Universitat Autònoma de Barcelona

2020/2021

Processing Remote Sensing Images

Code: 43384
ECTS Credits: 6

Degree	Type	Year	Semester
4314828 Remote Sensing and Geographical Information Systems	OB	0	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)

Other comments on languages

Approximately 55 % of the classes are in Catalan and 45 % in Spanish. Most of the bibliography are in English

External teachers

Adriano Camps

Antoni Broquetas

Jordi Cristóbal

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. Spectral behaviour of the different coverages in the thermal infrared region
5. Factors which influence the emissivity
6. Emissivity measurement. Field measurements
7. Emissivity measurement. Measured from satellite

Active microwave

1. Active Microwave Remote Sensing: Imaging Radar
2. Wave-Matter interaction: Radar Cross Section and

3. Backscattering Coefficient
4. Backscattering models
5. SAR polarimetry
6. SAR Interferometry

Passive microwave

1. Passive Sensors: Fundamentals and Physical 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:
7.1 Polynomial models 1st and 2nd degree. Application cases
7.2 Higher polynomial model degree. Application cases
7.3 Polynomial models with consideration relay
7.4 Models of rational functions
7.5 Delaunay Triangulation
8. Mixed Models: Theory and examples ASTER, MODIS, SSM/I and SMOS.
9. Error estimate. Statistical interpretation of the RMS
10. Mosaics and geometry images
11. 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)
3. Corrections based in multispectral and large mount of images: advantages and limitations

Methodology

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

Activities

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

Assessment

The evaluation of this subject consists of the following system:

a) The realization of 2 exams, that will be between 60 % and 70 % of the final note and that will include the theoretical and practical subject carried out. The exam that has not reached the minimum mark of 5 out of 10 must be repeated the day assigned by the teacher of the subject.

b) The accomplishment of different practical works proposed throughout the teaching of the module and delivered within the fixed term, that will be between 30 % and 40 % of the final note. A correct formal presentation and careful preparation will be assessed.

Assessment Activities

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

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