APPLICATION NOTE

Stealth Detection of Illicit Laboratories

Abstract

In today's war against terrorism, the illicit production of material threats used by terrorists has become a source of growing concern. These products are being illicitly fabricated in a number of clandestine laboratories by numerous terrorist and criminal groups. The precursors and solvents that are used in the production process each exhibit a unique infrared fingerprint, which can be detected and identified by using infrared hyperspectral imaging techniques. The Telops Hyper-Cam has recently demonstrated successful detection of a number of these precursors and solvents, representing an ideal solution to help find and dismantle the terrorist operated clandestine laboratories.

Introduction

In today's asymmetric warfare, the battle against terrorism has become a primary concern. One of the key problems that are currently faced is the difficulty to properly defend against the illicit production of materials that can be used as terrorist threats, especially those that are easy to produce from readily accessible constituents. The same applies to a major cause of concern that is related to terrorist groups' sizeable activities involving the production of various drugs, such as Methamphetamine (see Figure 1). The production of such illegitimate drugs represents an important source of funding for the terrorist groups and has become a growing worldwide problem.

The clandestine production of illicit materials in private and protected facilities cannot be easily accessed and dismantled. However, the production of these dangerous goods requires a number of precursors and solvents that can possibly be detected and identified with infrared hyperspectral imagers. This leads to the breakthrough possibility of performing stealth and remote detection of illicit laboratories. This new capability is thus believed to be a key asset to help win the war against terrorism.

Figure 1: Example of clandestine Methamphetamine laboratory

Experimental information

The Hyper-Cam, shown in Figure 2, offers a unique combination of spatial, spectral and temporal resolution. Users can select for each scenario how to best optimize these parameters in order to maximize the use of the measured information. The spectral resolution can reach up to several thousands of bands to fulfill the most demanding spectral characterizations. The Hyper-Cam-LW features a focal-plane array (FPA) detector containing 320x256 pixels over a basic 6.4°x5.1° field-of-view. The spectral resolution of the Hyper-Cam is user-selectable between 0.25 and 150 cm^{-1} over the 8 to 12 µm spectral range. The Hyper-Cam offers a high sensitivity for each pixel of the scene under observation, and its lightweight makes it ideal for field operation.

Figure 2: Hyper-Cam sensor

The Hyper-Cam sensor can also be operated in an airborne configuration for ground mapping. A flexible and modular platform (shown in Figure 3) provides the capability of mounting two Hyper-Cam sensors on the same aircraft, thus providing a dual band system for the detection and identification in both the Mid-Wave and Long-Wave infrared. The platform is equipped with all the required Inertial Navigation System and Global Positioning System (INS/GPS) as well as image motion compensation to achieve accurate pointing and geo-referencing.

Figure 3: Hyper-Cam airborne platform enables aerial-based detection

The Hyper-Cam was designed from the ground up so the control and the data acquisition are specifically optimized. The sensor is capable of generating calibrated data in real-time at the highest data rates. This real-time processing allows lossless compression by a factor of approximately 10-20, a welcomed factor for such a high-throughput instrument.

Results & Discussion

Multiple experiments have been conducted with Hyper-Cam sensors for a number of chemicals and drug precursors. They can be categorized in 2 main categories:

- Solvent vapors, such as acetone, methanol and formic acid.
- Solid explosives such as RDX and TNT

Solvents tend to have a high vapor pressure and a strong Mid-Wave and Long-Wave infrared absorption signature. The solvent vapors are typically evacuated from the production facility by fume hoods or vents. It then becomes possible to have an outdoor direct line-of-sight to observe these vapors which leak from the illicit laboratory, and to perform passive standoff detection and identification of the solvent vapors using the Hyper-Cam.

Indoor tests have been performed on a number of chemical vapors under controlled conditions. Figure 4 shows an example of detection and identification of formic acid vapor [1] in this indoor test and evaluation context.

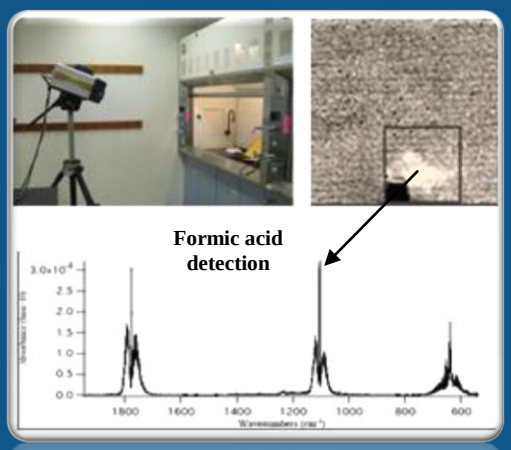

Figure 4: Imaging of formic acid vapor using the Hyper-Cam-LW.

As a next step, a clandestine laboratory has been simulated. Outdoor measurements of leaking chemical vapors have been performed using this simulated laboratory setup. This experiment adds challenges from real environmental elements such as a cluttered background and the effects of wind affecting the dynamics of the released chemicals. In this realistic environment, both acetone and methanol vapors have been successfully detected and identified in real-time by the Hyper-Cam. Detection and identification of both chemicals has been performed separately, as well as simultaneously when released as a mixture. A snapshot of the real-time video that was produced is shown in Figure 5 for a mixture of acetone and methanol.

The detection and identification of trace quantities of explosive powders such as RDX and TNT have also been performed by the Pacific Northwest National Laboratory using the Hyper-Cam-LW [2].

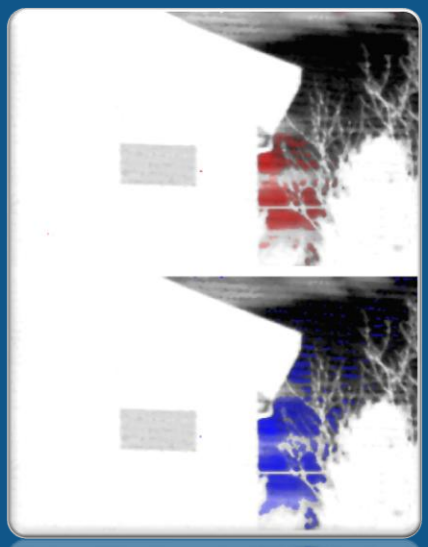

Figure 5: Imaging of acetone in red (top) and methanol in blue (bottom) leaking from a simulated clandestine laboratory. Mixture of both chemicals is detected simultaneously as both images – split for clarity purposes – are issued from a single video frame (split for clarity).

Conclusion

It has been demonstrated that the Hyper-Cam successfully detects and identifies the spectral signature of the main precursors and solvents used for the production of illicit materials for terrorist activities. Furthermore, the Hyper-Cam is a passive and standoff detection tool, well suited for both surface and airborne stealth operations. These Hyper-Cam capabilities make it an invaluable tool to aid the Forces in their war against terrorism, by helping them find and dismantle the illicit laboratories.

References:

[1] B. Rivard, Dept of Earth & Atmospheric Sciences, University of Alberta.

[2] Blake, T.A., Kelly, J.F., Gallagher, N.B., Gassman, P.L., Johnson, T.J., "Passive standoff detection of RDX residues on metal surfaces via infrared hyperspectral imaging, " Anal Bioanal Chem. 2009 Sep; 395(2):337-48 (2009).