Author: Josiah W. Smith

Advisor: Murat Torlak

Holographic Image Reconstruction using MIMO Inverse Synthetic Aperture Radar in the Near-Field

Abstract:

Two-dimensional and three-dimensional radio frequency image reconstruction algorithms have been developed for near-field imaging applications such as concealed item detection, ground penetrating radar, through-wall imaging and nondestructive evaluation and classification. These methods employ millimeter-wave (mmWave) active transceivers operating in the GHz and THz frequency ranges. While conventional synthetic aperture radar (SAR) imaging algorithms are based on a monostatic, full-duplex framework, this work spotlights the progress towards efficient, robust near-field algorithms leveraging the concept of virtual arrays realized by multistatic multiple-input-multiple-output (MIMO) radar systems. Using a wideband frequency modulated continuous wave (FMCW) multistatic MIMO radar system, three-dimensional holographic imaging algorithms are proposed, simulated, and implemented for the rectilinear SAR and cylindrical ISAR cases. The proposed algorithms overcome challenges inherent to the multistatic MIMO apertures such as virtual aperture, multi-channel array signal processing, multistatic MIMO calibration, and spatial sampling. In addition to MIMO-SAR, the MIMO inverse SAR (MIMO-ISAR) problem is discussed and addressed. This study investigates existing algorithms for efficient two-dimensional and three-dimensional holographic imaging on MIMO-SAR and MIMO-ISAR systems, proposes new efficient, near-field multistatic imaging algorithms, and demonstrates the implementation of novel super-resolution techniques on a MIMO-SAR and MIMO-ISAR mmWave FMCW system.