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Next-Generation Spectroscopic Technologies XI

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Introduction

The past twenty-five years have seen a massive investment in photonics, electronics, and MEMS aimed at developing new telecommunications capabilities and innovative consumer products. This has led to advances in miniature optics, light sources, tunable filters, array detectors, fiber optic sensors, and a range of other photonic devices across the whole electromagnetic spectrum, along with technologies for their mass production. Similarly, in recent years, there have been remarkable developments in handheld consumer electronics, especially mobile devices ("smartphones"). Today's devices contain advances in RF technology, processors, displays, operating systems, user interfaces, memory, Bluetooth, WiFi, GPS, cameras, accelerometers, etc. These technologies are increasingly being exploited in new spectroscopic instruments, and are now the base of next-generation handheld scientific instruments.

Portable and handheld instruments tend to be more targeted at specific applications than their laboratory predecessors. They may have performance (measured as resolution, spectroscopic range, signal-to-noise, etc.) that is 'good enough' for field screening applications. However, they are often more selective, smaller, cheaper, more robust, and designed to give these actionable answers to non-scientist operators in the field. Spectroscopy-based systems are now making critical judgments in environments and applications that were unreachable twenty years ago, from hazardous materials to the operating theater, and from field geologists to customs and border personnel.

Advances in array detectors (CCD, CID, InGaAs, InSb, SLS, MCT, CMOS, etc.), with compact wavelength-selection devices (LVFs, mosaics, Fabry-Perots), are enabling a new generation of faster imaging spectrometers with both laboratory and field applications. Lower-cost microbolometer infrared arrays have been developed, employing MEMS techniques. New laser-based sources (quantum cascade lasers, interband cascade lasers, supercontinua, terahertz, etc.), particularly in the mid-infrared, are being used in combination with advances in detector technology to create new spectroscopic platforms. Novel designs also enable very compact spectrometers and imagers, suitable for use on airborne platforms, including drones, and now we have the first generation of handheld hyperspectral imagers. The latest developments have driven the cost of hyperspectral imagers in the silicon detector region down dramatically, and are looking towards incorporating them in smartphones. The concurrent improvements in analytical theory, data analysis methods, algorithms, and the power of portable processors enable instrument designers to 'put a PhD scientist in the box' and empower field spectroscopic devices to give specific actionable answers.

This conference focused on advanced technologies for spectroscopic instrumentation, particularly the ultraviolet-visible, infrared, near-infrared, terahertz and Raman molecular techniques, but also included advances enabling miniature and portable spectrometers across the electromagnetic spectrum. Another critical topic area discussed was materials development relevant to shrinking the physical sizes of technologies enabling these applications. The 2017 and 2018 conferences both included special sessions on terahertz technologies and applications.

This conference premiered at Optics East 2007 in Boston, MA (United States), and has been part of the DCS Meeting for many years now. The conference is now rotating between three sites, Baltimore, MD; Anaheim, CA; and Orlando, FL; with the 2018 conference being in Orlando. It spanned two-and-a-half days, and was divided into sessions focusing on: Smartphone spectroscopy; Laser Sources and Spectroscopy; New Technologies; LIBS and Optical Emission Raman Spectroscopy and Imaging; Nanoscale Imaging, Novel Imaging Instruments; Terahertz Technologies and Applications. The Conference Chairs believe that this Conference in 2015 had the first SPIE session devoted to "Smartphone Spectroscopy", and we anticipate that this will be a continuing and growing part of this Conference. In all, 37 papers were presented, 26 of which are included in this volume.

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