Perception Systems

Academic Year: (2024 / 2025) **Review date: 04-02-2025**

Department assigned to the subject: Systems Engineering and Automation Department

Coordinating teacher: ESCALERA HUESO, ARTURO DE LA

Type: Electives ECTS Credits : 6.0

Year : 4 Semester :

SKILLS AND LEARNING OUTCOMES

RA1.3: Coherent knowledge of their branch of industrial engineering including some at the forefront of the branch.
RA2.1: The ability to apply their knowledge and understanding to identify, formulate and solve engineering problems using established methods.
RA3.1: The ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements.
RA3.2: An understanding of design methodologies, and an ability to use them.
RA5.1: The ability to select and use appropriate equipment, tools and methods.
RA5.2: The ability to combine theory and practice to solve engineering problems.
RA5.3: An understanding of applicable techniques and methods, and of their limitations.
CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CG1: Ability to resolve problems with initiative, creativity decision-making and critical reasoning skills, and to communicate and transmit knowledge, skills and abilities in the Industrial Engineering area.
CG3: Capacity to design a system, component or process in the area of electronic and automatic engineering in compliance with required specifications.
CG8: Knowledge and capacity to apply quality principles and methods.
CE11: Capacity for designing control systems and industrial automation.

OBJECTIVES

By the end of this content area, students will be able to have:
1. coherent knowledge of their branch of engineering including some at the forefront of the branch in perception systems;
2. the ability to apply their knowledge and understanding of perception systems to identify, formulate and solve engineering problems using established methods;
3. the ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements;
4. an understanding of design methodologies, and an ability to use them.
5. the ability to select and use appropriate equipment, tools and methods;
6. the ability to combine theory and practice to solve problems of perception systems
7. an understanding of applicable techniques and methods in perception systems, and of their limitations;

DESCRIPTION OF CONTENTS: PROGRAMME

1.- Introduction to Computer Vision.
1.1. Definitions.
1.2. History
1.3. Modules

1.4. Human vision sense
1.5. Applications

2.- Digital images.
2.1. Spatial sampling, grey levels.
2.2. Pixels.
2.3. Arithmetical and logical Operations.
2.4. Colour.

3.- Image Pre-processing.
3.1. Contrast
3.2. Noise reduction
3.3. Image sharpening
3.4 Edge detection.

4.- Segmentation.
4.1. Thresholding and labelling.
4.2. Region growing.
4.3. Split & Merge.
4.4. Mean-Shift

5.- Morphological Transforms and object description.
5.1. Morphological Transforms for binary images
5.2. Morphological Transforms for grey level images
5.3. Region descriptors.
5.4. Shape descriptors.

6.- Object recognition.
6.1. Basic concepts.
6.2. Bayes classifier.
6.3. Clustering.

7. Neural Networks
7.1 Introduction
7.2 Neural networks
7. 3 Loss function, gradient descent and retro-propagation

8. Deep learning.
8.1 Introduction
8.2 Convolutional neural networks

9. Architectures
9.1. Classifiers
9.2 Object detectors
9.3 Semantic segmentation.

10. Additional Techniques.
10.1 Variations to gradient descent.
10.2 Initialization
10.3 Regularization.

LEARNING ACTIVITIES AND METHODOLOGY

The learning activities and methodology are:
- Lectures, classes for resolution of doubts in small groups, student presentations, tutorials and individual work of students; aimed at the acquisition of knowledge (3 ECTS).
- Laboratory practices and sections of problems in small groups, individual tutorials and individual work of students, aimed at the acquisition of practical skills related to the syllabus of the subject (3 ECTS).

ASSESSMENT SYSTEM

% end-of-term-examination:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

Continuous evaluation based on personal work (60%), and two test-type exams carried out during classes (40%).

In extraordinary call, the evaluation will be based on a written exam.

BASIC BIBLIOGRAPHY

- GONZALEZ, R Digital image processing, Addison-Wesley.

- Ian Goodfellow and Yoshua Bengio and Aaron Courville Deep Learning, MIT Press, 2016

ADDITIONAL BIBLIOGRAPHY

- Gary Bradski, Adrian Kaehler Learning OpenCV: Computer Vision with the OpenCV Library, O'Reilly Media, 2008

BASIC ELECTRONIC RESOURCES

- . CONCEPTOS Y METODOS EN VISIÓN POR COMPUTADOR: http://intranet.ceautomatica.es/sites/default/files/upload/8/files/ConceptosyMetodosenVxC.pdf

- Ian Goodfellow and Yoshua Bengio and Aaron Courville . Deep Learning: http://www.deeplearningbook.org