Terahertz Computed Tomography Using a Large-format, Real-time Focal Plane Array Sensor

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Sub-millimeter scale image resolution afforded by the THz frequency band, coupled with the ability of THz waves to penetrate through packaging materials have sparked significant interest in THz frequencies for security screening. Conventionally, large-format THz images have been solely acquired using a raster scan of a single pixel, taking several minutes to create a single 2D image of a stationary scene. For stand-off screening applications, coherent THz radars with bulky reflector antennas and fast 2D scanning optics (via rotating mirrors) have cut the imaging time down to several frames per second (K. B. Cooper, IEEE Trans. on Terahertz Science and Technology, vol. 1, no 1, Sept. 2011). Nonetheless, the image resolution and the noise of the acquired images have yet to produce acceptable performance.

Recently, we developed a focal plane array (FPA) sensor for THz imaging with the goal of achieving video-rate (30 frames per second) performance. The THz camera is comprised of an 80×64 pixel FPA sensor, with each pixel consisting of broadband antennas monolithically integrated with heterostructure backward diodes (HBDs) for sensing. The FPA is optimized for diffraction limited image resolution and conjugate impedance matching for highest THz sensitivity in the 0.6-1.2 THz band. In this work, we will demonstrate computed tomography (CT) in the THz band using this newly developed THz camera.

A typical THz CT system consists of a THz source, a rotation stage holding the object and a THz detector that generates a 2D image of the object for various projection angles. Our THz camera is used as the sensor in the CT system, and the object under test is illuminated by a backward wave oscillator. A motorized stage rotates the illuminated object and the camera captures the projected images at each rotation angle. Due to the fast acquisition speed of the large-format THz camera, CT image acquisition can be done orders of magnitude faster than conventional raster scanning approaches. The THz tomography system, as well as 3D images of various enclosed objects will be presented at the conference.