UAB
Universitat Autònoma de Barcelona

Wireless Localization Systems

2026/2027

Code: 45649
Credits: 5

Degree programme	Type	Course
Telecommunication Engineering	OP	2

Contact lecturer

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Teaching staff

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Group languages

You can consult this information at the end of the document.

Prerequisites

To have successfully completed the first-year subject of Estimation and Detection Methods.

Objectives

Wireless location systems are essential in today's interconnected world, driving advances in fields such as healthcare, transportation, smart cities, and the Internet of Things (IoT). This course will provide an overview of the major existing and future wireless location technologies, including terrestrial and non-terrestrial wireless networks, as well as dedicated and opportunistic location systems. Mastering such a broad set of wireless location systems is becoming crucial for the highly skilled professionals demanded by our increasingly automated societies. This course aims to bridge this gap by providing a comprehensive description of the underlying fundamentals that make wireless location possible, while delving into existing wireless location systems and their practical applications, and exploring emerging trends in a rapidly evolving field.

Learning outcomes

- CA24 (Implement wireless location solutions, demonstrating competences both in the choice of appropriate location techniques and in their implementation through terrestrial and non-terrestrial networks, minimising environmental impact and maximising energy efficiency.) Implement wireless location solutions, demonstrating competences both in the choice of appropriate location techniques and in their implementation through terrestrial and non-terrestrial networks, minimising environmental impact and maximising energy efficiency.
- CA25 (Demonstrate a critical approach in the design and evaluation of location systems, considering factors such as authentication, integrity, and security, and integration with existing networks.) Demonstrate a critical approach in the design and evaluation of location systems, considering factors such as authentication, integrity, and security, and integration with existing networks.

- KA22 (Identify the main applications, motivations, and types of wireless location systems, including their physical and mathematical principles.) Identify the main applications, motivations, and types of wireless location systems, including their physical and mathematical principles.
- KA23 (Explain the fundamentals of localisation algorithms based on various measurement techniques (ranges, angles, and combinations of these) and the associated localisation observables.) Explain the fundamentals of localisation algorithms based on various measurement techniques (ranges, angles, and combinations of these) and the associated localisation observables.
- KA24 (Describe location technologies based on terrestrial and non-terrestrial networks, including LoRa, cellular networks (5G/6G), opportunistic signals, and GNSS and LEO-PNT systems.) Describe location technologies based on terrestrial and non-terrestrial networks, including LoRa, cellular networks (5G/6G), opportunistic signals, and GNSS and LEO-PNT systems.
- SA33 (Apply different wireless location techniques based on terrestrial and non-terrestrial networks.) Apply different wireless location techniques based on terrestrial and non-terrestrial networks.
- SA34 (Apply advanced integrity, authentication, and security aspects to wireless location systems.) Apply advanced integrity, authentication, and security aspects to wireless location systems.
- SA35 (Evaluate the accuracy and feasibility of different wireless location techniques in different application scenarios.) Evaluate the accuracy and feasibility of different wireless location techniques in different application scenarios.

Contents

1. Introduction to wireless localization

- Motivation and applications
- Types of wireless localization systems

2. Fundamentals of wireless localization

- Physical and mathematical principles.
- Enabling measurements for localization (RSS, TOA, TDOA, AOA, AOD, FDOA).
- Localization algorithms using range measurements.
- Localization algorithms using angular measurements.
- Localization algorithms using measurements differences.
- Localization algorithms combining different types of measurements.

3. Wireless localization using terrestrial networks

- Localization using low-power technologies (LoRA)
- Localization using cellular networks (5G/6G)
- Localization using opportunistic terrestrial networks (DVB-T).
- Legacy terrestrial localization systems

4. Wireless localization using non-terrestrial networks

- Localization using Global Navigation Satellite Systems (GNSS)
- Localization using dedicated LEO-PNT satellites
- Localization using opportunistic signals from LEO communication satellites
- Convergence between terrestrial and non-terrestrial networks (5G/6G NTN)
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5. Advanced localization features

- Integrity, authentication and security
- Data fusion and multi-layer localization systems
- Cloud processing

- AI-based positioning techniques

Learning activities and methodology

Title	Hours	ECTS	Learning outcomes
Theory lectures	28	1.12	CA25, KA22, KA23, KA24, SA35
Tutorials	15	0.6	SA33, SA34
Laboratory sessions	14	0.56	CA24, CA25, SA33, SA34, SA35
Study	65	2.6	CA24, CA25, KA22, KA23, KA24, SA33, SA34, SA35

Classroom activities

- Theory classes: presentation of theoretical content.
- Laboratory sessions: application of the techniques presented in the theory classes to different real systems and implementation with different simulation software.
- Partial and final exams.

Autonomous activities

- Study of the theoretical and practical contents of the subject.
- Problem solving and preparation of assignments with solutions to some sets of problems.
- Exam preparation.
- Practical work: carrying out and deepening of laboratory practices.

Annotation: within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continuous assessment activities

Title	Weight	Hours	ECTS	Learning outcomes
Laboratory	30%	1	0.04	CA24, CA25, SA33, SA34, SA35
Exam 1	35%	1	0.04	CA24, CA25, KA22, KA23
Exam 2	35%	1	0.04	CA25, KA24, SA33, SA34, SA35

The final grade for the subject is obtained as the weighted average of the grades obtained in the continuous assessment activities.

Second-chance exam

The student has the option of taking a second-chance exam, which will be held once the face-to-face classes have ended, during the retake exam period set by the school. In the second-chance exam, the student may retake the part corresponding to exam 1, the part corresponding to exam 2, or both at the same time. In any

case, the grade for the second-chance exam, whether corresponding to the retake of exam 1 or exam 2, will replace the grade that the student has obtained in the exam that is being retaken.

Once the grade for the second-chance exam has been replaced, the final grade for the subject is also obtained as the average of the grades for the exams (retaken, if applicable) and the laboratory grade.

Academic integrity and verification of authorship

The teaching staff reserves the right to call for an interview or an individual oral test of contrast when there are indications of copying or lack of authorship in an assessable activity. The impossibility of satisfactorily accrediting authorship may have effects on their qualification, in accordance with current academic regulations.

Consideration of "Not Assessable"

The final grade will be "Not Assessable" only when the student does not take any exam, neither those of the continuous assessment nor the retake.

Consideration in the case of copying or plagiarism

Without prejudice to other disciplinary measures that may be deemed appropriate, and in accordance with current academic regulations, tests or reports where the student has committed irregularities, such as plagiarism, cheating, copying, allowing copying, etc., which could lead to a variation in the qualification, will be graded with a zero.

Bibliography

- S.A. Zekavat, R. M. Buehrer (Eds), *Handbook of position, location; Theory, practice and advances*, Wiley/IEEE Press, 2019
- A. Bensky, *Wireless positioning technologies and applications*, Artech House, 2008.
- Y.T.J. Morton et al. (Eds), *Position, navigation, and timing technologies in the 21st century*, vols. 1 and 2, Wiley/IEEE Press, 2021.
- F. Van Diggelen, *A-GPS: Assisted GPS, GNSS and SBAS*, Artech House, 2009.

Software

Laboratory sessions will make use of the Matlab software.

Course groups and languages

The information provided is provisional until November 30. After this date, you will be able to consult the language of each group through this link. To access the information, you will need to enter the course CODE