Interference Mitigation for Radon Transform mmW/THz Imaging Radars Using Flat-top Beams

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Millimeter Wave (mmWave) and Terahertz (THz) wave applications have attracted the attention of the research community due to their small wavelength that enables the design of high spatial resolution radar imaging systems. As such, imaging systems at these frequencies can be utilized for remote sensing, surveillance, and security applications. Additionally, the short wavelength can lead to compact imaging sensors which can be mounted in UAVs or CubeSats that demand for lightweight/low-profile devices.

Typically, THz imaging systems deploy a large number of radiating elements to cover large apertures that enable high spatial resolution imaging. Also, the large number of elements leads to the use of hundreds or even thousands of transceiver resulting in physically bulky and complex setups. To alleviate the aforementioned problem, we have proposed an imaging technique based on the Radon transform in [P. C. Theofanopoulos et al., "A novel THz radar imaging system using the radon transform," in *2017 IEEE APS/URSI*], which allows for high special resolution imaging using a handful of elements. Specifically, the imaging is carried out using a rotating linear phased array as a monostatic sensor. The linear array produces a controlled, highly astigmatic fan beam that illuminates only a linear portion of the field of view (FOV) and measures the backscattered signal. The controlled fan beam is swept across the object area, recording the reflected signal at multiple elevation angles. The recorded signals correspond to a single projection of the Radon transform. Then, the fan beam is rotated azimuthally (0-180^{o}) repeating the parallel beam scanning in multiple azimuth angles. These rotated sets of scans form the Radon projections of the illuminated surface area. Finally, the object's image is reconstructed using the inverse Radon transform of the collected data. However, the linear array's radiation pattern on the second plane is almost omnidirectional and extends beyond the FOV. As a result, the scattered signal from objects outside the FOV can cause interference in the received signals and distort the synthesized radar image. As such, by reducing the gain of the antenna on the second plane and forming a conical beam, we achieve significant reduction in interference that has direct impact on the radar image quality. In this study, we present a novel flat-top beam antenna array that limits the radiation within a specified FOV and suppresses the reception of signals outside it.

The design of the flat-topped beam phased-array is based on an iterative optimization technique to control the side-lobe level and the beamwidth of the radiation pattern. During the conference, the theoretical background of the imaging technique will be discussed, along with the new array design procedure. Additionally, a series of results will be presented establishing the image interference reduction by using the new approach.