Abstract:

There are several advantages of imaging at terahertz frequencies compared to microwave or infrared: the wavelengths in this regime are short enough to provide high resolution with modest apertures, yet long enough to penetrate clothing. Moreover, unlike in infrared, the terahertz frequencies are not affected by dust, fog, and rain. Several groups around the world are working on the development of terahertz imagers for various applications. One option is to use passive imaging techniques, which were very successful at millimeter-wave frequencies, by scaling in frequencies to terahertz range. We have developed an ultra wideband radar based terahertz imaging system that that uses a 675 GHz solid-state transmit/receive system in a frequency modulated continuous wave (FMCW) mode. The imager has sub-centimeter range resolution by utilizing a 30 GHz bandwidth. It has comparable cross-range resolution at a 25m stand-off distance with a 1m aperture mirror. A fast rotating small secondary mirror rapidly steers the projected beam over a 50 x 50 cm target at range to produce images at frame rates exceeding 1 Hz. In this talk we will explain in detail the design and implementation of the terahertz imaging radar system. We will show how by using a time delay multiplexing of two beams, we achieved a two-pixel imaging system using a single transmit/receive pair. Moreover, we will also show how we improved the signal to noise of the radar system by a factor of 4 by using a novel polarizing wire grid and grating reflector.