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Optics and Photonics for Counterterrorism, Crime Fighting, and Defence XI; and Optical Materials and Biomaterials in Security and Defence Systems Technology XII

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Introduction to Part A: Optics and Photonics for Counterterrorism, Crime Fighting, and Defense

Welcome to the proceedings of the 2015 conference on Optics and Photonics for Counterterrorism, Crime Fighting and Defence.

The conference was arranged around two themes: The first of these was the detection and identification of dangerous, hidden, and suspicious materials, weapons, and contraband; the second was the identification in CCTV and thermal imagery of suspicious activity; people, their actions, and objects associated with them. The conference included an open discussion on the difficulties of detecting, imaging, and characterising concealed objects and materials.

The first session on short-range detection and identification of chemical and biological warfare agents highlighted the breadth of technology maturity in this field. The first speaker from the United States [9652-01] described a Raman-based instrument for chemical warfare agent detection that was commercially available. The second speaker, from Italy [9652-03], described experiments using a range of UV wavelengths to identify biological agents from their fluorescence. The session ended with a speaker from the Japanese Police Science Research Institute [9652-04] describing experiments to read writing obliterated by overprinted ink.

Continuing the short range detection theme, the second session began with a speaker from the Russian Federation [9652-05] describing how resonant and non-resonant laser desorption could be used to identify explosives residues without the need to wipe a suspicious surface. A professor from Japan [9652-06] provided an update on his work on building and commercialising an instrument for detecting explosives hidden inside bottles of liquid, a continuing problem at airports. The next speaker, from Denmark [9652-07], described an EU-funded project to develop a sensor for identifying dangerous chemicals from the way their vapour changed the colour of an array of dye spots. The session was closed with a United Kingdom research paper [9652-08] describing the detection and identification of metals using a magnetic induction imaging technique with extra sensitivity provided by an optical atomic magnetometer readout. In answers to questions, the speaker agreed that it might be possible to detect a metal object within a metal box.

As a memorial to Professor Colin Lewis who began the open discussions of this conference, we dedicated this year's open discussion to his memory. The discussion's title was "Detecting, imaging and characterisation of objects through barriers: Can we do this?" Sadly, Dr Stepan Lucyszyn (who was to lead the

discussion was unable to be present, so after a paper on THz time domain spectroscopy for explosives detection from the Russian Federation [9652-10], the conference chairs managed the discussion. Notes of this discussion are presented in the next section of these proceedings.

The second day of the conference had the theme, "Suspicious Activity: People, their Actions, and Objects associated with them." It began with a presentation from France [9652-11] that described how a combination of audio and CCTV could quickly detect dangerous behaviour in a railway station or carriage. The second presentation from the Netherlands [9652-12] described how imagery of people moving in the scene could be used to auto-calibrate the field of view of one camera and to coordinate between camera images. The same speaker [9652-13] then went on to describe algorithm learning techniques for the detection and tracking of people when there were only a few training examples. A United Kingdom speaker [9652-14] explained how the estimation of a person's range from a thermal image was affected by their posture, but that this error could be corrected if their movements were taken into account. The final presentation in the section came from Germany [9652-15]. The speaker showed how he could track people moving in CCTV imagery and then identify when objects became suspicious by no longer being associated with anyone.

Session five continued where the previous session had left off, with a paper from China [9652-24] on forehead identification as a way of determining the orientation of a face caught on CCTV. The Netherlands speaker then returned [9652-16] to describe how imagery from body-worn cameras could be correlated with results from static CCTV imagery to help in retrospective investigations. A German speaker [9652-17] explained how tamper detection in software and hardware had not been brought together. He explained how relatively simple components – a camera, a door opening sensor, software for detecting people, and skin – could be brought together to help an operator determine who had interfered with a computer cabinet.

For longer range imaging, a French speaker [9652-18] described how a combination of a pulsing illuminating laser and a linked fast optical switch in the receiving optics could offer a bolt-on solution to difficult surveillance problems across a wide range of wavelengths. For airborne equipment where power size and weight were limited, a United Kingdom speaker [9652-19] described how he had managed to use just a laptop to extract track information in real time from imagers mounted in the nose cone of an aeroplane. The final presentation from Georgia [9652-20] described a sensor for the real time measurement of the polarisation state of an object; a parameter that can be used to distinguish man-made from natural objects.

Two presentations from India [9652-22, 9652-23] were not given because the author had failed in his attempt to obtain a visa for travel to the conference. The

subject of the papers was biometrics research at the Indian Institute of Technology; the first on face recognition, the second on palmprint recognition. Because of the importance of these topics the two papers are included in these proceedings.

If you came to the 2015 conference, or if you are reading this book or CD and wished you'd been there, or feel you can contribute to next year's event, then please note that we shall be meeting in Edinburgh, United Kingdom, towards the end of September 2016.

Douglas Burgess
Gari Owen
Harbinder Rana

Notes from the Open Discussion on "Detection, Imaging and Characterisation of Objects through Barriers: Can we do this?"

For reasons of technical challenges and cost, the THz waveband is the last region of the electromagnetic spectrum to be evaluated and exploited. The aim of this session was to debate the claims put forward by people researching this frequency about its detection and resolution capabilities, particularly against obscured or hidden materials and objects. Here is an example of the type of claim encountered:
…The researchers demonstrated that they could detect the signal from 67 feet away, the length of their laboratory space, but theoretically they could identify materials hundreds of feet or even miles away.

If we consider the detection process as a chain, then maybe that helps identify where improvements need to be made:
Source of radiation (if active imaging) – atmosphere – barrier – target – barrier – atmosphere – detector – processing – decision making.

All of these components influence the process. Some are under the control of the system designer, some are not.

It is generally accepted that THz radiation is useful only for a few 10s of metres range. It was suggested that in general it may be more realistic to detect "components rather than systems" e.g., component chemicals of explosives; CO_2 from humans. The issue then becomes: What can be exploited? The key is to look for a signature. An example we had seen in the earlier presentation was the possibility of the detection of a copper object inside an aluminium box.

The barrier determines the possibility of exploitation. A barrier is frequently scenario dependent, e.g., a wet wall has different transmission properties from a dry wall. Wall penetration may be limited by clutter problems. Future building techniques using reflecting foils might limit the applicability of THz technologies.
It was suggested that novel architectures should be developed from spectrometers that maximise the use of returned signals – some commercial THz instruments have not been designed for this application.

For active systems, the source of illuminating radiation is a parameter that can be controlled and varied, perhaps to suit the application or scenario.
Cost is a major issue in system acceptance by users and is usually grossly underestimated. There are economies of scale but often the number of products required is typically small.

The discussion ended without any actions on the participants, but with much food for thought that should lead to more presentations in future conferences.