Course syllabus

Radar och fjärranalys
Radar and Remote Sensing

EITN90, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED E
Date of Decision: 2023-04-11

General Information

Elective for: E4-fh, F4, F4-tf, F4-f, F4-fel, MFOT1, MSOC2, N4-hn, Pi4-bs
Language of instruction: The course will be given in English

Aim

Radio detection and ranging (radar) is one of the most used sensor systems for automatic surveillance of people, machines, and nature. When put on a platform like an aircraft or a satellite, it is often used to form images of the ground and its properties, called remote sensing. The aim of this course is to give an overview of typical radar systems and their operational principles, ranging from scattering mechanisms and wave propagation to electronics implementation and machine learning techniques applied to the signals. Each student needs to perform a design of a radar system for a specific application, demonstrating ability to trade different requirements against each other.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- using a block diagram, describe the basic function, principles of operation, and interrelationships of the basic units of a radar system
- understand the nature of electromagnetic waves with respect to concepts as wave speed, wave impedance, polarization, coherence, and propagation through layered structures such as the atmosphere, soil, or building materials
- describe different scattering mechanisms at different wavelengths, target sizes, and material properties

- discuss how pulse width, peak power, and beam width affect radar performance
- explain the differences between different types of radar systems, like monostatic and bistatic, active and passive, and pulsed and continuous-wave radar
- be able to choose waveform and detection algorithm for unambiguous and accurate target detection
- describe typical applications in surveillance, unmanned vehicles, remote sensing, imaging etc

Competences and skills
For a passing grade the student must

- be able to use the radar range equation to estimate the maximum detection distance for a target
- quantify target scattering properties using the concept of radar cross section, using handbook formulas and simulation software
- be able to numerically process real radar data, such as extracting range and velocity from scattered pulses, machine learning techniques for target classification, or producing images from synthetic aperture radar data

Judgement and approach
For a passing grade the student must

- apply the acquired knowledge by carrying through a project designing a radar system for a specific application, demonstrating understanding of weighting desired technical performance to implementation cost and time

Contents

Radar systems on block level, electromagnetic wave properties and propagation through layered structures, scattering theory and radar cross section, stealth technology, radar range equation, antenna pattern, doppler shift, radar signal processing, synthetic aperture radar, MIMO radar, target classification using machine learning, remote sensing and imaging. The theory is demonstrated with practical experiments, and numerical processing of radar data.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: For the grade 3 completed assignments, electronic quizzes, and a project with oral presentation and written report are required. The assignments, quizzes, and the project must be done during the course. For higher grades an oral examination is required.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Admission

Admission requirements:

- For N the courses FMFF20 Mathematical Methods of Nanotechnology AND EITF90 Electromagnetics and Electronics are required
- EITF80 Electromagnetic Fields or EITF85 Electromagnetic Field Theory or ETEF01 Electromagnetic Field Theory

The number of participants is limited to: No
The course overlaps following course/s: ETE071, ETEN05

Reading list

- Mark A. Richards, James A. Scheer, and William A. Holm: Principles of Modern Radar: Basic Principles. Scitech Publishing, The Institution of Engineering and Technology, 2010. Available as an e-book through the university library.
- J. A. Richards: Remote Sensing with Imaging Radar. Springer, 2009. Supplementary literature, available as an e-book through the university library.

Contact and other information

Course coordinator: Daniel Sjöberg, daniel.sjoberg@eit.lth.se
Course homepage: http://www.eit.lth.se/course/eitn90
Further information: With less than 12 participants, the course may be given with reduced teaching and more self studies.