Course guide
240IAU32 - 240IAU32 - Perception Systems

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.
Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Optional subject).
Academic year: 2023  ECTS Credits: 4.5  Languages: Spanish

LECTURER

Coordinating lecturer: Sanfeliu Cortes, Alberto
Others: Garrell Zulueta, Anais

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEEAUT4. Apply vision techniques by computer, shape recognition and merging of multi-sensorial data in automated production systems.
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Transversal:
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.
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CT5. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.
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Basic:
CB 6. (ENG) Tenir i comprendre coneixements que aportin una base o oportunitat de ser originals en el desenvolupament i/o aplicació d'idees, sovint en un context d'investigació.

CB 7. (ENG) Que els estudiants sàpiguin aplicar els coneixements adquirits i la seva capacitat de resolució de problemes en entorns nous o poc coneguts dintre de contextos més amplis (o multidisciplinars) relacionats amb la seva àrea d'estudi.

CB 8. (ENG) Que els estudiants siguin capaços de d'integrar coneixements i enfrentar-se a la complexitat de formular judicis a partir d’una informació que, essent incompleta o limitada, inclogui reflexions sobre les responsabilitats socials i ètiques vinculades a l'aplicació del seus coneixements i judicis.

TEACHING METHODOLOGY
- Magistral classes where the theoretical concepts will be explained and the exercises will be solved using the computer
- Practice classes in the computer room laboratory
- A short project of a specific topic will be done by the students

LEARNING OBJECTIVES OF THE SUBJECT

The goal of this subject is to learn which are the types of sensors and techniques that are used to obtain information of the environment in order that a robot system could detect, identify the objects (human faces, vehicles, traffic signals, etc.) and obstacles, to navigate and interact with the objects and persons. The students will learn how the video cameras, range systems (by stereo vision, laser or radar) work. They also will learn techniques of detection, identification, classification and tracking among others. They will do lab practices and will apply these techniques in a short Project to prove their acquired knowledge.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>Hours small group</td>
<td>13,5</td>
<td>12.00</td>
</tr>
<tr>
<td>Self study</td>
<td>72,0</td>
<td>64.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>27,0</td>
<td>24.00</td>
</tr>
</tbody>
</table>

Total learning time: 112.5 h
## CONTENTS

### DATA ACQUISITION

**Description:**
Topics  
1.1 Type of sensors  
1.2 Acquisition of range data  
1.3 Basic concepts and image formation

**Related activities:**
Practices in the perception system lab

**Full-or-part-time:** 4h  
Theory classes: 4h

### DIGITAL IMAGE PROCESSING

**Description:**
Topics  
2.1 Image enhancement and smoothing  
2.2 Mathematical morphology

**Related activities:**
Practices in the perception system lab

**Full-or-part-time:** 4h  
Theory classes: 4h

### SEGMENTATION AND FEATURE EXTRACTION

**Description:**
Topics  
3.1 Contour detection  
3.2 Region detection  
3.3 Connectivity analysis and labeling  
3.4 Basic edge and region feature extraction

**Related activities:**
Practices in the perception system lab

**Full-or-part-time:** 4h  
Theory classes: 4h

### FEATURE DETECTION AND DESCRIPTORS

**Description:**
Topics  
4.1 Point feature detection and descriptors  
4.2 Line feature detection and descriptors

**Related activities:**
Practices in the perception system lab

**Full-or-part-time:** 6h  
Theory classes: 6h
REPRESENTATION AND DESCRIPTION

Description:
Topics
5.1 Contour descriptors
5.2 Region and texture descriptors

Related activities:
Practices in the perception system lab

Full-or-part-time: 2h
Theory classes: 2h

RECOGNITION

Description:
Topics
6.1 Basic concepts
6.2 Classifiers
6.3 Learning techniques and classification (boosting)
6.4 Neural networks

Related activities:
Practices in the perception system lab

Full-or-part-time: 7h
Theory classes: 7h

DATA FUSION AND APPLICATIONS

Description:
Topics
7.1 Techniques of data fusion
7.2 Application to automation and robotics

Related activities:
Practices in the perception system lab
Short project of a real life application of perception systems

Full-or-part-time: 17h
Theory classes: 3h
Practical classes: 12h
Guided activities: 2h
GRADING SYSTEM

Through the course, the student will have to solve specific lab exercises of the different topics of the subject. The professor will evaluate the exercises. There will be also a short project that will be selected by the student, where the student has to show the acquired knowledge. This short project will be presented and evaluated in an oral presentation. For the solution of some of the exercises and the complete project, the students will use MatLab.

The evaluation system will consist on the following elements:

- Evaluation of the exercises in the lab: (30% of the course score)
- Evaluation of a final exam: (35% of the course score)
- Evaluation of the short project: (35% of the course score)

For this course 2020-2021, due to the impact of the Convid-19 at the teaching of the subject and his evaluation, the evaluation will modify of the following form: "\[\text{Note} \times \text{Weight} \]

The final note will compound from four partial notes: "\[\text{Note} \times \text{Weight} \]

- Evaluation of the laboratory exercises of practices in Matlab: 25% of the note
- Evaluation of the short-projects: 25% of the note
- Evaluation of the class exercises: 15% of the note
- Evaluation of the final exam: 35% of the note

EXAMINATION RULES.

The final exam will have two parts, one of theoretical concepts and the second one of exercises.

For this course 2020-2021, because of the impact that is having the Convid-19 at the teaching of the subject and his evaluation, the final examination will be of the following form: "\[\text{Note} \times \text{Weight} \]

- The final examination will consist of a combination of conceptual questions and exercises

BIBLIOGRAPHY

Basic:

Complementary:

RESOURCES

Audiovisual material:
- Nom recurs. Resource

Other resources:
MatLab program to do the practices