COMMUNICATION ENGINEERING AND ELECTRONIC TECHNOLOGIES

(Lecce - Università degli Studi)

Teaching LABORATORY OF WIRELESS COMMUNICATIONS AND RADAR

GenCod A006431

Owner professor Giuseppe RICCI

Teaching in italian LABORATORY OF WIRELESS COMMUNICATIONS AND

Teaching LABORATORY OF WIRELESS COMMUNICATIONS AND RADAR

SSD code ING-INF/03

Reference course COMMUNICATION ENGINEERING AND ELECTRONIC

Course type Laurea Magistrale

Credits 6.0

Teaching hours Front activity hours: 54.0

For enrolled in 2022/2023

Taught in 2023/2024

Course year 2

Language ENGLISH

Curriculum Telecom Applications

Location Lecce

Semester Second Semester

Exam type Oral

Assessment Final grade

Course timetable
https://easyroom.unisalento.it/Orario

BRIEF COURSE DESCRIPTION

General Background:

- A brief introduction to Matlab programming.

List of potential laboratory experiences:

- Lab Experience #1: *CFAR Radar Detection using Matlab*

1. CFAR detection techniques: motivation and basic strategies;
2. Coherent and Incoherent detection;
3. Implementation of different CFAR detection schemes: cell averaging (CA) CFAR, greatest of (GO) CFAR and smallest of (SO) CFAR, censored CA-CFAR, and ordered statistic (OS);
4. Analysis under ideal and non-ideal conditions (clutter edges and multiple targets).

- Lab Experience #2: *FMCW Radars*

1. Design of algorithms for target detection and parameter(s) estimation;
2. Acquisition of real data in an automotive scenario;
3. Design of decision rules for detection and tracking of multiple targets;
4. Performance analysis based on synthetic and real data.

- Lab Experience #3: *Target Detection using Real Radar Data*

1. Statistical analysis and processing of real radar data;
2. Estimation of the power spectral density and model fitting;
3. Design and implementation of detection algorithms to reveal the presence of targets embedded in real clutter.

- Lab Experience #4: *Design of algorithms for the localization of a wireless node*

1. Implementation of algorithms based on received signal strength measurements;
2. Implementation of algorithms based on time of arrival measurements;
3. Implementation of algorithms based on direction of arrival measurements;
4. Performance analysis using synthetic data.

- Lab Experience #5: *Simulation and Analysis of 5G Wireless Communication Systems*

1. Transmitted signal generation (single-carrier and multi-carrier technologies);
2. Multiple-input multiple-output (MIMO) and Multiple-input single-output (MISO) radio channel modeling;
3. Downlink and Uplink mmWave communications;
4. Channel Estimation (LOS and NLOS) and Performance Analysis.

Lab projects will include if necessary

- A review of pulsed radars and a brief introduction to frequency-modulated continuous wave (FMCW) radars.
- A review of goodness of fit techniques.
- An introduction to positioning techniques.
- An Introduction to modeling and simulation of wireless communication systems.

REQUIREMENTS	Prerequisites: statistical signal processing and learning, digital communications
COURSE AIMS	**Overview.** This is a laboratory-based course intended to show the application of statistical signal processing techniques to the design and the analysis of wireless systems and radars. **Learning Outcomes**. ***Knowledge and understanding*** After the course the student should know the tools necessary 1) to fit a statistical model to data and 2) to design algorithms to retrieve information chosen according to the adopted model. ***Applying knowledge and understanding*** After the course the student should be able to *fit a statistical model to data in terms of first order distribution and autocorrelation function; *solve detection and estimation problems for the selected applications. *Evaluate the performance parameters and discuss complexity issues associated with different solutions. ***Making judgements*** Students should acquire the ability to compare pros and cons of different approaches to the solution of a specific problem (laboratory experiences). ***Communication*** The ability to communicate on technical topics should be acquired by reporting on laboratory experiences. ***Learning skills*** Laboratory experiences will require elaborating on techniques introduced in previous courses, also with the help of selected readings suggested by the instructor. Identifying solutions to non trivial problems will be important to be ready for autonomous lifelong learning.
TEACHING METHODOLOGY	Lectures and computer/experimental projects. Most of the activity is performed in the laboratory where students can setup experiments regarding radar signal processing and wireless transmissions in Matlab and/or using Software Defined Radio (SDR) platforms. To attend the course, the student is NOT required to have knowledge of these tools in advance
ASSESSMENT TYPE	The exam will be composed of an *oral part* (30%) and a *practical part (70%)* where some modifications to the software and experiments developed during the course will be required; the objective of the practical part is not to focus on programming skills, but to verify the knowledge level of the discussed topics.
REFERENCE TEXT BOOKS	1) Handouts (in progress). 2) M. C. Jeruchim, P. Balaban, K. S. Shanmugan, "*Simulation of Communication Systems*," Plenum Press, 1992. 3) R. B. D'Agostino and M. A. Stephens, "*Goodness of Fit Techniques*," Marcel Dekker, 1986. 4) J. Proakis: "*Digital Communications*", McGraw Hill, 2000. 5) D. Tse and P. Viswanath: "*Fundamentals of Wireless Communication*" Cambridge University Press, 2005. 6) R. W. Stewart, K. W. Barlee, D. S. Atkinson, and L. H. Crockett: "*Software defined radio using MATLAB & Simulink and the RTL-SDR',* University of Strathclyde Engineering (free ebook), 2015.