UCLA Henry Samueli School of Engineering
Electrical & Computer Engineering Dept.

Ph.D Defense

Terahertz Focal-Plane Array for Terahertz Time-Domain Imaging

Xurong Li

Advisor: Professor Mona Jarrahi

Monday, December 5, 2022 * 1:00 p.m. – 3:00 p.m.

Engineering Bldg. IV * Faraday Room, #67-124

Zoom https://ucla.zoom.us/j/95768128356

Abstract: Imaging systems operating in the terahertz part of the electromagnetic spectrum are in great demand because of the distinct characteristics of terahertz waves in penetrating many optically-opaque materials and providing unique spectral signatures of various chemicals. However, the use of terahertz imagers in real-world applications has been limited by the slow speed, large size, high cost, and complexity of the existing imaging systems. These limitations are mainly imposed due to the lack of terahertz focal-plane arrays (THz-FPAs) that can directly provide the frequency-resolved and/or time-resolved spatial information of the imaged objects.

During my doctoral studies, I designed, fabricated, and characterized the first THz-FPA that can directly provide the spatial amplitude and phase distributions, along with the ultrafast temporal and spectral information of an imaged object. Terahertz time-domain imaging on amplitude and phase objects is demonstrated in both terahertz lens-free and lens-based imaging systems. By eliminating the need for raster scanning and spatial terahertz modulation, our THz-FPA offers more than a 1000-fold increase in imaging speed compared to the state-of-the-art. The high imaging speed enables the first terahertz video captured in a terahertz time-domain imaging system with a frame rate of 16 fps.

The unprecedented rich information in the terahertz time-domain imaging data can facilitate many new applications. As the first proof-of-concept, we utilized the multispectral nature of the amplitude and phase data captured by the plasmonic photoconductive THz-FPA to realize pixel super-resolution imaging of objects. We successfully imaged and super-resolved etched patterns in a silicon substrate and reconstructed both the shape and depth of these structures with an effective number of pixels that exceeds 1 kilo pixels. Beyond these proof-of-concept super-resolution demonstrations, the unique capabilities enabled by our plasmonic photoconductive THz-FPA offer transformative advances in a broad range of applications that use hyperspectral and three-dimensional terahertz images of objects for e.g., industrial inspection, security screening, and medical diagnosis, among others.

Biography: Xurong Li received the B.S. degree in Microelectronics from Peking University, China in 2016, and the M.S. degree in Electrical and Computer Engineering from University of California, Los Angeles in 2018. His research focuses on the terahertz focal-plane array for terahertz time-domain spectroscopy and imaging. He is the recipient of CESASC scholarship in 2018 and summer mentor research scholarship in 2021.

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