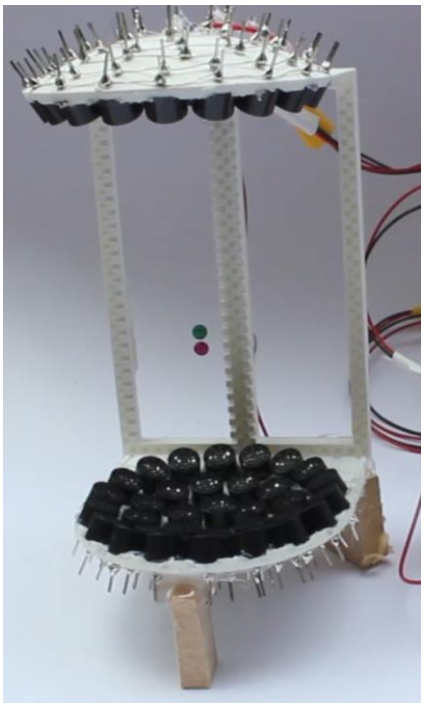
Bachelor / Master Thesis

Point-Spread-Function Characterization of a Terahertz Synthetic Aperture Imaging Approach Using Acoustic Levitation

UNIVERSITÄT DUISBURG ESSEN

Offen im Denken

Terahertz waves have higher spatial resolution compared to microwaves enabling imaging with sub-mm resolution. For many imaging applications, an object is placed in a focused terahertz beam either in a transmission or a reflection geometry. This limits the spot size to approximately 1 mm as it depends on the numerical aperture of the optics. To overcome the numerical aperture limit of the optical system, a divergent beam for 3D image reconstruction with a synthetic aperture can be used. By back projection, the recorded terahertz traces are mapped on a volume, creating the reconstructed image.



source: www.instructables.com/Acoustic-Levitator

To improve the image quality, a calibration must be performed. Usually, the three-dimensional point spread function (PSF) is used in image processing in a matched filter approach. To measure the PSF, a metal sphere with the size determined by the shortest wavelength is typically used. However, the size of the mounting device must be small in comparison to the wavelength. As the terahertz spectrum can exhibit several terahertz, the mount must be within the minimum detectable feature size of aorund 50 µm. Since realizing this small structure is challenging, another method to realize a mount for the small metal sphere is to use acoustic levitation.

Acustic levitation uses ultra sound to create standing waves. The created ultrasound nodes can be used to hold an object at a fixed place in space. Therewith, the small metal sphere can be levitated and be used in reference measurements.

The task includes:

- the creation of a time and work plan,
- the familiarization with the concept of acoustic levitation,
- the manufacturing of the device for acoustic levitation,
- the testing of the device with different samples,
- the calculation of a point-spread-function,
- the documentation of the work,
- the regular participation in group seminars,
- the presentation of an interim report,
- the final presentation of the work,
- the submission of the documentation and the presentation in PDF format as well as the hand in of the printed documentation to the Prüfungsamt according to the regularisation in the Prüfungsordnung.

Helpful skills:	Experience in soldering. Basic knowledge of programming (Arduino/Python or Matlab preferred). Interests in 3D image processing.
Character of the project:	40% System Build / 20% Measurements / 20% Image Processing / 20% Modelling
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