THz Microbolometers for Imaging Applications

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Abstract— I briefly describe some recent THz cameras we have developed, emphasizing the most recent: a conically-scanned, 128-element linear array of ultrawideband, 4K microbolometers.

I. Introduction And Background

Although detection systems for the 100 GHz – 10 THz band have been used for decades in specialized imaging applications such as radio astronomy, the terahertz band has recently become the focus of intense interest for homeland security and other terrestrial applications. The unique and compelling features of this spectral band are its penetration, spatial resolution, and non-ionizing character. An archetypal application is the screening of personnel, such as airline passengers or stadium attendees, for concealed weapons.

I briefly describe some recent THz cameras we have developed, emphasizing the most recent: a conically-scanned, 128-element linear array of ultrawideband, 4K microbolometers. An earlier camera, based on a 2D, staring array of uncooled microbolometers, required the use of active illumination, and I will comment briefly on system tradeoffs involved in active versus passive cameras for terrestrial imaging applications. The ~100 mK noise-equivalent temperature difference (NETD) of the cryogenic microbolometers enables completely passive indoor personnel screening[1].

II. Results

A single-pixel, superconducting hot-spot microbolometer that forms the basis of our present camera has been described elsewhere[2]. A notable feature of the camera is that these microbolometers do not require any form of cooled readout electronics, such as SQUID's, in order to operate at their fundamental phonon-noise limited sensitivity level. This is made possible by a transimpedance readout circuit that forms a good noise-match to the 4K, ~100 ohm microbolometers.[3]

The ultrawideband sensitivity of microbolometers, 0.2 – 1.5 THz in this particular case, distinguishes them from other detector approaches, some of which are now embedded in 100 GHz systems that have reached the commercial marketplace. Moreover, this ultrawideband sensitivity is directly reflected in the appearance of images taken with this system (see Fig. 1), for example in the tradeoff between spatial resolution and penetration. I will also describe a simple monochromator that can be included in the system to enable"true-color" i.e. multispectral, THz imaging.

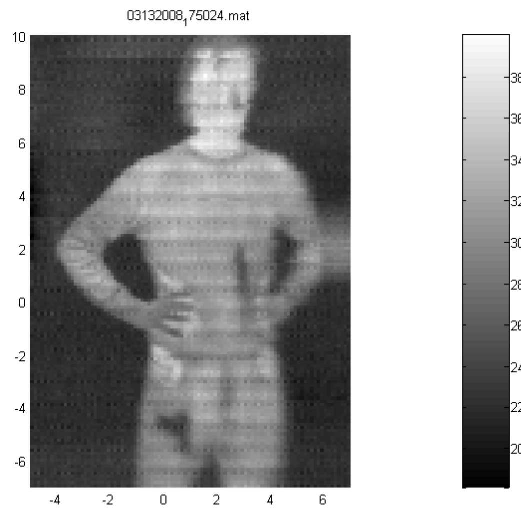

Figure 1. Passive indoor image of a subject hiding a ceramic knife and metallic handgun, taken with a scanned, 8-element linear array of cryogenic microbolometers

Besides the ultrawideband sensitivity, our current approach (again in contrast with the earlier uncooled camera) emphasizes a modular rather than monolithic focal-plane architecture. Besides the advantages of robustness to manufacturing yield and reconfigurability, terrestrial imaging usually requires very wide fields-of-view, which are better accomplished with modular detectors.

References

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