University of Stuttgart
Institute of Robust Power Semiconductor Systems

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BALLUFF

Master's thesis

to be assigned

ILH RF-group

Radar Imaging Concepts with self-mixing radar

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Motivation:

A novel FMCW radar principle operates without an explicit local oscillator signal in the receiver (Rx), but relies on self-mixing of the Rx. Thus, the Rx is electrically, as well as locally completely independent from the transmitter (Tx). In contrast to common radars, the information gained is not the absolute distance *to* the target object, but the absolute distance *between* multiple surfaces. This allows numerous potential applications, particularly in the fields of production engineering, medicine, materials analysis and safety.

Goals:

Covered by the project MIRADOR (Self-mixing **mi**llimeter-wave **rad**ar based on multiple surface **r**eflections) and supervised by experts from *Balluff GmbH*, radar imaging combined with a novel, self-mixing radar principle should be investigated.

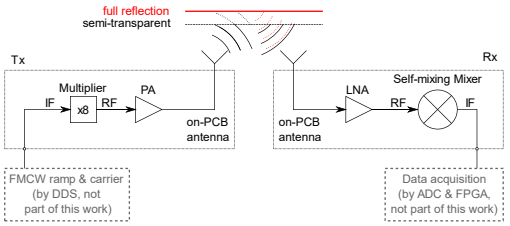
The idea of radar imaging is to gain picture-like information about a unknown target using radar measurements from different positions. Through different angles of view on the target, one is able to resolve regions of stronger/weaker scattering. Compared to optical images, radar imaging is not limited to 2D images, but also 3D-volumes can be provided.

As Tx and Rx are not synchronized by a phase coherent reference signal, both can be positioned more flexible, which is beneficial for radar imaging.

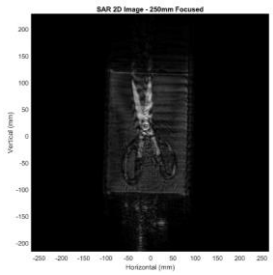
Until now, a specific demonstrator hardware is already developed and evaluated in the E-band (60 to 90GHz).

Thesis Outline:

- Derive a modified radar imaging algorithm to handle signals from self-mixing radar hardware.
- Implement the algorithm and validate its feasibility through signal simulations.
- Derive system requirements/limits like sampling distance and geometrical constraints.
- Verify your results using the demonstrator hardware und an automated scanner hardware



Self-mixing radar demonstrator frontend (E-band) and scheme with independent Tx and Rx



Exemplary scanner hardware and radar image

Your Qualifications:

- Master student in electrical engineering, similar.
- Good knowledge in signal theory (Fourier transform, ...)
- Programming experience in python is beneficial.
- Knowledge of Radar fundamentals is advantageous

Language: German/English

**the workload will be adjusted accordingly*

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