Location

Carl-Cranz-Gesellschaft
Argelsrieder Feld 22, bldg. TE 03,
D-82234 Wessling-Oberpfaffenhofen

Participants will receive details to the seminar location as well as a list of nearby accommodations with the confirmation of registration. Please note that the accommodation is not included, and participants are asked to make their own hotel accommodation.

Fee

EUR 2.990,--
CCG is a non-profit organisation, exempt from value-added tax in Germany. For foreign seminar locations the local tax regulations are applicable. Members of CCG receive a discount of 10 %. Student discounts are available on request. Discounts cannot be combined.

The invoice is to be paid within 14 days of invoice issue date by direct deposit only.

Registration

Please register up to 2 weeks before the seminar via E-Mail anmelden@ccg-ev.de or online at www.ccg-ev.de
You will receive a confirmation E-Mail with further information.

Further Information

For more information about our organization please contact:
Carl-Cranz-Gesellschaft e.V.
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Tel. +49 (0) 8153 / 88 11 98 -12
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For more information on the content of the seminar please contact

Dr. Greg Showman, Georgia Tech Research Institute,
Atlanta, GA (USA), E-Mail: Greg.Showman@gtri.gatech.edu

Substitutions and Cancellations

Substitutions of participants may be made at any time. Cancellation of an accepted registration later than 14 days prior to the start of the seminar is subject to a 25% cancelation fee. No shows will be billed for the entire seminar fee.
CCG reserves the right to cancel a course up to 14 days before the course's beginning in case of low number of participants or for other significant reasons. Furthermore, CCG reserves the right, against the announcement in the programme, to possibly replace at short notice a lecturer and also the lecturer's topic. Any claims for damages shall be excluded.

Radar Signal Processing

Who Should Attend

Engineers, scientists, managers, and technicians responsible for the design, development, evaluation, and testing of modern radar systems • Radar and RF/MMW missile seeker engineers • Personnel involved in high-resolution/imaging radar applications • Radar designers involved in clutter-limited target detection

Focus

Modern radars strive for increased performance; however, dramatic improvements in radar components are becoming more difficult to achieve after decades of refinement. In contrast, computer processing power continues to grow exponentially, enabling on-board real-time implementation of traditional Fourier-based techniques as well as more advanced algorithms. Radar systems today employ advanced waveform generators and collect wideband data with a significant degree of coherence, which allow tremendous increases in performance if the proper signal processing is implemented to exploit these features.

The seminar provides a comprehensive overview of the basics of radar with an emphasis on the role of signal processing and applications of these fundamentals to more advanced radar modes such as synthetic aperture radar (SAR) and ground moving target indication (GMTI) radar. This begins with a review of the underlying concepts from general digital signal processing, linear algebra, and random processes, which will provide the basis for a presentation of techniques employed by modern radar systems including pulse compression waveforms, Doppler processing, and antenna array-based techniques.

With these fundamentals in hand, more advanced techniques such as the detection of slow-moving targets against a clutter background with GMTI processing and the formation of high-resolution imagery with SAR become accessible. The basic operating principles of these modes will be presented as well as a discussion of factors affecting system performance.

Contemporary concepts in radar will be discussed. These include solutions to the difficult problem of target tracking in dense environments and the novel concept of multiple-input, multiple-output (MIMO) radar that has been borrowed from the field of communications. Model based approaches inspired by spectral analysis will be presented along with those from the new field of compressed sensing.

This seminar will provide a strong grounding in the fundamentals of radar signal processing and give the attendee ample opportunity to see how these are applied in radar systems today and what the future may hold.

Lecturers

Dr. Mike Davis	Georgia Tech Research Institute, Atlanta, GA
Dr. Greg Showman	Georgia Tech Research Institute, Atlanta, GA

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Sensorik / Erkundung

Seminar SE 2.08

Radar Signal Processing: Fundamentals, Applications, and Advanced Topics

June 30th - July 4th 2025
Oberpfaffenhofen near Munich

Scientific Coordination

Dr. Greg Showman
Georgia Tech Research Institute, Atlanta, GA

Seminar Outline

Monday, June 30th, 2025
10.15 – 16.30

10.15 – 10.30 Introduction

10.30 – 12.00
13.00 – 14.30
15.00 – 16.30
M. Davis
G. Showman

Radar and Signal Processor Basics
Basic radar system concepts and the role of signal processors, including FMCW and pulse-type radar • Radar range equation and basic detection theory • Basic signal radar related processor concepts and implementation • Coherent detection implementation and issues concerning interfacing with the signal processor • Sampling theory and effects of quantization on coherent signal integration • Examination of the radar environment and the relationship of clutter to target detection • Statistical theory of target and clutter characteristics, as well as target and clutter models

Tuesday, July 1st, 2025
08.30 – 16.30

08.30 – 10.00
10.30 – 12.00
M. Davis
G. Showman

Fundamentals of Signal Processing
Fourier analysis • Time-frequency uncertainty principal of waveforms • Linear time-invariant systems and convolution • Mixers • I/Q receivers and complex baseband signal representations • Sampling theory and aliasing • Quantization • Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters • Fast Fourier Transforms • Basic concepts in probability and random processes • Linear algebra

13.00 – 14.30
M. Davis

Detection Theory
Binary hypothesis testing • Bayesian and Neyman-Pearson tests • Detection of signals in Gaussian noise • Receiver Operating Characteristic (ROC) curves • Constant False Alarm Rate (CFAR) adaptive detection

15.00 – 16.30
G. Showman

Waveforms and Pulse Compression
Matched filter theory • Ambiguity functions for radar waveform analysis • Measures of resolution • Pulse compression • Linear FM waveforms • Phase-coded waveforms • Pulse-Doppler waveforms

Wednesday, July 2nd, 2025
08.30 – 16.30

08.30 – 10.00
G. Showman

Moving Target Indication (MTI) and Pulse Doppler (PD) Radar
MTI multi-pulse delay-line cancellation • PD Fourier analysis • Overcoming blind speeds through PRF diversity • MTI and PD figures of merit and factors limiting performance

10.30 – 12.00
M. Davis

Antennas and Array Processing
The role of antennas in radar systems • Array antennas for enhanced angular resolution • Narrowband signal models • Linear beamforming • Adaptive nulling

13.00 – 14.30
G. Showman

Ground Moving Target Indication (GMTI) Radar
Target and clutter models • Space-time adaptive processing (STAP) • Implementation issues

15.00 – 16.30
M. Davis

GMTI Performance Benchmarking
SINR loss and probability of detection • Minimum detectable velocity • Parameter estimation accuracy • Area coverage rate • Performance prediction example

Thursday, July 3rd, 2025
08.30 – 16.30

08.30 – 10.00
G. Showman

Synthetic Aperture Radar (SAR)
Principals of coherent imaging and two-dimensional resolution • Stripmap and spotlight operation • Survey of image formation methods • Consequences of motion errors

10.30 – 12.00
M. Davis

SAR Performance Benchmarking
Image interpretability • SAR resolution • Image contrast • Sources of additive and multiplicative noise • SAR area coverage rate • Performance prediction example

13.00 – 14.30
G. Showman

Target Tracking
Regression analysis • Kalman filters • Alpha-beta filters • Coordinate transformations and the extended Kalman filter • Survey of data association methods

15.00 – 16.30
M. Davis

Multiple-Input, Multiple-Output (MIMO) Radar
MIMO radar concepts • MIMO virtual array • MIMO radar performance benchmarking • The phased array vs. orthogonal waveforms • MIMO SAR • MIMO GMTI • Comparison of MIMO radar and MIMO communications

Friday, July 4th, 2025
08.30 – 12.00

08.30 – 10.00
G. Showman

Spectral Estimation Techniques
Classical spectral estimation • CLEAN algorithm • Parametric maximum-likelihood • Covariance estimation • Minimum Variance (MVDR) methods • Eigenspace approaches (principle components, MUSIC) • Model order selection • ARMA models

10.30 – 12.00
M. Davis

Compressed Sensing and Radar
Compressed sensing concepts • Application of compressed sensing to radar detection • Application of compressed sensing to radar imaging

Language

English

Course Material

Each attendant will be provided with detailed course material in English, and will receive a free copy of the book:

"Fundamentals of Radar Signal Processing",
by Mark A. Richards
McGraw Hill Electronic Engineering, 2005