules simultaneously in real time,” Oliviera said.

Expecting to have a prototype ready in November 2018, the FLAIR project coordinated by TEKEVER AUTONOMOUS SYSTEMS in Portugal received a grant of €3,072,020 from Horizon 2020 via the Photonics Public Private Partnership.

Participants from five other European countries include: Senseair AB (Sweden); NKT Photonics A/S, Danmarks Tekniske Universiteit (Denmark); New Infrared Technologies SL (Spain); Stichting Katholieke Universiteit (Netherlands); Eidgenossische Materialprufungs-Und Forschungsanstalt, CSEM Centre Suisse D’Electronique et de Microtechnique SA – Recherche et Developpement (Switzerland).

About FLAIR

www.h2020flair.eu

About Photonics21

Photonics21 is the European Technology Platform (ETP) for photonics, a technology encompassing all of the products and processes around the emission, manipulation and detection of light. Photonics is integral to a wide range of industries that include the medical, healthcare, transport, manufacturing, and telecommunications sectors.

"Photonics21" was set up in December 2005 to bring the community of photonics researchers and industries together. The European Commission defined photonics as one of six European Key Enabling Technologies (KET's) in September 2009. Shortly after, the European Research & Innovation Program "Horizon 2020" invited Photonics21 to become a "Public Private Partnership" (PPP). The "Photonics 21 Association", a legal entity under Belgium law, became the private contract partner in November 2013 in a Public Private Partnership (PPP) in conjunction with the EU Commission.

Today Photonics21 represents more than 3000 personal members from across Europe and

abroad. Our members are experts in the photonics industry, research organisations and universities who actively engage with us to develop a joint photonics strategy for future research and innovation in Europe.

With the global photonics market growing from €350 Billion in 2011 to €447 Billion in 2015, Photonics remains a strong industry. The European photonics industry, estimated to be worth €70 billion, has considerable global leadership positions and employs over 300,000 people directly.

With positive growth forecast, current industry trends like digitalisation, resource efficiency, individual and zero failure production will drive the photonics industry further.

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