ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

93000820 - Vision Analysis And Deep Learning

DEGREE PROGRAMME

09AQ - Master Universitario En Ingenieria De Telecomunicacion

ACADEMIC YEAR & SEMESTER

2023/24 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	93000820 - Vision Analysis And Deep Learning
No of credits	6 ECTS
Type	Optional
Academic year ot the programme	Second year
Semester of tuition	Semester 3
Tuition period	September-January
Tuition languages	English
Degree programme	09AQ - Master Universitario en Ingenieria de Telecomunicacion
Centre	09 - Escuela Tecnica Superior De Ingenieros De Telecomunicacion
Academic year	2023-24

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Carlos Cuevas Rodriguez (Subject coordinator)	C-306	carlos.cuevas@upm.es	Sin horario.
Carlos Roberto Del Blanco Adan	C-306	carlosrob.delblanco@upm.es	Sin horario.
Narciso Garcia Santos	C-324	narciso.garcia@upm.es	Sin horario.
Julian Cabrera Quesada	C-320	julian.cabrera@upm.es	Sin horario.

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

The subject - recommended (passed), are not defined.

3.2. Other recommended learning outcomes

- Study simultaneously the subject Predictive and descriptive learning

- Study simultaneously the subject Machine learning lab

- Random Signals

- Digital Signal Processing

- Digital Image Processing

- Signals and Systems

4. Skills and learning outcomes *

4.1. Skills to be learned

CE1 - Capacidad para aplicar métodos de la teoría de la información, la modulación adaptativa y codificación de canal, así como técnicas avanzadas de procesado digital de señal a los sistemas de comunicaciones y audiovisuales.

CG1 - Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación.

CG2 - Que los estudiantes sepan aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios (o multidisciplinares) relacionados con su área de estudio.

CG4 - Que los estudiantes sepan comunicar sus conclusiones ?y los conocimientos y razones últimas que las sustentan? a públicos especializados y no especializados de un modo claro y sin ambigüedades.

CG5 - Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

CT3 - Capacidad para adoptar soluciones creativas que satisfagan adecuadamente las diferentes necesidades planteadas.

CT4 - Capacidad para trabajar de forma efectiva como individuo, organizando y planificando su propio trabajo, de forma independiente o como miembro de un equipo.

CT5 - Capacidad para gestionar la información, identificando las fuentes necesarias, los principales tipos de documentos técnicos y científicos, de una manera adecuada y eficiente.

4.2. Learning outcomes

RA280 - To know the theory and applications of segmentation, detection and tracking algorithms

RA279 - To know the theory and applications of video filtering algorithms

RA275 - Manage the mathematical and conceptual tools that serve as a basis for the Digital Video Processing techniques

RA274 - Knowledge of the practical problems that can be solved with video processing techniques

RA276 - Knowledge of the applications based on the spatio-temporal analysis of video signals

RA281 - Handle some of the fundamental computer tools for the implementation of Digital Video Processing algorithms

RA273 - Knowledge, characterization, acquisition and manipulation of video signals

RA277 - To know the theory and applications related to the algorithms of motion estimation and analysis

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

The goal of this subject is to provide the student with the knowledge required for the description, analysis, and manipulation of video signals. Students are expected to gain an overview of the theory required for video signal processing, covering the fields of motion estimation and analysis, filtering, spatial and temporal segmentation, and detection and tracking of visual objects. Moreover, the last part of the subject is focused on the fundamentals of machine learning and deep learning for image-based applications. The laboratory sessions will allow the better assimilation of the theoretical concepts. Additionally, to bring theoretical knowledge into practice, many specific applications will also be presented as examples of using the studied techniques. Therefore, an applied and participatory methodology is used.

5.2. Syllabus

1. Introduction to image and video processing
    1.1. 3D/2D projection
    1.2. Digital image and video
    1.3. Spatio-temporal sampling
2. Motion estimation
    2.1. Introduction
    2.2. Algorithms
3. Video filtering
    3.1. Noise reduction
    3.2. Video stabilization
4. Image and video segmentation
    4.1. Image segmentation
    4.2. Foreground segmentation
    4.3. Temporal video segmentation
5. Deep learning for computer vision
    5.1. Machine learning fundamentals

5.2. Deep learning solutions

6. Schedule

6.1. Subject schedule*

Week	Classroom activities	Laboratory activities	Distant / On-line	Assessment activities
1	**Unit 1** Duration: 04:00 Lecture			
2	**Unit 1** Duration: 04:00 Lecture			
3	**Unit 2** Duration: 04:00 Lecture			
4	**Unit 2** Duration: 02:00 Lecture	**Laboratory 1** Duration: 02:00 Laboratory assignments		
5	**Unit 3** Duration: 04:00 Lecture			**Lab report** Group work Continuous assessment and final examination Not Presential Duration: 05:00
6	**Unit 4** Duration: 04:00 Lecture			**Midterm exam** Written test Continuous assessment Presential Duration: 02:00
7	**Unit 4** Duration: 02:00 Lecture	**Laboratory 2** Duration: 02:00 Laboratory assignments		**Lab exam** Problem-solving test Continuous assessment and final examination Presential Duration: 00:10
8	**Unit 4** Duration: 04:00 Lecture			
9	**Unit 5** Duration: 02:00 Lecture	**Laboratory 3** Duration: 02:00 Laboratory assignments		**Lab exam** Problem-solving test Continuous assessment and final examination Presential Duration: 00:10
10	**Unit 5** Duration: 04:00 Lecture			

11	**Unit 5** Duration: 04:00 Lecture			
12	**Unit 5** Duration: 04:00 Lecture			
13	**Unit 5** Duration: 02:00 Lecture	**Laboratory 4** Duration: 02:00 Laboratory assignments		
14		**Laboratory 5** Duration: 04:00 Laboratory assignments		**Lab report** Group work Continuous assessment and final examination Not Presential Duration: 05:00
15				**Lab report** Group work Continuous assessment and final examination Not Presential Duration: 05:00
16				**Classroom assessment: Assessment tests in the classroom in any of the face-to-face classes throughout the course** Other assessment Continuous assessment Presential Duration: 00:00
17				**Final exam** Written test Continuous assessment Presential Duration: 01:30 **Final exam** Written test Final examination Presential Duration: 03:00

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The schedule is based on an a priori planning of the subject; it might be modified during the academic year, especially considering the COVID19 evolution.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
5	Lab report	Group work	No Presential	05:00	6.67%	/ 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1 CT4
6	Midterm exam	Written test	Face-to-face	02:00	15%	/ 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1
7	Lab exam	Problem-solving test	Face-to-face	00:10	6.67%	0 / 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1 CT4
9	Lab exam	Problem-solving test	Face-to-face	00:10	6.67%	0 / 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1 CT4
14	Lab report	Group work	No Presential	05:00	6.67%	/ 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1 CT4

15	Lab report	Group work	No Presential	05:00	13.32%	/ 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1 CT4
16	Classroom assessment: Assessment tests in the classroom in any of the face-to-face classes throughout the course	Other assessment	Face-to-face	00:00	20%	/ 10	
17	Final exam	Written test	Face-to-face	01:30	25%	/ 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1

7.1.2. Global examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
5	Lab report	Group work	No Presential	05:00	6.67%	/ 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1 CT4
7	Lab exam	Problem-solving test	Face-to-face	00:10	6.67%	0 / 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1 CT4
9	Lab exam	Problem-solving test	Face-to-face	00:10	6.67%	0 / 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1 CT4

14	Lab report	Group work	No Presential	05:00	6.67%	/ 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1 CT4
15	Lab report	Group work	No Presential	05:00	13.32%	/ 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1 CT4
17	Final exam	Written test	Face-to-face	03:00	60%	5 / 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1

7.1.3. Referred (re-sit) examination

Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
Extraordinary examination	Written test	Face-to-face	03:00	60%	5 / 10	CG4 CT3 CT5 CG2 CG5 CG1 CE1

7.2. Assessment criteria

Evaluation will assess if students have acquired all the competences of the subject. Thus, evaluation through extra call (extraordinary evaluation) will be carried out considering all the evaluation techniques (EX, ET, TG, etc.) used in regular call (ordinary evaluation).

The partial and global tests will be carried out on the dates and times of evaluation approved by the School Board for the current course and semester, except for those evaluation activities of learning outcomes that are difficult to grade in a final test. In this case, these evaluation activities will be carried out throughout the course.

Any type of copying or fraudulent action in an evaluation item implies a grade of zero in the final grade of the call corresponding to the celebration of such item (ordinary or extraordinary).

The grade of the subject will depend on the evaluation modality followed by the student. In any case, the subject will be passed when a grade equal to or greater than 50% of the total score is obtained.

The completion of laboratory practices is a mandatory, non-recoverable activity, as practical laboratory activity is essential to ensure the corresponding competencies and learning outcomes of the subject and the availability of the laboratory is limited. The practice schedule included in this guide is indicative and may be subject to changes depending on the semester calendar and laboratory availability. The final dates and times will be published at the beginning of the teaching period.

The laboratory activity constitutes a liberatory block within the academic course and it will be necessary to obtain at least a 3.5/10 in the overall grade of it in order to pass the subject. Any evaluation or submission made may require a complementary oral evaluation by the teacher to validate that it has been carried out by the student without the help of AI systems.

Obtaining a qualification equal or greater to 50% in the overall evaluation of the exams is required to pass the course in any evaluation modality.

Regular call (progressive evaluation):

The progressive evaluation will consist of:

- Classroom assessment (20% of the final score): Short tests during the theoretical classes, or exercises and short assignments associated with said classes.

- Laboratory (40% of the final score): Deliveries/exams associated with laboratory practices.
- Midterm exam (15% of the final score): Exam that covers the content of the first 3 units of the subject.
- Final exam (25% of the final score): Exam that covers the content of the last 2 units of the subject.

Regular call (global evaluation):

Students who do not wish to participate in the progressive assessment must indicate it in the term and form that will be informed at the beginning of the teaching period.

The global evaluation will consist of:

- Laboratory (40% of the final score): Deliveries/exams associated with laboratory practices.
- Final exam (60% of the final score): Exam that covers the content of all the subject.

Extra call:

The final score will be obtained as follows:

- Laboratory (40% of the final score): Deliveries and exams associated with laboratory practices.
- Final exam (60% of the final score): Exam that covers the content of all the subject.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Slides of the subject	Web resource	Available at UPM's Moodle repository
R.C. Gonzalez y R.E. Woods, Digital Image Processing, Prentice-Hall, 2008 (3rd. Edition).	Bibliography	
A. Murat Tekalp, Digital Video Processing, (2nd Edition) Prentice Hall, 2015	Bibliography	
I. Koprinska, S. Carrato, Temporal video segmentation: A survey, Signal processing: Image communication, vol. 16, no, 5, 2001, Elsevier	Bibliography	
T. Bouwmans, Traditional and recent approaches in background modeling for foreground detection: An overview, Computer Science Review, Vol.11 2014, Elsevier	Bibliography	
R.M. Haralick, L.G. Shaphiro, Computer and Robot Vision, Volumne I y II, Addison-Wesley 1992	Bibliography	
C. M. Bishop, Pattern Recognition and Machine Learning (Information Science and Statistics), 2006, Springer-Verlag New York, Inc., Secaucus, NJ, USA.	Bibliography	
D. A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach (2nd ed.), 2011, Prentice Hall Professional Technical Reference	Bibliography	

R. Szeliski, Computer Vision: Algorithms and Applications (1st ed.), 2010, Springer-Verlag New York, Inc., New York, NY, USA.	Bibliography	
Laboratory of signals (A-202-L)	Equipment	Workroom for the realization (in pairs) of laboratory sessions
Ian Goodfellow et al, Deep Learning, MIT Press, 2016	Bibliography	Available in http://www.deeplearningbook.org
Chollet, Francois. Deep learning with Python. Simon and Schuster, 2021	Bibliography	

9. Other information

9.1. Other information about the subject

Advertisements:

All the global information related to the subject will be published on its website on the Moodle platform: https://moodle.upm.es/titulaciones/oficiales/course/view.php?id=2307

Sustanable Development Goals (SDGs):

This subject is related to the following SDG.

- 4.4: "By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship"
- 4.7: "By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture?s contribution to sustainable development"
- 9.5: "Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and

development spending"

- 9.c: "Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020"
- 17.6: "Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms, including through improved coordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism"