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Terahertz and Millimeter Wave Imaging

Eddie Jacobs
Roger Appleby
Dennis Prather

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Eddie Jacobs
The University of Memphis
Department of Electrical and Computer Engineering
206 Engineering Science Building
Memphis, Tennessee 38152-3180
E-mail: eljacobs@memphis.edu

Roger Appleby
The Institute of Electronics Communications and Information Technology
Queen's University Belfast
NI Science Park
Queen's Road Queen's Island
Belfast, Northern Ireland, BT3 9DT
E-mail: applebyroger@yahoo.co.uk

Dennis Prather
University of Delaware
Department of Electrical and Computer Engineering
140 Evans Hall
Newark, Delaware 19716-3130
E-mail: dprather@ee.udel.edu

As engineers and scientists, we use a variety of techniques to concisely represent information. The ubiquitous equations and plots found in the pages of this journal demonstrate this well; however, nothing rivals the power of an image to convey information. As a result, in our relentless pursuit to explore and exploit the information available in all parts of the electromagnetic spectrum, imaging is often the end goal for the systems we develop. Terahertz and millimeter wavelengths have been no exception to this pursuit, and since we first began sensing at these wavelengths, we have constantly developed and improved systems for forming images.

The twelve articles in this special issue give a glimpse into the many developments in imaging at these wavelengths. You will find technologies leveraged and expanded from longer wavelength remote sensing, such as the paper on 3-D synthetic aperture imaging by Henry et al. Recur et al. apply tomography, most commonly used in x-ray imaging, to terahertz frequencies. Although readily available to microwave engineers, broadband amplifier-based pixels, such as presented in the paper by Sarkozy et al., represent new capabilities for passive imaging at submillimeter wavelengths. Parametric oscillators, also common in the microwave regime, are shown as possible sources for the terahertz domain in the paper by Li et al. The exploitation of millimeter wave polarization is discussed in the paper by Wilson et al., and the advantages of incoherent illumination at terahertz frequencies are related in the paper by Petkie et al. Hedden, Dietlein, and Wikner show the application of array antenna techniques to active submillimeter wave imaging, while Mait et al. explain the effect of array structure on the quality of passive imaging at millimeter wavelengths. Advanced imaging techniques such as compressive sensing (Patel and Mait) and coded apertures (Furxhi et al.) are represented in this issue both for millimeter and submillimeter wavelengths. Advanced image processing techniques are applied to improving the quality of millimeter wave images (Mundhenk, Baron, and Matic) and to extracting pertinent information from them (Yeom et al.).

These technologies, individually or in combination, will continue to influence the development of imaging systems at millimeter and terahertz wavelengths. The emerging technological developments described in this edition offer significant contributions to current and future engineers and scientists working in these areas. This benefit commends the articles to you, challenging us to bring intelligent responses and continued creativity to these areas.

Eddie L. Jacobs is an associate professor in the department of Electrical and Computer Engineering at the University of Memphis. He was previously at the U.S. Army Night Vision and Electronic Sensors Directorate, Fort Belvoir, Virginia, where he led a team of engineers and scientists developing models of the performance of passive and active imaging sensors. His research interests are in novel imaging sensor development, electromagnetic propagation and scattering, and human performance modeling. He received BS and MS degrees in electrical engineering from the University of Arkansas, and a doctor of science in electrophysics from The George Washington University.

Roger Appleby received his BSc in chemistry from Leicester University in 1974 and his PhD in 1977. A postdoctoral study on laser light scattering from solutions and liquid crystals was completed at the University of Queensland, Australia, from 1977 to 1979. He then joined the UK MoD and carried out research into image intensifiers, thermal imagers, and lasers. He led the passive millimeter-wave imaging team at QinetiQ Malvern, United Kingdom until 2010. He chaired a NATO panel TG14 on passive and active millimeter wave imaging. He is currently a professor at Queen's University Belfast, a visiting professor at Glasgow University, and runs his own consultancy company in millimeter wave and submillimeter wave technology. He is an SPIE Fellow and a Fellow of the Royal Academy of Engineering.

Dennis Prather began his professional career by joining the U.S. Navy in 1982, where he still serves in the reserves as an Engineering Duty Officer. After active duty, he received his BSEE, MSEE, and PhD from the University of Maryland in 1989, 1993, and 1997, respectively. During this time he worked as a researcher for the Army Research Laboratory, where he performed research on both optical devices and architectures for information processing. In 1997 he joined the Department of Electrical and Computer Engineering at the University of Delaware. He is currently an Endowed Professor of electrical engineering. He is a Fellow of SPIE and OSA, and a Senior Member of IEEE. In 2000, he received the Outstanding Junior Faculty in the College of Engineering and the William J. Kastner Award for Naval Engineering Excellence. In 1999 he received the National Science Foundation CAREER Award and the Office of Naval Research Young Investigator Award.