Course guide
270226 - PIVA - Image Processing and Machine Vision

Last modified: 30/01/2024

Unit in charge: Barcelona School of Informatics
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: BACHELOR'S DEGREE IN DATA SCIENCE AND ENGINEERING (Syllabus 2017). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, English

LECTURER

Coordinating lecturer: JAVIER RUIZ HIDALGO

Others: Segon quadrimestre:
JAVIER RUIZ HIDALGO - 11, 12
PHILIPPE SALEMBIER CLAIRON - 11, 12

PRIOR SKILLS

The knowledge acquired in the subjects of the degree in previous courses.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.

Generical:
CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CG4. Identify opportunities for innovative data-driven applications in evolving technological environments.
CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.

Transversal:
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.

Basic:
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

TEACHING METHODOLOGY

The subject is based on classroom theory classes and laboratory. The theory classes follow the program defined in this teaching guide. Within the lectures, the dialogue between professors and students is promoted by proposing exercises and activities to be carried out jointly based on particular aspects of the topic being dealt with. The laboratory classes exemplify the contents developed in the theory classes.

LEARNING OBJECTIVES OF THE SUBJECT

1.Acquire basic knowledge of frequency representation and advanced image filters.
2.Understand the use of tools for geometric processing.
3.Understand how to use object segmentation and detection techniques.
4.Acquire the basic knowledge of motion estimation and tracking.

STUDY LOAD

Type	Hours	Percentage
Hours large group	45,0	30.00
Hours small group	15,0	10.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Filtering and Frequency Analysis

Description:
Frequency representation: FT, DFT
Advanced filters: linear, non-local, bilateral
Multiscale image analysis I: Downsampling / Upsampling, Interpolation, pyramid, wavelets & CNNs

Geometrical Processing

Description:
Mathematical morphology and lattice
Filters by reconstruction
Variational model and level sets

Region-based model

Description:
Transition-based segmentation: Edge detection, Active contour
Homogeneity-based segmentation: Classification, Region growing & Watershed

Object-based model

Description:
Object recognition: Local features, Bag of words Region proposals, Regression

Video Analysis

Description:
Motion estimation, Optical flow
Tracking

ACTIVITIES

Unit 1

Description:
Theory, exercise and laboratory classes corresponding to Unit 1

Specific objectives:
1

Related competencies :
CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

Full-or-part-time: 29h 42m
Theory classes: 9h
Laboratory classes: 3h
Self study: 17h 42m

Unit 2

Description:
Theory, exercise and laboratory classes corresponding to Unit 2

Specific objectives:
2

Related competencies :
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

Full-or-part-time: 29h 42m
Theory classes: 9h
Laboratory classes: 3h
Self study: 17h 42m

Unit 3

Description:
Theory, exercise and laboratory classes corresponding to Unit 3

Specific objectives:
3

Related competencies :
CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CG4. Identify opportunities for innovative data-driven applications in evolving technological environments.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

Full-or-part-time: 29h 42m
Theory classes: 9h
Laboratory classes: 3h
Self study: 17h 42m

Unit 4

Description:
Theory, exercise and laboratory classes corresponding to Unit 4

Specific objectives:
3

Related competencies :
CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CG4. Identify opportunities for innovative data-driven applications in evolving technological environments.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

Full-or-part-time: 29h 42m
Theory classes: 9h
Laboratory classes: 3h
Self study: 17h 42m

Unit 5

Description:
Theory, exercise and laboratory classes corresponding to Unit 5

Specific objectives:
4

Related competencies :
CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.
CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.
CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.
CT6. Autonomous Learning. Detect deficiencies in one's own knowledge and overcome them through critical reflection and the choice of the best action to extend this knowledge.
CT7. Third language. Know a third language, preferably English, with an adequate oral and written level and in line with the needs of graduates.
CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

Full-or-part-time: 29h 42m
Theory classes: 9h
Laboratory classes: 3h
Self study: 17h 42m

GRADING SYSTEM

Final mark is obtained from:

- Parcial exam: P (20%)
- Final exam: F (50%)
- Laboratory: L (30%)

Grade = max (0.5F+0.2P+0.3L ; 0.7F+0.3L)

With the re-evaluation (R) , the final mark is:

Grade = 0.7R+0.3L

BIBLIOGRAPHY

Basic:
- González, R.C.; Woods, R.E. Digital image processing. 4th ed., global ed. New York, NY: Pearson, 2018. ISBN 1292223049.
- Szeliski, R. Computer vision: algorithms and applications. London: Springer, 2011. ISBN 9781848829350.