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Compressive THz Imaging Using Single-pixel Sensors: A Practical Perspective

Yagmur Ozturk*(1), and Kubilay Sertel(2)
(1) The Ohio State University, 1330 Kinnear Rd, Columbus, OH, USA 43212; e-mail: ozturk.33@buckeyemail.osu.edu
(2) The Ohio State University, 1330 Kinnear Rd, Columbus, OH, USA 43212; e-mail: sertel.1@osu.edu

Utility of THz Imaging for many practical applications hinge on the availability of a low-cost, hand-help imaging system capable of high-resolution and low-noise performance. State of the art THz imaging and spectroscopy instrumentation rely on single pixel transmitter and receiver sensors that are synchronized to reject noise and interference. The synchronization is either achieved in optical-domain using femtosecond lasers, or via electronic means, using heterodyne systems based on vector network analyzers (VNAs) and high-performance frequency extenders. Both approaches are capable of high dynamic range and full complex measurements (amplitude and phase), however, full high-performance 2-port network analysis is only achievable using VNA-based electronic systems.

Retrieving the signal phase is essential in many THz imaging applications, including but not limited to non-destructive evaluation of samples involving optically-opaque scenarios such as coatings, covers and packaging. For example, phase-sensitive through-package imaging can be achieved using a single-pixel THz sensor via raster scanning the sample area. THz Computed tomography has also been developed using single-pixel THz sensors.

Our group has developed single-pixel THz imaging systems using high-resistivity Si as a spatial light modulator [1] which is also capable of recovering the single phase from intensity-only measurements, using the "*Phaselift*" approach [2].

Such a simplified sensor can reduce the cost of current systems and realize a hand-help THz imaging sensor. As a hand-held sensor, it is prone to mechanical interference since the user's hands may not be steady during the data acquisition time, which is essentially a serial process in single-pixel imaging systems. In this talk, we will summarize the details of single-pixel "*Phaselift*" THz imaging and discuss the practical limitation of hand-help THz imaging sensors by analyzing the camera motion as a random walk. Performance details for various scenarios will be illustrated and the impact of mechanical noise on the final image quality will be discussed.

1. S. A. N. Saqueb, and K. Sertel. "Phase-Sensitive Single-Pixel THz Imaging Using Intensity-Only Measurements." IEEE Transactions on Terahertz Science and Technology 6.6 (2016): 810-816

2. E. J. Candes, T. Strohmer and V. Voroninski, "Phaselift: Exact and stable signal recovery from magnitude measurements via convex programming", *Commun. Pure Appl. Math.*, vol. 66, no. 8, pp. 1241-1274, 2013