Modulation Transfer Function in Terahertz FPAA Quasi-Optical Imaging Systems

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Nowadays MMW, THz and even IR quasi-optical imaging systems based on usage of focal plane antenna array (FPAA) gain acceptance for lots of applications including remote sensing, weapons and explosive detection, surveillance, different radar applications, etc. The receiving elements of the FPAA may exhibit different performance: antenna-coupled detectors/mixers, antennas connected with mixers through impedance-matching circuits (waveguides), antennas connected with direct amplification and detection MIMIC circuits, etc. It is obvious that spatial and sampling features of the FPAA and the FPAA-based imaging systems mainly depend on both focusing lens properties and characteristics of the array antennas [1-4]. In present work factors determining spatial resolution of quasi-optical imaging systems based on usage of focal plane antenna arrays are considered in detail. Rigorous analytical expressions for point spread functions (PSF) and modulation transfer functions (MTF) of FPAA receiving elements and the imaging system as a whole are derived both for spatially-coherent (radars) and spatially-incoherent imaging systems (including radiometric cameras) and for any kind of radiation polarization. Accurate PSF and MTF functions are calculated for long horn antenna and resonance-dipole antenna. Further, combined effects of image formation, sampling and reconstruction in focal plane antenna array (FPAA) MMW /THz imaging systems are rigorously analyzed. Formalism of average modulation transfer functions for sampled imaging systems is applied for MTF analysis of both the subsystems and the entire FPAA MMW/THz imaging system and for any kind of radiation polarization. Possibilities of usage of accurately calculated PSFs of the FPAA imaging systems for further advancement of super-resolution algorithms. The developed approach may be effectively used for computer aided design of MMW/THz FPAA imaging systems being able to consider combined effects of imaging, sampling and reconstruction procedures.

References

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