Universitat Autònoma de Barcelona

2019/2020

Navigation and Earth Observation Systems

Code: 43846
ECTS Credits: 6

Degree	Type	Year	Semester
4315985 Geoinformation	OB	0	1

Contact

Name: Jordi Corbera

Email: Desconegut

External teachers

Juan Fernando Marchán Hernández

Marc Torres Saura

Use of Languages

Principal working language: spanish (spa)

Prerequisites

This course has no specific requirements. Students should only have a basic knowledge of using general software such as Windows, Excel and Word.

Objectives and Contextualisation

Earth observation systems offer a synoptical view of land. The advantage of having a point of view at a certain altitude has been used by aerial platforms for more than a century. More recent, however, is the operational use of satellite systems, that had its origin and broad use from the 70s when the Landsat programme began. Nowadays spectral, spatial and temporal resolution are components of an equation of uses and applications that spans from the optical and thermal systems to the active systems, such as radar and lidar, that give a better knowledge of land for environmental applications, resource management and sustainability.

Navigation is the ensemble of arts and techniques used to go from point A to point B in an efficient and safe way. It is possible to go from A to B knowing the speed and heading to follow, taking references and angles from known points, or knowing the coordinates of points A and B on a navigation chart, either on paper or on the screen of an electronic device.

At the end of XIXth century and the begining of XXth, using terrestrial radiocommunication systems and different methods of triangulation it was possible to calculate position knowing the coordinates of the points from which radiocommunication signals were broadcast. In the decade of 70s it was thought that it would be better to have those broadcasting stations on board of orbiting satellites, instead of having them on the ground, in order to have permanent signal coverage. Thus was born the concept of satellite navigation systems, which from US GPS to European GALILEO had democratised the concepts of positioning and navigation.

In this context, the specific goals of the course are to give:

- the basic knowledge to understand and use the data gathered by satellite observation systems and by global navigation satellite systems. Particularly in the key aspects of precision and of spectral, spatial and temporal resolution.

- the theretical and practical understanding to have a criticalthinking on the most appropriate technologies and approaches to solve actual projects of geoinformation production and integration, both in the field of Earth observation and in that of positioning.
- the specific practical skills to use and analyse satellite data from Earth observation and navigation systems.

Competences

- Apply the physical fundamentals of the observation of the Earth to the analysis and treatment of data from remote sensors.
- Continue the learning process, to a large extent autonomously.
- Identify and use navigation and positioning systems and techniques precisely and reliably with the various different assumptions of navigation and data collection in the field.
- Integrate geospatial information technologies, services and applications with the aim of providing an optimal solution to each application case.
- Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
- Use knowledge critically and understand and take on board the ethical responsibility, legislation and social implications of the use and diffusion of geospatial information and its derived products.

Learning Outcomes

1. Carry out the post-processing and analysis of data provided by satellite global navigation and positioning systems.
2. Choose the system of coordinates for a particular geographic context.
3. Continue the learning process, to a large extent autonomously.
4. Identify the sensors and derived data products for each type of study and application.
5. Integrate geospatial information technologies, services and applications with the aim of providing an optimal solution to each application case.
6. Know and apply the techniques for analysing and processing sensor-acquired data.
7. Know the main types of satellite platforms and sensors.
8. Perform operations to transform data between different systems of coordinates.
9. Recognise the characteristics peculiar to the different families of cartographic projections to produce maps of specific scales and geographic contexts (local, national, continental or global).
10. Recognise the functioning and calibration of observation sensors for carrying out the necessary processing of the data they provide.
11. Recognise the physical process relating data measured by earth observation systems with the information obtained in the form of physical parameters.
12. Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
13. Use different systems of coordinates for different national and international contexts.
14. Use knowledge critically and understand and take on board the ethical responsibility, legislation and social implications of the use and diffusion of geospatial information and its derived products.
15. Use navigation and positioning techniques to establish both navigation and position reliably and accurately.
16. Use positioning and navigation instruments with differing levels of accuracy and performance.
17. Use the set of instruments needed for measuring biophysical parameters and for processing and analysing the data they provide.
18. Visualise and extract information from the data from the different types of images obtained through Earth observation systems.

Content

Positioning, topography and navigation

1. Introduction to the concept of navigation.

2. Global navigation satellite systems (GNSS).

3. Geodesy, measurement, spatial reference systems and map projections.

4. Navigation sensors, systems integration and architectures.

5. Geolocation, practical cases and corrections.

Image processing, photogrammetry and Earth observation

1. Fundamentals of digital image processing.

2. Introduction to optical remote sensing.

    Photogrammetric cameras.

    Multispectral sensors.

    Hyperspectral sensors.

3. Multi/hyperspectral data correction.

    Radiometric correction.

    Geometric correction.

    Atmospheric correction.

4. Microwave remote sensing. Theory and applications.

5. Getting quantitative information from remote sensing data.

6. Introduction to photogrammetry. Theory and applications.

7. Geometric correction principles and strategies for airborn and satellite platforms.

8. Synthetic-aperture radar (SAR).

    Principles.

    Interferometry SAR.

    Differential interferometry SAR.

    Polarimetry SAR.

Methodology

Theoretical knowledge (both fundamental and thecnical concepts) are introduced by summary lectures that reinforce critical thinking by analysing selected refferences (study cases, scientific papers, videos, etc.) and seminar discussion.

Operational knowledge (use of field measurement instruments and software) is developed by means of guided exercises done in the classroom or autonomously. In the case of Earth observation, practical exercises comprise image search, download and image processing, and in the case of positioning systems the exercises include field data capture and postprocessing.

Thus, learning is achieved by means of three types of activities.

Directed activities: Directed activities are theoretical and practical lectures in a computer lab. They include solving case studies and practical exercises. Lectures are the common thread of the course. Lectures serve to systematize all the content, to present the state of the art of the different subjects, to provide methods and techniques for specific tasks, and to sum up the knowledge to learn. Lectures organize also the autonomous and complementary work done by the students

Supervised activities: Supervised activities are focused on the execution of a semester project, consisting of a real case study, carried out through workshop hours, autonomous work and tutorials. This semester project allows to apply together all the knowledge and technical skills learnt in all the courses of the semester. The semester project is a milestone for the students and the actual demonstration that they had achieved the learning goals of all the courses of the semester. It is also the main evidence for evaluation as students should have to submit at the end of the semester a report that summarizes the whole project and do an oral presentation.

Autonomous activities: Autonomous work of the students includes personal readings, data and documentation search, complementary exercises and the personal development of the semester project.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Guided practical exercises at the classroom	12	0.48	6, 1, 2, 8, 5, 13, 15, 16, 17, 18
Lectures on basic concepts	24	0.96	7, 4, 3, 9, 12, 14
Type: Supervised			
Field exercises	4	0.16	2, 5, 12, 16
Supervised exercises	11	0.44	6, 1, 4, 14
Type: Autonomous			
Design and presentation of potential applications integrating remote sensing and navigation	29	1.16	14
Study and exercises	40	1.6	3, 12, 14

Assessment

CONTINUOUS EVALUATION

a) Evaluation procedure and activities:

Evaluation of the course is based mostly on the semester project, that comprises two evaluation activities. The elaboration and submission of a synthesis report and the oral presentation of the project done. Given the technical content of the course, the weight assigned to the project report is 40% of the total course grading, assuming that it is the most appropriate means to explain all the technical details of the project, and a weight of 20% at the oral presentation. The course assessment is completed with the evaluation of the practical exercises done along the course, that account for another 40% of the total course grading.

Except when expressly noticed, all the evaluation activities (report and oral presentation of the semester project, as well as practical exercises) have to carried out individually.

Time assigned to each evaluation activity includes the time spent in making all the material evidences for evaluating each activity (e.g., writing of the report, preparing the presentation slides, etc.).

b) Evaluation schedule:

1st semester project report: Making during all the semester. Submission at the end of semester, on January 24 th 2020.

1st semester project oral presentation: Making during all the semester. Oral presentation at the end of semester, on January 30th and 31st 2020.

Course practical exercises: Making and submission weekly or biweekly along the semester.

c) Grade revision:

Once the grades obtained are published, students will have one week to apply for a grade revision by arranging an appointment with the corresponding teachers.

d) Procedure for reassessment:

1st semester project report: It could be reassessed in the following two weeks after the submission date scheduled. Reassessment will require the submission of a new whole report in case of negative evaluation of the former report submitted.

1st semester project oral presentation: It could be reassessed in the following week after the date scheduled for the oral presentation. Reassessment will require doing again the oral presentation in case of negative evaluation of the former presentation done.

Course practical exercises: Can not be reassessed.

To have right to a reassessment the student will have to have been previously evaluated in a set of activities that account for at least two thirds of the total course grading. Therefore he or she will have to have been evaluated of the 1st semester project report (40%) and of the 1st semester project oral presentation (20%) in the dates scheduled.

The right to a reassessment will only be granted to students that, having not passed the course (e.g., having a total course grade below 5 over 10), had obtained at least a total course grade above 3,5 over 10.

Plagiarism or copying in any activity will deserve a grade of 0 in this activity and could not be recovered. In case of repeated offence all the course grade will be FAIL. It is considered "copy" a work that reproduces all or a sunstantial part of another student's work. It is considered "Plagiarism" to present all or part of an author's published work without citation of the original sources, either analogic (e.g., paper) or digital. See more information over plagiarism at http://wuster.uab.es/web_argumenta_obert/unit_20/sot_2_01.html.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Oral presentations	20	6	0.24	1, 2, 8, 5, 10, 11, 12, 13, 14, 16, 18
Practical exercises	40	12	0.48	6, 1, 2, 4, 3, 10, 11, 9, 13, 15, 17
Report submissions	40	12	0.48	7, 4, 10, 11, 9, 18

Bibliography

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