

Optical Engineering

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Infrared Systems

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Infrared sensing technology has come a long way since Herschel made the unexpected discovery in 1800 that radiation at wavelengths beyond the visible spectrum were measurable by his rudimentary bolometer instrument. The tremendous advancements in this technology have been propelled heavily through defense research and development, aimed at providing important night vision and target detection capabilities for surveillance, reconnaissance, targeting, and threat warning systems. The maturation of the underlying infrared sensing technology, specifically infrared optics and focal plane arrays, has not only enhanced the system capabilities for these missions, but has also resulted in the proliferation of infrared systems into a more diverse set of air, land, sea, and space-based platforms. Furthermore, infrared sensing has become more affordable through the advent of uncooled and high-operating-temperature focal plane arrays, which has opened up civilian and commercial applications such as thermography, law enforcement, fire and security, weather monitoring, transportation, and spectroscopy.

This *Optical Engineering* special section consists of ten papers that explore novel infrared sensor system concepts to address this wide range of applications, as well as the key infrared component technology that enables current and future sensor systems. It begins with an examination of some specific advances in infrared focal plane array technology that hold promise in making infrared imaging systems affordable while achieving excellent radiometric sensitivity. The first two papers address longwave infrared microbolometer technology, arguably the key technology underlying the dramatic recent proliferation in infrared imaging systems beyond the military market to commercial and civilian applications. These two papers address the reduction in pixel pitch (Lohrmann et al.) and the correction of detector temperature instability (Nugent, Shaw, and Pust) needed to further improve imaging capabilities. The third focal plane array paper by Martyniuk et al. explores III-V superlattice semiconductor structures that may allow high-performance midwave infrared imaging at elevated operating temperatures relative to the standard InSb devices that must be cooled to 80 K.

The next group of papers addresses infrared optics and camera design, specifically for systems requiring the capability to image in multiple spectral bands or with multiple fields-of-view. Thompson explores the optical design and materials challenge associated with multispectral imaging using a

common aperture and focal plane. Lilley et al. address the optical design challenge of achieving multiple fields of view in a single infrared camera, while Vizgaitis and Hastings combine dual-band infrared imaging with simultaneous picture-in-picture imaging. Finally, Miller et al. provide a thorough assessment of the design challenges and methods associated with the camera line-of-sight stabilization that is required for high-definition imaging from nonstationary ground-based and airborne platforms.

The final group of papers addresses infrared system applications beyond traditional passive imaging. A nondestructive evaluation application dealing with the identification of metal defects through a coating layer is addressed by Zeng et al. using sonic excitation and infrared imaging. Infrared spectroscopy using an active quantum cascade laser source is reported by Philips and Bernacki, and applied to microscopy of explosives particles. The infrared spectroscopy application is continued by LeVan, who provides novel concepts for performing infrared hyperspectral imaging from space-based platforms for earth remote sensing applications.

While it is not possible for a single special section to provide a comprehensive perspective of the state of the art in a diverse field such as infrared sensing, this collection brings together some interesting papers detailing important advances in infrared systems technology for the readers of *Optical Engineering*.



Michael T. Eismann received a B.S. in physics from Thomas More College in 1985, an M.S. in electrical engineering from the Georgia Institute of Technology in 1987, and a Ph.D. in electro-optics at the University of Dayton in 2004. From 1987 through 1996, he was employed by the Environmental Research Institute of Michigan, where he was involved in research concerning active and passive electro-optical and infrared (EO/IR) targeting and reconnaissance sensors, optical information processing, and holographic optics. Since 1996, he has been performing electro-optical and infrared sensor research in the Sensors Directorate of the Air Force Research Laboratory (AFRL). He is the senior scientist for EO/IR Sensors, where he is responsible for overseeing the development of active and passive electro-optical and infrared sensor technology, and the transition into operational airborne targeting and reconnaissance systems. He is also an adjunct assistant professor at the Air Force Institute of Technology and a Fellow of AFRL, SPIE, and the Military Sensing Symposia.



Philip Perconti currently serves as the Director of the Sensors & Electron Devices Directorate of the Army Research Laboratory. He has responsibility for leading the Army's primary basic and applied research programs in sensors, electronics, signal processing, and power and energy component technologies. His duties include operation of unique electronics and photonics materials fabrication and characterization facilities that enable world-class component research and development. Previously, he was director of the

Science and Technology Division at the Army's Night Vision and Electronic Sensors Directorate. In this position, he was responsible for applied research of component technology and concepts underpinning the most advanced night vision EO/IR materials and components found in fielded and emerging Army sensors. He has published extensively on many aspects of military sensing and countermeasure technology. He has authored and coauthored over 40 publications, including three book chapters. He holds two patents. He is a technical fellow of the Military Sensing Symposium. He earned his doctorate in electrical and computer engineering from The George Washington University, Washington, D.C.