Microwave Sensing, Signals and Systems (MS³)

Master Market 2021

Microwave Sensing, Signal and Systems – MS3
Faculty of Electrical Engineering, Mathematics and Computer Science

TU**Delft**
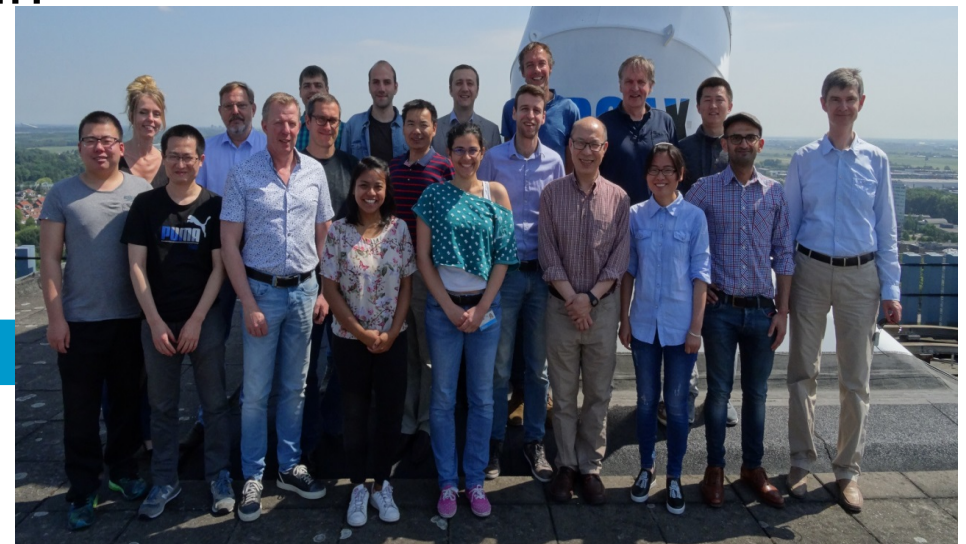
Delft University of Technology

Microwave Sensing, Signals and Systems (MS3)
Who, where, what, why, thesis

- Professor

- 2 Associate Professors

- 2 Assistant Professors

- 1 Affiliated Researcher

- 4 supporting/ technical staff

- *4 Postdocs*

- *12 PhD students*

The only Dutch academic radar TEAM

Microwave Sensing, Signals and Systems (MS3)
Who, **where**, what, why, thesis

MS3
21 - 22 Floors and roof

Microwave Sensing, Signals and Systems (MS3)
Who, where, **what**, why, how

We create technology for tomorrow's radar sensing applications

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Microwave Sensing, Signals and Systems (MS3)
Who, where, what, why, thesis

Microwave eye: – a device which can detect, localize, visualize and quantitatively characterize objects in a complex environment

Two directions in research:

1. *Sensor design and analysis*

   - antenna system design,
   - sensor diversity (waveforms, positions)

2. Cognitive radar

   - information detection – signal processing
   - radar management

Focus is on high resolution radar, which differentiates our research from other radar groups in academia.

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Microwave Sensing, Signals and Systems (MS3)
Who, where, what, why, thesis

- Automotive radars;

- Surveillance incl. weather radars,

- Microwave scanners, medical imaging, Ground Penetrating Radar, landmine detection,

- 5G (multi-beam front-end).

Microwave Sensing, Signals and Systems (MS3)
Who, where, what, why, **thesis**

Key features of MS thesis by MS3:

- Embedding of MSc topics into running research, cutting edge research topics

- Close cooperation with the research team (PhDs and PD)

- Individual supervision and training

- Experimental capabilities

- *Optional: with industry*

- Publications of the thesis results (*excellent for your CV*)

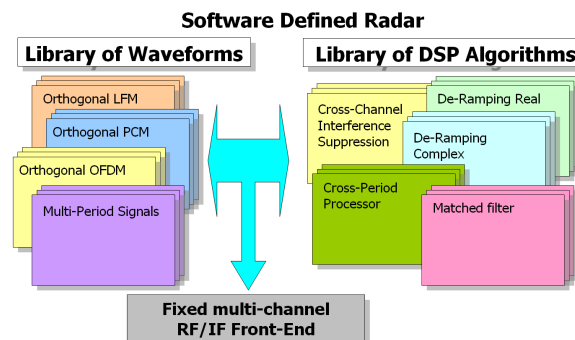## Testimonies of our former students

- see also http://radar.tudelft.nl/News/indexitem.php?mi=408

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Microwave Sensing, Signals and Systems (MS3)
Who, where, what, why, thesis

Create your own microwave eye for robotic vision, automotive applications, safety&security, or environment monitoring:

- Design new *sounding signals*
- Develop new *antenna systems and signal processing*
- Develop new *algorithms* for better target detection, tracking, recognition and physical parameters retrieval
- Develop radar management
- Experimentally *verify* your radar

Software Defined Radar

Library of Waveforms	Library of DSP Algorithms
Orthogonal LFM	De-Ramping Real
Orthogonal PCM	Cross-Channel Interference Suppression / De-Ramping Complex
Orthogonal OFDM	Cross-Period Processor
Multi-Period Signals	Matched filter

Fixed multi-channel RF/IF Front-End

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Master theses projects – Francesco

http://radar.tudelft.nl/People/bio.php?id=661

- You will see projects where radar is a tool for **situational awareness**: not just measuring distance, velocity, position of objects, but discovering their "*identity*", and/or *classifying* the presence/lack of certain phenomena.

- Concrete **examples** you may work on? Healthcare (human activities recognition; gestures classification; normal/abnormal gaits and vital signs); automotive (pedestrian/cyclist vs vehicles; obstacles vs object to drive over); surveillance (drones vs birds; drones models; payloads on drones), …

- Keywords = **competences** you will have & develop for/in these projects: radar theory & signal processing; machine learning & AI applied to radar data/classification problems; experiment design & data collection (COVID permitting); programming MATLAB-Python.

-> Check the **booklet** on our website radar.tudelft.nl

Master theses projects – Hans Driessen

http://radar.tudelft.nl/People/bio.php?id=347

Context of the topics

- We treat radar as an active sensor for building situational awareness
- Phased array, multi-function
- We investigate novel concepts for signal and data processing, radar management, and machine learning in dynamic systems
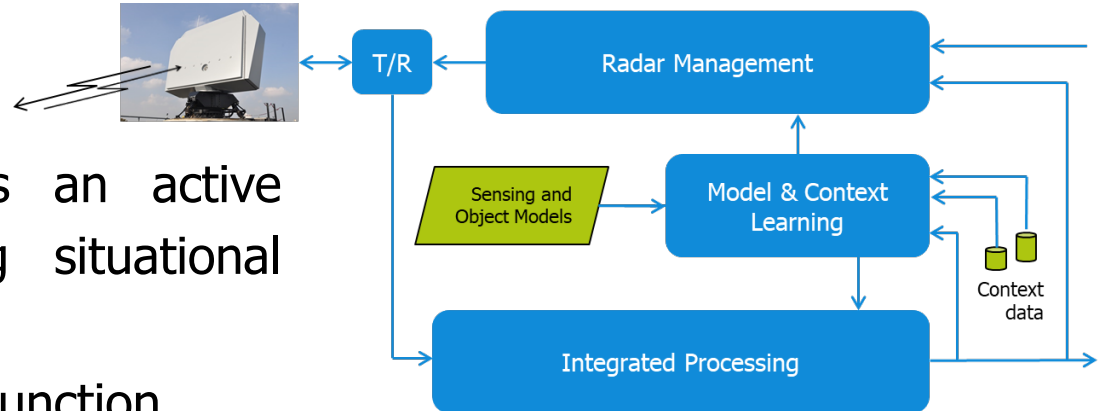
Just a few example topics

- Statistically sound techniques for dealing with extended objects, and the environment, such as the sea surface and propagation effects;
- Extending radar management with object search;
- Extending the current concept of dynamic detection and estimation with machine learning techniques such as Gaussian Process Models

Topics can be tuned to individual student wishes!

Master theses projects – Oleg

http://radar.tudelft.nl/People/bio.php?id=22

- You will see projects where **modern flexible digital radar technology** provides an opportunity to extend the dimensions of sensing signals features space and **improve the sensing quality** via *radar architecture, waveforms and processing algorithms optimization* to **user goals, interests and applications.**

- Concrete **examples** you may work on? *surveillance* (small drones improved detection and identification (drones vs birds); phase noise effects in phased array radar, their simulation and mitigation); *Doppler polarimetry* (model-based algorithms for improved target detection, for advanced atmospheric remote sensing)*; digital design of modern radar* (MIMO/polarimetric/multichannel FPGA-based FMCW receivers; digital architecture of cognitive radar).

- Keywords = **competences** you will have & develop for/in these projects: radar theory & signal processing; statistical signal/data processing for detection, estimation and classification; experiment design & data collection (our radars are working even during COVID); programming MATLAB-Python.

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Master theses projects – Nikita Petrov

http://radar.tudelft.nl/People/bio.php?id=101

Automotive radar signal processing

- Auto-calibration & self-diagnostics;
- Sensing and localization

Radar Signal Processing

Vital signs monitoring

Dynamic monitoring of breathing and heart-beat rate

Dual-band dual-polarimetry data processing

Improved target detection / tracking / classification using dual-band dual polarimetry radar(s)

Expertise you will develop in these projects: radar theory, mathematical modelling of the physical process; signal processing; radar data handling; experiment design & data collection (COVID permitting); programming.

Master thesis projects – Yankı Aslan
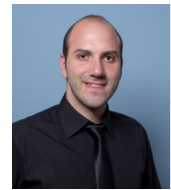
➢ **System-based** design approach for array synthesis and beamforming

✓ Electromagnetics ✓ Circuit design ✓ Signal processing

✓ Thermal management ✓ Medium access control

➢ What you can work on:

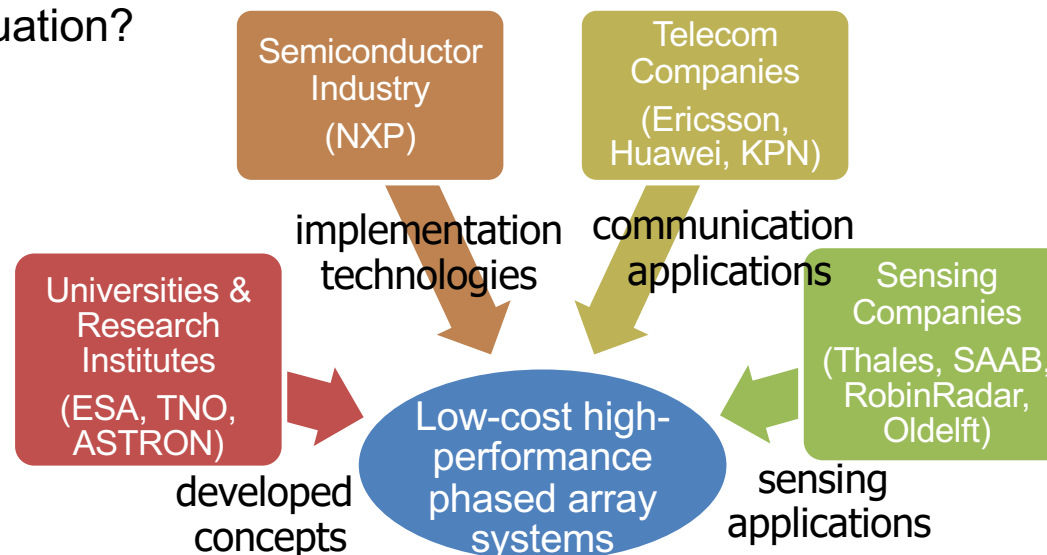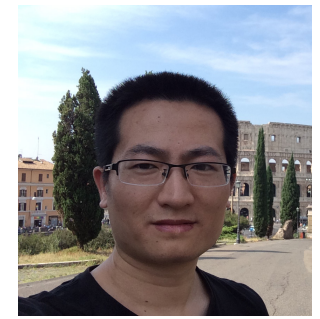|	
» Antenna & beamforming network design, testing	(antennas + circuits)
» Optimization techniques for large-scale antenna arrays	(antennas + DSP)
» Wireless system development	(antennas + propagation models)
» Electro-thermal antenna & front-end modeling	(antennas + PA models)

How?

theory, simulation, experiments

Why?

to address the **cost and complexity** issues in **5G and beyond**

➢ After graduation?

Semiconductor Industry (NXP)

Telecom Companies (Ericsson, Huawei, KPN)

implementation technologies

communication applications

Universities & Research Institutes (ESA, TNO, ASTRON)

Sensing Companies (Thales, SAAB, RobinRadar, Oldelft)

developed concepts

Low-cost high-performance phased array systems

sensing applications

MS³
Microwave Sensing
Signals & Systems

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MSc thesis with Jianping Wang

http://microelectronics.tudelft.nl/People/bio.php?id=107

Microwave Sensing ← **New Concepts in Imaging Sci.**

Microwave Imaging

(e.g. SAR, MIMO, UWB, Distri.)

Radar Signal Processing

(signal est.)

Imaging algorithms

Array Design (pola, MIMO)

Beamforming DOA

Interference Mitigation

- Super-res. imaging techniques
- Ghost imaging
- Orbital Angular Momentum

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Master Thesis Projects

Model-driven DL for Interference Mitigation in FMCW Radars

- Model/Prior + DL
- Application: automotive radar; weather radar

Efficient Deep Microwave Imaging by Algorithm Unrolling

- Model + Data;   Optimization Algorithms

Super-resolution Radar With Partially Coherent Waveforms

- Waveform + Antenna Array

Personal Development: radar SP/MW Imaging theory; Mathematical/EM modeling; Problem formulation, analysis and tackling skills; Programming (MATLAB, Python)

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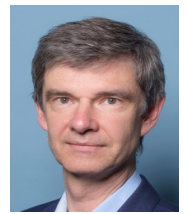# Master theses projects – Bert Jan Kooij

- Imaging techniques that are an extension of the classical radar technique and are able to reconstruct not only the location of the reflection, but go beyond that location of the reflection. Some of these techniques are able to reconstruct the permittivity and conductivity of a scattering object. The goal is to find imaging techniques that fill the gap between radar-imaging (fast, low quality of image) and full wave inversion techniques (very slow, high quality). The techniques that are used are based on the Maxwell-equations and require some basic knowledge of these equations in order to do research in collaboration with me, to find fast and good images with minimal artifacts.

- The research is carried out using Matlab. All is done with the aid of computer simulations, so there are no measurements involved.

- Keywords = **Mathematical competences, Matlab experience, Maxwell equations and Interest in Theoretical Research**

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-> Check the **booklet** on our website radar.tudelft.nl

Master theses projects – Alexander

http://radar.tudelft.nl/People/bio.php?id=11

- Development of electromagnetic models of distributed (and moving) targets and feature/parameter retrieval algorithms for **remote sensing**.

- Concrete **examples** you may work on? Subsurface object detection and classification, EM modelling of moving distributed targets (e.g., bicyclists, drones), simultaneous MIMO systems using orthogonal waveforms

- Keywords = **competences** you will have & develop for/in these projects: physical understanding of electromagnetic wave interaction with objects; electromagnetic theory and computational electromagnetics, experimental studies (COVID permitting); usage EM design tools and programming in MATLAB.

-> Check the **booklet** on our website radar.tudelft.nl

Master theses projects – industrial partners

Brood spectrum of opportunities (some are temporarily limited by COVID19):

- System studies with Damen, NXP (UWB radar)
- Automotive radar systems and signal processing with NXP
- Human activities and state retrieval with Philips Research, IMEC, Valkamp
- Antenna systems with Thales, NXP, TNO, ASTRON, Fraunhofer FHR, Hensoldt
- Waveform design and signal/information processing algorithms Thales, TNO
- tbc

-> Check the **booklet** on our website radar.tudelft.nl and contact us

Your possible future after thesis

PhD at MS3!

TUDelft

Next steps to your thesis

Individual meetings with the potential supervisors:
- March 29, lunch time. Contact by e-mail first!
- verify your study program

Possible summer extra projects and internship in industry
- Contact person from the booklet or a.yarovoy@tudelft.nl. Express clearly what do you want.

Thesis start: October – December 2021

Thesis event EE and CE

Thesis event on 30 March, 12:45-13:45

In a panel discussion of graduate students EE and CE will share their experience with you!
Of course you can ask the panel questions during this event.

This event is information about experiences.
Find out what first steps you need to take to get started, and what you can expect during your graduation. Be there!

Chair: Prof.dr.ir. W.A. (Wouter) Serdijn

https://tudelft.zoom.us/j/96114943031?pwd=MHVjcDVPWXc0WFVFSG9NbDQ3TitLUT09

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