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

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

Welcome to the Proceedings of the 2014 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 and suspicious materials, weapons, contraband and counterfeits. The second was the identification in CCTV and thermal imagery of people, their activities, and to what extent they posed a threat. The conference concluded with a discussion about how optics and photonics could best help counter crime and terrorism. We were particularly pleased to welcome contributors from countries not previously represented, for example Finland and Ukraine.

The first session, papers 1 to 4, concentrated on the short-range detection and identification of explosives. Speakers from the Russian Federation and Italy described techniques for identifying microscopic levels of materials and how to expose hidden materials: from the USA we learned how the structure of a sample could affect reflectance measurements used for materials identification. The second session, papers 5 to 9, continued the detection theme with speakers from Japan, Israel and the Russian Federation. Speakers from the Netherlands and Finland then broadened the scope into the forensic examination of blood stains and paper.

In session three, paper 10 from Japan extended the sensing range for chemical and biological warfare agents by using a higher powered laser and a Ukrainian speaker, paper 12, described developments in sensors to detect and identify biological warfare agents. A British speaker, paper 11, described how the thermal infrared wavebands could be exploited to make a low cost covert data communicator.

The second conference theme, "Identifying threats posed by people"—began with three papers, 13, 14 and 16, from the Netherlands. These described their work in identifying moving people in CCTV imagery, and demonstrated the ability, post an event, to track a suspect between a set of non-overlapping cameras. It was startling to learn how they had managed to run a trial of pickpocket identification in a working shopping mall!

As further approaches towards identifying intent, a German speaker, paper 19, discussed pose recognition and a Dutch speaker, paper 21, compared optical flow and silhouette-based methods for tracking people. UK speakers analysed thermal imagery, paper 17, described a combined image intensifier and thermal

imager for dismounted soldier night operations, paper 18, and discussed issues around automatic lip reading from CCTV images, paper 15.

The final session ended with an Israeli description, paper 23, of their success in countering the adverse effects of turbulence on long range CCTV imagery of suspect activity. This naturally led into an open discussion about detecting more threats, (described in more detail in the Round Table Discussion on the following page). If you came to the 2014 conference, or if you are reading this in the book, CD, or on the Digital Library 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 Toulouse in September 2015.

Douglas Burgess
Gari Owen
Harbinder Rana

Round Table Discussion: Detecting more threats: more pixels, more cameras, both, or better image processing and analytics

This final round table discussion, moderated by Doug Burgess, addressed the issue of the contribution optics and photonics could make to the defeat of terrorists and the like. The starting point was the issue of more and/or better cameras, or better image processing or analytics to identify people and assess their level of threat. The discussion widened to include the sensing and identification of dangerous or suspicious materials and devices, and how the two could work in tandem. The conclusions of the discussion are presented here as three points.

When are the optical and photonic technologies useful and not useful?

There is a time line that spans an incident, beginning beforehand where there is an opportunity to detect intent. The line passes through the incident and ends some time afterwards when there is an opportunity for forensic scene examination and for scrutinising CCTV recordings to identify the actions of perpetrators. Optics and photonics are particularly useful after the incident for forensic identification of suspicious materials, and for identifying from video imagery the journeys taken by terrorists. They are less able to detect the intent of someone planning an atrocity, but may be of help to psychologists who might suggest that an elevated pulse rate or temperature was an indication of stress, but then how does stress correlate with carrying out a hostile activity?

How effective does a system need to be?

Whilst someone responsible for specifying or purchasing a protection system may demand 99% effectiveness, a solution capable of working to such a specification may be impossible and/or unaffordable. A better alternative may be a mix of more lower-cost units that can each make modest contributions to an overall effect. Perhaps success rates as low as 40% could be tolerated for such equipment? The onion skin approach is a good analogy, where multiple concentric layers all have to be breached to reach the sensitive heart. On their own, such low effectiveness values are not appropriate for equipment supporting an observer—too high an alarm rate will overwhelm an operator—but might not affect an automatic system to the same extent. Alerts are OK so long as there is a next stage to respond to suspect situations; a SWAT team on standby is unlikely. As the IRA stated after the 1984 Brighton hotel bombing where Prime Minister Margaret Thatcher was the intended target: *"Today we were unlucky, but remember, we only have to be lucky once; you will have to be lucky always."*. This is another reality that faces us.

Technology exploitation

Terrorists can take up technology much faster than government agencies. A new low cost thermal imager connected to a smart phone flying under a quadrocopter could make an excellent low cost surveillance sensor available now for a few hundred dollars.

Introduction to Part B: Optical Materials and Biomaterials in Security and Defence Systems Technology

Dear reader, welcome to the Proceedings of the 2014 conference on Optical Materials and Biomaterials in Security and Defense Systems Technology held in Amsterdam, Netherlands, 22–23 September 2014.

This conference highlighted state of the art emerging nano-bio materials and devices and their role in the development of new security and defense systems. Outstanding scientists, as well as R&D representatives from high tech companies, made great contributions to address innovative biopolymers and advanced materials for application in optolectronic and photonic devices. Three conference sessions focused on optical, photo-assisted chemical, electrochemical sensing. Rich and exciting discussions in all six sessions were a good stimulus to promote closer collaboration and awareness of common objectives and potential advances in a multidisciplinary approach to innovative defense systems technology. The conference was an excellent frame in which researchers from different areas ranging from materials science to physics, from chemistry and biology to engineering, had close discussions with industrial partners. Moreover, it is worth stressing how the Panel Discussion on "The Need for a Step Forward in Sensing. Electrochemical and Optical Sensing: Competition, Complementary, Hyphenation, Application," established a real and effective pillar on standard materials and methodologies for hyphenated sensing. The problems arising at the intersection of academia and research centres with industrial companies were also a subject of discussion. A report on this exciting Panel Discussion is included in the subsequence pages. All the published manuscripts were peer reviewed and we would like to thank all the authors of this volume for their valuable contributions and the referees for ensuring the high quality of the published papers.

The contributions of the Organizers and Session Chairs are gratefully acknowledged too. Special thanks are due to Bob Liebermann for his great contribution to the Panel Discussion.

Roberto Zamboni
François Kajzar
Attila A. Szep

Panel Discussion: The Need for a Step Forward in Sensing. Electrochemical and Optical Sensing: Competition, Complementarity, Hyphenation, Applications

In the frame of *Conference 9253B* the following Panel Discussion was held: 'The Need for a Step Forward in Sensing. Electrochemical and Optical Sensing: Competition, Complementarity, Hyphenation, Applications' on Tuesday, 23 September 2014

Moderators:

- **Bob Lieberman,** Intelligent Optical Systems Inc. (United): rlieberman@intopsys.com
- **Renato Seeber,** Univ. of Modena and Reggio Emilia (Italy): renato.seeber@unimore.it
- **Roberto Zamboni,** Institute of Organic Synthesis and Photoreactivity, CNR (Italy): roberto.zamboni@isof.cnr.it

Participants:

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- **Hendrik Emons,** European Commission's Joint Research Ctr., Institute for Reference Materials and Measurements (Belgium): hendrik.emons@ec.europa.eu

A short introduction of the moderators was devoted to point the discussion to the following items:

- The increasing need of continuous monitoring of various systems in order to give responses to evolving events 'in real time'.
- Sensing, even coupling of different transductions, as suitable tool for this purpose, in contrast to laboratory instrumentation.

- Role of academia and non-profit research centres in supporting the activities of companies developing sensing systems: how to promote integration of their efforts.

The general consensus expressed concerning the first two points was also based on specific situations illustrated in the talks of the session on Monday and Tuesday. No doubts were advanced about the necessity of implementing sensing systems for first, fast alarms, and also accepting a few false positives. The actual situation would then be confirmed in subsequent increasingly accurate, though time consuming and expensive, laboratory tests.

Once these commonly shared views were underlined, the discussion shifted to the critical point of how to encourage and favour exchange and coordination between the needs of companies, either working in developing sensing systems or in using them, with the competencies present inside academia and research centres. It is recognized that the latter entities may play an invaluable role, though at a different level within the pipeline leading to the realization of a sensor. The mission of programs for transnational research projects, such as FP7 and Horizon2020 of the European Union, is to encourage such collaboration, both by providing financial support and by encouraging both sides involvement, i.e., the research institutions and the companies, to focus their efforts towards a common goal.

Different opinions have been expressed, especially concerning universities and the actual role of a more or less applied, more or less challenge-driven character of research in education, specifically in the field of sensing. The issue was quickly enriched by additional critical points that were discussed and developed.

On one hand, the value of basic, curiosity-driven research, pursuing the testing/realization of 'ideas', devotion to open novel scientific pathways and promoting the highest educational value was emphasized. On the other hand, critical issues arise whenever the academic role is, in collaboration with suitable companies, closer to the realization of sensing devices or to the use of them. Moreover, it is not easy for companies to open the environment in which they operate to the academic community, primarily due to obvious reasons of confidentiality. However, the piece by piece submission of information on a complex problem to academia may result in an unsatisfactory reciprocal interaction.

The necessity of opening a more effective interface with the companies realizing sensing systems as well as, possibly, with those using them, has found common agreement, both by the participants belonging to industry and by those acting in the field of research institutions.

A key point has been identified in properly balancing 'curiosity-driven research', namely acting from an educational point of view, with the 'problem solving' educational approach, which is closer to the immediate requests of companies.

There is, for example, an open issue: sufficient efforts should be made in order to underpin innovative analytical approaches with the validation of new analytical methodology. Are these two tasks necessarily disconnected from each other in the frame of academic research activities, or can they play complementary roles along an educational pathway?

The currently used key performance indicators for academia have been identified as a possible source of problems even within academia: the production of journal articles has increased above any limits, and poor quality results, or even duplication of them, are often reported, even in prestigious journals, so much so that the doubts about what is being reported are legitimate. For the same reasons, the scientific literature is not always of definite help to the companies that want to apply what was reported. Moreover, the data has often undergone poor statistical analysis, so that repeatability and reproducibility of the results with a given sensing system are not always clear, and details about the exact procedure are often absent. Academic reports which are not completely reliable may call into question their validity and require them to be verified independently. An old academic habit is still well alive and is partly due to the attitude of publishers: what is not successful is not published, even if the proof of this is a very challenging task. This habit definitely does not optimize the efforts of the researchers in academia and in R&D of companies. The obvious result evidenced by companies is that there is often a remarkable gap between the academic literature and the needs of applications.

The participants recognized the importance of open innovation. It has been acknowledged that finding the best coupling of academic competencies and education with the needs of companies constitutes the key point, so that a world-wide open brokering action would be a solution sought by both parties. On the other hand, not all the brokers operating on the market have proved to deserve full faith, to say the least. The companies that are in direct contact with the needs of the market cannot, however, play such a role. How to implement a similar instrument, in order to make needs and willingness meet most effectively, constitutes a homework assignment that the attendees of the Panel Discussion intend to pursue. As to innovation suppliers, the cost per contact is limited, but an immediate reaction to calls, on the basis of poorly defined specifications about the actual request, is often required.

Occasions for joining different competencies are identified in the activities supported by research projects of the European Union, as well as by different entities operating in the US, such as the Small Business Technology Transfer (STTR) & Small Business Innovation Research (SBIR), which foster a form of cooperation between the US and Europe. Programs like those dealing with world climate, oceanography, or health research are among those that most spontaneously require active transatlantic collaboration. The participants of the Panel Discussion are, in principle, willing to act as a possible node of a growing network, constituting a reference for bilateral collaboration, as well as nuclei of a wider partnership.