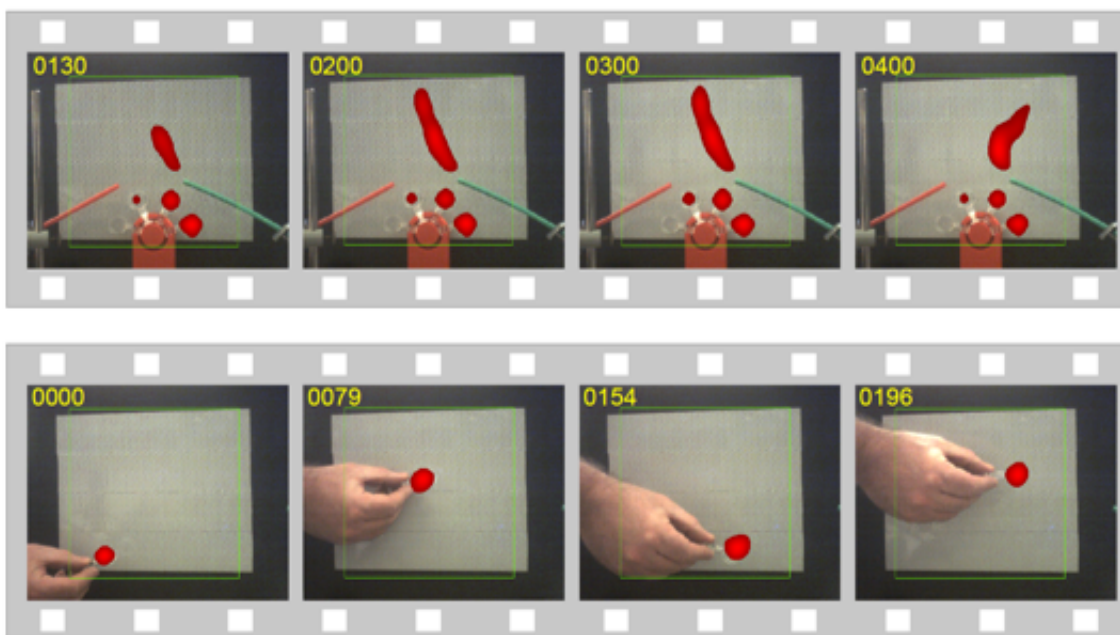


Low-cost imaging system detects natural gas leaks in real time

February 6 2017



Researchers developed a new infrared imaging system that could one day offer low-cost, real-time detection of methane gas leaks. The top row shows movie frames from a low-resolution (16x16) computational image of a gas leak, overlaid onto a high-resolution color image from a CMOS camera. Only the methane gas is detected (red), when 0.2 liters per minute of methane are delivered via the green tube and 2 liters per minute of nitrogen are delivered from the red tube. The bottom row shows movie frames where a methane gas sample cell is moved by hand across the field-of-view. Credit: Graham M. Gibson, University of Glasgow

Researchers have developed an infrared imaging system that could one day offer low-cost, real-time detection of methane gas leaks in pipelines and at oil and gas facilities. Leaks of methane, the primary component of natural gas, can be costly and dangerous while also contributing to climate change as a greenhouse gas.

"Despite [methane gas](#) being invisible to the eye, we have developed a method of color-coding this gas information and overlaying it onto a conventional camera image," said Dr. Graham M. Gibson from the University of Glasgow, Scotland, who led the technical work. "This allows the user operating the camera to look around, identify things and see an overlay of where the gas is present."

Gibson, along with the rest of the research team, worked with M Squared to develop the real-time infrared [imaging system](#). In The Optical Society journal *Optics Express*, the researchers show that the system can acquire videos of methane gas leaking from a tube at about 0.2 liters per minute. The technology could also be expanded to other wavelengths or ranges of wavelengths, allowing the detection of a host of gases and chemicals.

Dr. Graeme Malcolm OBE, CEO and Co-Founder of M Squared, said: "One of the challenges from a commercial point of view has been translating infrared technology to bigger markets where price points are sensitive. This new technology could allow [infrared imaging](#) and sensing to become more readily available and help improve the environment by reducing gas losses in the oil and gas industry."

Combining technologies

Although commercial systems that use imaging to detect methane gas are available, they are very expensive and don't work well under all environmental conditions. The new imaging system could offer a less

expensive and sensitive way to detect methane gas in a variety of conditions. It incorporates active hyperspectral imaging technology developed by M Squared and a single-pixel camera developed by the Glasgow research team.

The system performs hyperspectral imaging by projecting a series of infrared light patterns onto the scene using a laser wavelength that is absorbed by methane. These patterns are created with a laser and tiny device with hundreds of thousands of moving mirrors, known as a digital micromirror device. An image showing where methane has absorbed the light is reconstructed by detecting the light that scatters off the scene and computationally comparing it to the original projected patterns.

The fact that the new methane gas imaging system uses active illumination—meaning it provides its own light source—comes with several advantages compared to the passive illumination systems used in currently available gas detectors, including systems that detect gas using temperature differences.

Dr. Nils Hempler, Head of Innovation at M Squared, said: "For systems using passive illumination, darkness or rain will cause the signal reaching the imaging system to vary or be non-existent. An active illumination source is independent of environmental changes, including changes in temperature or light, and provides enhanced contrast and higher sensitivities."

The researchers used a single-pixel camera to measure the light scattered from the scene because traditional cameras with millions of pixels are either unavailable or prohibitively expensive in the infrared wavelengths. The single-pixel camera is key to creating a commercial methane gas imaging system that might cost only a few thousand dollars, significantly less than today's commercially available gas detection imagers. Since the system doesn't use any scanners or other moving parts, it could be easily

turned into a portable instrument.

In the paper, the researchers showed that their system could image methane gas leaking from a tube about 1 meter from the camera with a video-rate imaging speed of approximately 25 frames per second. They also demonstrated that their method was sensitive to methane even when other gases were present between the camera and methane.

"One of the things that we found is that we don't necessarily need high-resolution images when detecting gas leaks," said Gibson. "A relatively fast frame rate on your camera provides more information about where the gas is leaking from than having very high-resolution images."

Moving out of the lab

One of the next steps for the researchers is to demonstrate their imaging setup outside the controlled laboratory setting to see how it performs in real-world scenarios. They also want to try the approach with more powerful lasers, which might allow imaging from a greater distance and increase the sensitivity of the gas detection.

"Using broadly tunable laser sources rather than the fixed wavelength source used in this paper can extend this method to detection of other hydrocarbons, threat materials such as chemical warfare agents and explosives, and other biologically important substances used in healthcare and diagnostics," said Hempler.

More information: G.M. Gibson, B. Sun, M.P. Edgar, D.B. Phillips, N. Hempler, G.T. Maker, G.P. Malcolm, M.J. Padgett, "Real-time imaging of methane gas leaks using a single-pixel camera," Opt. Express, Vol. 25, Issue 4, 2998-3005 (2017). [DOI: 10.1364/OE.25.002998](https://doi.org/10.1364/OE.25.002998) , www.osapublishing.org/oe/abstr...cfm?uri=oe-25-4-2998

Provided by Optical Society of America

Citation: Low-cost imaging system detects natural gas leaks in real time (2017, February 6)
retrieved 9 April 2024 from

<https://phys.org/news/2017-02-low-cost-imaging-natural-gas-leaks.html>

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