TECHNICAL NOTE TN2022_3 – GAS MEASUREMENT WITH A THERMAL CAMERA

Introduction

Gas detection and identification is an important application where hyperspectral cameras can bring valuable information. For instance, it can give insights about pipe leakage as well as characterize an ignition process. However, their measurements by hyperspectral sensors need a thermal contrast.

LWIR = LONG-WAGE INFRARED (8 – 12 um)

MWIR = MID-WAVE INFRARED (3 – 5 um)

Article

Gas plumes can be monitored by hyperspectral cameras. Since they have different molecular compositions, their detection and characterization are possible. There are numerous applications where gases need to be detected or monitored:

- Pipe leakage
- Packaging leaking
- Ignition monitoring

Gases are often monitored with thermal hyperspectral cameras, such as SPECIM LWIR and MWIR devices. A temperature contrast is needed, as depicted in Fig.1 below. Data were acquired outside, with a rather cold temperature (ca. -5 degrees C), no clouds, and the person on the left side of the image was actioning an air blower (including 1,1,1-2-tetrafluorethane), blowing from the left to the right. The gas inside the blower was at ambient temperature.

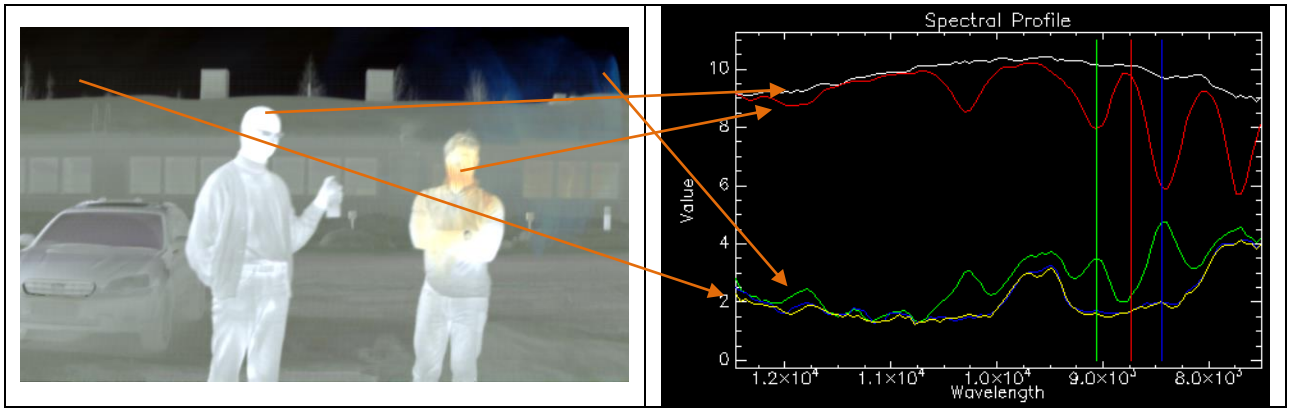

Figure 1: LWIR hyperspectral image of gas and related radiance spectra.

In Fig.1, several spectra are represented:

- White spectrum: relates to the emission spectrum of a warm human body. This one can be used as a reference spectrum for the red one

- Red spectrum: since the head of the man on the right side of the image is much warmer than the gas plume, the red spectrum is the spectrum of a warm body (i.e. white spectrum) through the gas (transmission).

  ➔ The gases included in the bottle (air and propellant) are having strong **absorption peaks at 7.75um, 8.5um, 9um, 10.2um and 11.7 um.**

- Yellow and blue spectra: relate to the emission spectrum of a cold and clear sky, through the atmosphere (ca. -50 degrees C). This will be used as a reference for the green spectrum.

- Green spectrum: since the gas is much warmer than the cold sky, the green spectrum relates to the emission of the gasses released from the blower.

  ➔ The gases included in the bottle have strong **spectral emission at 7.75um, 8.5um, 9um, 10.2um and 11.7 um**.

Notice how the red (absorption) and green (emission) spectra are mirrored to each other. This makes sense, as absorption and emission always occur at the same wavelengths. Spectra presented in Fig.1 are in radiance. For carrying such measurement with SPECIM thermal cameras, and converting the raw data into radiance, we advice the reader to go through the TN “Thermal cameras and RS50”.

We recommend using spectral cameras with a spectral range beyond 2.7 um. Shorter wavelength would be possible, but either the gases or the background would need to be warmer.

Disclaimer

Version history

Version	Date	Author	Comments
1.0	Oct. 4th 2022	MMA, HHO	