Guia docent
230315 - LIDAR - Sistemes de Teledetecció amb Lidar

Última modificació: 16/11/2016

Unitat responsable: Escola Tècnica Superior d'Enginyeria de Telecomunicació de Barcelona
Unitat que imparteix: 739 - TSC - Departament de Teoria del Senyal i Comunicacions.

Titulació: MÀSTER UNIVERSITARI EN ENGINYERIA DE TELECOMUNICACIÓ (Pla 2013). (Assignatura optativa).
MÀSTER UNIVERSITARI EN ENGINYERIA ELECTRÒNICA (Pla 2013). (Assignatura optativa).

Curs: 2016 **Crèdits ECTS:** 2.5 **Idiomes:** Anglès

PROFESSORAT

Professorat responsable: Francesc Rocadenbosch

Altres: Francesc Rocadenbosch

COMPETÈNCIES DE LA TITULACIÓ A LES QUALS CONTRIBUEIX L'ASSIGNATURA

Específiques:
CE1. Capacitat per aplicar mètodes de la teoria de la informació, la modulació adaptativa i codificació de canal, així com tècniques avançades de processat digital del senyal als sistemes de comunicacions i audiovisuals.
CE13. Capacitat per aplicar coneixements avançats de fotònica i optoelectrònica, així com electrònica d'alta freqüència.
CE14. Capacitat per desenvolupar instrumentació electrònica, així com transductors actuadors i sensors.

METODOLOGIES DOCENTS

- Lectures
- Application classes
- Individual work
- Exercises
- Oral presentations
- Other activities: End-to-end simulation, visit to the UPC multi-spectral lidar station (European Infrastructure, OPTIONAL ACTIVITY upon operational time-slot availability of the station, number of students, and course schedule).
- Extended answer test (Final Exam)

The teaching and learning methodology combines expositive classes with more interactive ones, where systems and case problems are simulated and/or discussed based on literature reviews. A guided simulation mini-project (computer based) is progressively introduced during course.

Exercises:
- Description: Exercises to strengthen the theoretical knowledge and with a focus to guide the computer-based mini-project.
Oral presentation/interview*:
- Description: Presentation of the link-budget simulation mini-project (session 19).
(*) Depending on the total number of students enrolled.
Extended answer test (Final examination):
- Description: Final examination (multiple-answer test, session 20).

OBJECTIUS D'APRENENTATGE DE L'ASSIGNATURA

The course focuses on a tutorial discussion of the main techniques, systems and subsystems, and applications related to LIDAR (laser-radar) remote sensing. The course presents the grounds of the technological, physical, and data-retrieval keys involved in relation to the applications of these remote sensing systems in the ground-based and space-borne contexts. Present-day application fields comprise atmospheric observation (pollution concentration and physical-variables monitoring), wind remote sensing (e.g., eolic farms), detection and monitoring of chemical species, and others, in the industrial field.

Learning results of the subject:
- Ability to develop LIDAR (laser-radar) remote-sensing systems for atmospheric sensing and chemical-species detection in the context of both ground-based and satellite-based systems.
- Ability to specify, analyse, and evaluate the performance of different types of LIDAR systems using end-to-end software simulation.
- Ability to model and interpret retrieved lidar data in terms of level-1 products (atmospheric reflectivity, attenuation) and level-2 products (pollution content and transport, gas-species concentration, and wind velocity).
- Ability to understand and forecast a wide range of LIDAR applications including pollution monitoring and gas detection in the environmental/regulatory field, wind retrieval in relation to eolic farms, telemetry, 3-D imaging and scanning in architecture, and bathymetry (sea surface and submarine investigation).
- Knowledge exposure to continental and world-wide network initiatives concerning both active and passive optical remote sensing instruments.
- Ability to develop laser-radar/optical-active remote-sensing systems: telescope ("optical antenna") and opto-electronic receiver design, equipment and subsystems, channel modeling, link budget, and architecture specification.
- Ability to design laser-radar remote sensing systems (LIDAR) for atmospheric environmental sensing (pollution) and chemical-species detection, either as ground-based or satellite-based systems.
- Ability to integrate Telecommunication Engineering technologies and systems, as a generalist, and in broader and multidisciplinary contexts, such as remote sensing, atmospheric probing, and imaging.
- Ability to develop signal processing methods and algorithms for data retrieval and interpretation in atmospheric, environmental and industrial LIDAR remote sensing.

HORES TOTALS DE DEDICACIÓ DE L'ESTUDIANTAT

Tipus	Hores	Percentatge
Hores aprenentatge autònom	42,5	68.00
Hores grup gran	20,0	32.00

Dedicació total: 62.5 h

CONTINGUTS

1. BACKSCATTER LIDAR SYSTEMS

Descripció:
1.1. Foundations and Architecture
1.1.1. Basic design parameters: Elastic lidar equation
1.1.1.1. Optical (OVF, background radiance)
1.1.2. Signal conditioning and acquisition
1.1.2.1. Signal conditioning: Receiving Chain
1.1.2.2. Acquisition systems: Photon counters
1.2. Examples of real systems

Dedicació: 15h
Grup gran/Teoria: 4h 30m
Aprenentatge autònom: 10h 30m

2. SYSTEM LINK BUDGET: END-TO-END SIMULATION

Descripció:
2.1. Receiving chain: OE conversion and resolution (review)
2.2. Generalised signal-to-noise ratio (noise-dominant modes)
2.3. Example problem I
2.4. Lidar range estimation: Simulation.
2.5. Elastic-Raman link budget (problem proposal)

Dedicació: 16h 30m
Grup gran/Teoria: 0h 30m
Grup mitjà/Pràctiques: 4h
Aprenentatge autònom: 12h

3. RAMAN SYSTEMS

Descripció:
3.1. Raman Lidar
3.1.1. Basics about the Raman effect
3.1.2. Atmospheric probing and system layout
3.1.2.1. Temperature measurement
3.1.2.2. Molecular species (gas) detection
3.1.2.3. Water-vapor measurement
3.2. Elastic-Raman systems: End-to-end-simulation (problem revision)

Dedicació: 9h
Grup gran/Teoria: 2h
Grup mitjà/Pràctiques: 1h
Aprenentatge autònom: 6h

4. WIND-LIDAR SYSTEMS

Descripció:
4.1. Coherent Doppler Lidar
4.1.1. Architecture
4.1.2. Design considerations
4.2. Direct-detection Doppler systems

Dedicació: 6h
Grup gran/Teoria: 2h
Aprenentatge autònom: 4h

5. OTHER LASER-RADAR SYSTEMS

Descripció:
5.1. DIAL: Detection of gas species
5.2. Other laser-radar systems

Dedicació: 6h
Grup gran/Teoria: 2h
Aprenentatge autònom: 4h

6. EVALUATION

Descripció:
6.1 Oral presentation/interview (2h)
6.2 Final exam (2h)

Dedicació: 10h
Grup gran/Teoria: 4h
Aprenentatge autònom: 6h

SISTEMA DE QUALIFICACIÓ

Final examination: 50%
Oral presentation*: 50%
(*) Guided Link-budget program

BIBLIOGRAFIA

Bàsica:
- Fujii, T.; Fukuchi, T. Laser remote sensing [en línia]. Boca Raton [etc.]: Taylor & Francis, 2005 [Consulta: 12/05/2015]. Disponible a: http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10143572. ISBN 0824742567.

RECURSOS

Altres recursos:
E.D. Hinkley (Editor), R.T.H. Collis, H. Inaba, P.L. Kelley, R.T. Ku, S.H. Melfi, R.T. Menzies, P.B. Russell, V.E. Zuev. LASER MONITORING OF THE ATMOSPHERE. Springer-Verlag, 1976.