Universitat Autònoma de Barcelona

Processing Remote Sensing Images

Code: 43384
ECTS Credits: 6

2024/2025

Degree	Type	Year
4314828 Remote Sensing and Geographical Information Systems	OB	0

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Teaching groups languages

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

Prerequisites

Prerequisites are not required

Objectives and Contextualisation

At the end of the course, the student will be able to:

- Master different tools primary processing of aerial and satellite imagery.
- Dominate the physical principles that govern remote image capture and transformations of the content of the image itself.
- Distinguish the different sources of image geometric deformations and possible signal interference caused by atmospheric captured or lighting effects (topography, etc.).
- Correctly apply the methodologies to mitigate the different error sources in order to be able to view and extract physical parameters of the received data.

Competences

- Apply different methodologies for the primary processing of images obtained by remote sensors in order to subsequently extract geographic information.
- Continue the learning process, to a large extent autonomously.
- Design and apply a methodology, based on the knowledge acquired, for studying a particular use case.
- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
- Take a holistic approach to problems, offering innovative solutions and taking appropriate decisions based on knowledge and judgement.
- Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.
- Use different specialised GIS and remote sensing software, and other related software.

Learning Outcomes

1. Continue the learning process, to a large extent autonomously.
2. Correctly apply methodologies to mitigate the different sources of error in order to visualise and extract physical parameters from the data received.
3. Design and apply a methodology, based on the knowledge acquired, for studying a particular use case.
4. Distinguish the different sources of geometric image deformation, and the possible interferences in the captured signal caused by atmospheric effects or illumination effects (topography, etc.).
5. Show expertise in the physics principles that govern remote image capture and transformations made to the content of the image itself.
6. Show expertise in using different primary processing tools for aerial and satellite images.
7. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
8. Take a holistic approach to problems, offering innovative solutions and taking appropriate decisions based on knowledge and judgement.
9. Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.

Content

PHYSICAL PRINCIPLES OF REMOTE SENSING

Solar spectrum

1. Concepts: radiation and electromagnetic spectrum, polarization. Fundamental relationships between frequency, length and transported wave energy.
2. Basic physical parameters (terminology and symbology, definitions, units): Radiant energy, energy flow, energy intensity, radiance energy excitance, irradiance, reflectance, albedo, transmittance, absorptance; absorbance. spectral magnitudes.
3. Specular reflection, diffuse and lambertiana.
4. Black body (Planck's law, Stefan-Boltzmann law, Wien's displacement law).
5. Solar radiation. Exoatmospheric characteristics and the surface of the Earth; interaction with the atmosphere and atmospheric windows.
6. Spectral signatures. Main characteristics of water, soil and rocks and vegetation in the visible and infrared non thermal.
7. Factors that influence the spectral signature.

Thermal

1. The thermal radiation emitted by the Earth. Remote Sensing approaches.
2. Physical parameters of the thermal infrared region.
3. KCL. black body, white body and gray body. selective radiators. Thermal behaviour of an object-related parameters.
4. Thermal behavior of an object: related parameters.
5. Spectral behaviour of the different coverages in the thermal infrared region.

6. Factors which influence the emissivity.
7. Emissivity measurement. Field measurements.
8. Emissivity measurement. Measured from satellite.

Active microwave

1. Active Microwave Remote Sensing: Imaging Radar.
2. Wave-Matter interaction: Radar Cross Section and Backscattering Coefficient.
3. Backscattering Coefficient.
4. Backscattering models.
5. SAR polarimetry.

Passive microwave

1. Passive Sensors: Fundamentals andPhysical Principles.
2. Applications of passive microwave E.O.
3. Microwave Radiometers:
    1. Figures of Merit: Angular Resolution and Radiometric Resolution.
    2. Calibration: internal, external, use of multi-look information.
4. Present and future EO Passive Microwave Mission.

GEOMETRIC CORRECTION OF AERIAL AND SATELLITE IMAGERY

1. Geometric corrections. Deformation sources. Orthoimage, orthophoto and orthophoto of authentic orthophotomap concepts. Corrections in vectorial bases.
2. Physical models (collinearity equations orbit models), semi-empirical (polynomial corrections, models of rational functions, Delaunay triangulation) and mixed. Model of radar images: determining the sampling step azimuth and distance. Relief role. Ground control points (GCP), test points, homologous points.
3. Geometry of the radar image. Sampling of the image. Geometric distortion of images. Accurate geocoding images using Digital Elevation Models (DEM or DEM). Obtaining DEM and Radar Mapping. Approaches to areas of low relief. Examples.
4. Basic correction process. Nearest neighbor, bilinear and bicubic interpolation: Chromatic, radiometric and geometric in image resampling. Considerations about output pixel size.
5. Sources of GCP. Automatic GCP.
6. Basics of physical models. Consideration of the relief.
7. Basics of semi-empirical models:
    1. Polynomial models 1st an 2nd degree. Application cases.
    2. Higher polynomial model degree. Application cases.
    3. Polynomial models with consideration relay.
    4. Models of rational functions.
    5. Delaunay Triangulation.
9. Mixed Models: Theory and examples ASTER, MODIS, SSM/I and SMOS.
10. Errorestimate.Statistical interpretation of the RMS.
11. Mosaics and geometry images.
12. Practical realization of the main models.

RADIOMETRIC IMAGE CORRECTION

1. Radiometric corrections. Calibration sensors. Sources of signal distortion. DN conversion to radiances. Interest and obtaining reflectances.
2. Formulation corrections in the visible and infrared non thermal.
2.1 Sun and atmspheric roles. Exoatmospheric radiance, transmittance. Variation throughout the year. Spectral variation. Diffuse atmospheric radiation.
2.2 Relief role: incidence angle, projected shadows. Celestial sphere. Neighboring reflected radiation.
2.3 Combining sensors in the same study. Usability of pseudoinvariant areas (PIA).
2.4 Combined use of *in situ* sensors such as handheld spectroradiometers or sun photometers.
3. Corrections based in multispectral and large mount of images: advantages and limitations.

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Master classes / exhibitions	27	1.08	1, 2, 3, 4, 5, 6, 7, 8, 9
Resolution exercices	8	0.32	1, 2, 3, 4, 5, 6, 7, 8, 9
Type: Supervised			
Classroom practices	34	1.36	1, 2, 3, 4, 5, 6, 7, 8, 9
Tutorials	4	0.16	1, 2, 3, 4, 5, 6, 7, 8, 9
Type: Autonomous			
Personal study	15	0.6	1, 2, 3, 4, 5, 6, 7, 8, 9
Reading of articles / reports of interest	2	0.08	1, 2, 3, 4, 5, 6, 7, 8, 9
Writing reports	58	2.32	1, 2, 3, 4, 5, 6, 7, 8, 9

Principal working language: spanish (spa), although the bibliographic materials may be in other languages, mostly English.

In this module there are 3 groups of learning activities:

- Targeted activities consist of classes of theory and practices that will be carried out in a specialized computer room. At the beginning of each of the subjects that make up the module, the teachers will explain the structure of the theoretical-practical contents, as well as the evaluation method.
- Supervised activities consist of classroom practices that will allow you to prepare the work and exercises of each subject, as well as tutorial sessions with the teachers in case the students request it.
- Autonomous activities are a set of activities related to the elaboration of works, exercises and exams, such as the study of different material in the form of journal articles, reports, data, etc., defined according to the needs of autonomous work of each student

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

Continous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Practical works	40% - 60%	0	0	1, 2, 3, 4, 5, 6, 7, 8, 9
Theoretical and practical exam	60% - 70%	2	0.08	1, 2, 3, 4, 5, 6, 7, 8, 9

This module does not incorporate single assessment.

The evaluation of this subject consists of the following system:

- Brief theoretical and practical exams (50% of the grade), carried out during the teaching of the module, in the form of a truly continuous assessment. These exams will be face-to-face, of short duration (approximately 20'-30') and will be carried out at the beginning of some classes to check that students are understanding the course topics (prepared by themselves in many cases) as they are addressed. Then, once each exam is finished, and still in the classroom, the teacher will consolidate all the needed details, devoting some extra time to practical issues, etc. In addition, the results of these short assessments will be available almost immediately, which allows students to have a very fine control of how their course is progressing. This brings us closer to a flipped classroom teaching methodology, in which students do not need to prepare partial or final exams since they prepare the classes in advance, they continuously self-assess and thus the classroom time can be devote to solve doubts, consolidate knowledge and tackle all kinds of practical exercises (but based on a good knowledge of the theory, previously studied by themselves).
- Theoretical exams of specific parts of the module (20 % of the grade).
- The completion of different practical works proposed throughout the teaching of the module and delivered within the set deadline. A correct formal presentation and careful preparation will be assessed (30 % of the grade).

The exams or other evaluation procedures not reaching the minimum mark of 5 out of 10 will be considered "failed" and they must be repeated.

A student who has submitted less than 20 % of the requested assignments will be considered "non-evaluable". The same mark will be assigned to any student who has not taken any of the theoretical-practical tests, as it is considered that the student has not been able to provide sufficient evaluation evidence.

Aspects to take into account.

- Regular class attendance in class is highly recommended for the correct monitoring of the subjects. Only in cases of physical impossibility of face-to-face assistance is streaming monitoring justified, since an important part of the experiences and learning are fully achieved through contact with the teaching staff and classmates.
- If the tests cannot be taken in person, their format will be adapted (maintaining their weighting) to the possibilities offered by the UAB's online tools.
- If practical work has to be delivered, this delivery must be done within the deadlines for them to be evaluated.
- The review of grades for each assessment activity is done by writing an email to the responsible teacher in order to agree the date and time.
- On carrying out each evaluation activity, Lecturers will inform about the procedures to be followed for reviewing all grades awarded, and the date on which such a review will take place.

Extraordinary exams.

- This extraordinary exam is unique.
- Students will have the opportunity to take an extraordinary exam the day or days scheduled by the faculty.

Cheating: Copies and plagiarisms.

- By copies, we refer to the evidence that the work, project, exam, etc has been partially or totally created/answered without the intellectual contribution of the author. In this definition, we also include theproven attempt to copy in the exams and delivered works and projects and the violation of the laws that assure intellectual authorship. Plagiarisms refer to the works and texts from other authors that someone pretends to be his/her own creation. It is a crime against intellectual property. In order to avoid committing plagiarism, quote all the sources that you use when writing the report of a project. Accordingto UAB's law, copies and plagiarisms or any other attempt to alter the results of one's own evaluation or someone else's -allowing to copy, for example- implies a result in the corresponding part (theory, problems or practical tasks) of a 0 and, in this case, the student will fail the subject. This does

not limit the right to take academic and legal actions against those who have participated. See UAB documentation about copies and plagiarisms
http://wuster.uab.es/web_argumenta_obert/unit_20/sot_2_01.html.

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Software

MiraMon, ArcGIS, QGIS, MATLAP, ENVI, R, SNAP, Office Microsoft

Language list

Name	Group	Language	Semester	Turn
(TE) Theory	1	Catalan/Spanish	first semester	morning-mixed