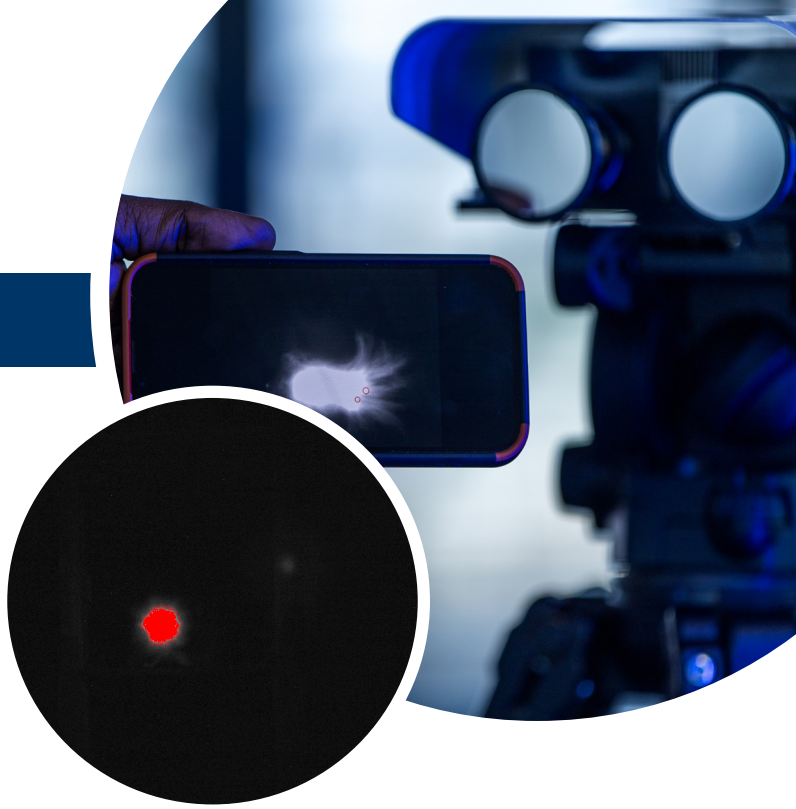
CSIR OPTRONIC SENSOR SYSTEMS

Gunshot detection system



The CSIR has developed an optical imaging system for the detection of small and medium to large shots from a firearm. The system detects the Potassium signature produced by a chemical reaction or combustion of the propellant inside a firearm.

Due to little atmospheric absorption and an efficient filtering mechanism, the concept enables long-range detection of gunshot fires with a low false alarm. The system is inexpensive since it is built with widely available commercial off-the-shelf parts, such as CMOS cameras, lenses and filters. By integrating ultra-narrow band filtering methods and in-house image processing tools, the sensor can detect a near-infrared firearm flash with discrete temporal signatures in the order of hundreds of microseconds.

How it works

A gun, regardless of its size, operates by converting the chemical energy of a propellant into kinetic energy possessed by the bullet. The propellant mixture determines the nature of the signature that is produced when the gun is fired. All solid propellants' (single, double or triple base) compositions include some amounts of additives to impart desirable properties. Because of performance, the alkali element (Potassium symbol K on the periodic table) is added to the propellant as an oxidising action and to suppress gun muzzle flash. The presence of Potassium salt suppressants in propellants amplifies the K signature and motivated the development of a sensor system that is able to detect and locate the K-line emission at longer ranges.

Using the system

The prototype consists of two high-speed cameras with a common field of view (FOV) placed side by side. The sensors are optimised to detect the K-line signature (hence the name K-line camera) and the ambient background (reference camera). The two sensors are synchronised at the electronic level such that pairs of images produced are obtained at the same instant. Gunshot detections are made by comparing the K-line channel image to the reference channel image. Pixels that are much brighter in the K-line channel relative to the reference channel are gunshot detections.

The system can be used in:

Smart cities/police:

- Situational awareness
- Early warning
- Recorded gunshot events for forensics
- Detection of gunshots
- Geolocation of gunshots
- Real-time detection of firearms

Army:

- Protection of army bases and vehicles
- Protection of helicopters
- Spotting of enemy gunshots
- Offer 360-degree hemispherical coverage

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Fire Detection Sensor

The CSIR has also developed an optical imaging sensor for the detection of wildland vegetation fires through imaging of the alkali metal Potassium from burning biomass. The technology prototype, known as the K-line sensor, was launched in 2018 as a secondary payload onboard the ZA-Cube2 satellite. It is currently orbiting the Earth at a low Earth orbit of approximately 600 km with a GSD at Nadir of 63 m.

The figure below shows the CSIR-developed K-line sensor payload for the satellite, UAV, and a drone carrying the sensor during an experimental demonstration of the sensor's concept of operation. The UAV sensor weighs 1.4 kg, including batteries and antennas.

The current sensor prototype consists of a combination of two CMOS cameras with a common 10° field of view (FOV) placed side by side. One sensor is furnished with an ultra-narrow bandpass filter optimised for the detection of the Potassium emission lines. The second sensor is furnished with a bandpass filter that is close to but excludes the target band; this is called the "reference channel". The K-line and reference channels are temporally synchronised at the electronic level, such that pairs of images produced are obtained at the same instant. Fires are detected by comparing the K-line channel image to the reference channel image. Pixels that are much brighter in the K-line channel relative to the reference channel are candidate fire detections.

Current UAV sensor functions and applications

- Space remote sensing
- Spectroscopy
- NIR sensing
- Imaging of potassium emissions
- Detection of vegetation fires
- Live streaming to the ground station

Future functional features and applications

- Improved sensor resolution and sensitivity
- Provision of fire geolocation information
- Advanced image processing software
- Monitoring of fire developments
- Tracking fire propagation
- Making fire evolution predictions in real time
- Live image streaming to the ground station

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