Advanced Perception Systems

Academic Year: (2019 / 2020) **Review date: 05-05-2020**

Department assigned to the subject: Systems Engineering and Automation Department

Coordinating teacher: AL-KAFF , ABDULLA HUSSEIN ABDULRAHMAN

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

OBJECTIVES

Basic skills
CB6 Own and understand the knowledge that can provide a base or opportunity to be original in the development and/or application of ideas, in the context of research
CB7 That students know how to apply the acquired knowledge and ability to problem-solving in new or unknown environments within broad (or multidisciplinary) contexts related to their field of study
CB8 That students be able to integrate knowledge and deal with the complexity of formulating judgments from information that is incomplete or limited include reflections on the social and ethical responsibilities related to the application of their knowledge and judgments
CB9 That students know how to communicate their conclusions, knowledge and latest reasons sustain them public specialized and non-specialised in a way clear and unambiguous
CB10 That the students possess the learning skills which allow them to continue studying in a way that will be largely self-directed or autonomous.

General competencies

Ng3 Capacity proactive approach and resolution of issues raised under new environments or little-known, within the context of IoT.
Ng4 Ability of teamwork, integrating multidisciplinary approaches.
Ng5 Capacity of public communication of concepts, developments and results, related activities in IOT, adapted to the profile of the audience.
Ng6 Capacity for the application of the acquired knowledge and solve problems in new environments or little known within contexts broader and multidisciplinary, with the ability to integrate knowledge.
CG7 Ability to communicate (orally and in writing) the conclusions - knowledge and latest reasons sustaining them - public specialized and non-specialised in a way clear and unambiguous.
CG8 Continued self-directed learning and autonomous capacity.

Specific skills
CE9 Programming skills and simulation of perception systems and control at various levels (high-intermediate-low): OpenCV, ROS, Gazebo, etc.
CE10. ability to integrate different systems of perception and control processes both from the point of view of hardware and software.

LEARNING OUTCOME
The aim of this course is that the students are able to dominate the advanced techniques of perception systems and deep learning algorithms with monocular images and stereo (point clouds), in order to implement real-world applications related with the purposes of the Internet of things (IoT). In addition, to the ability in integrating the different elements that make up a perception system for process control.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to computer vision
1.1. Definitions and Concepts
1.2. Optics, digital cameras, and 3D sensors.
1.3. Applications.
1.4. Color spaces and grayscale.

2. Digital images and point clouds
2.1. Image Filtering, Noise reduction, and thresholding
2.2. Geometric Transformations.

2.3. Homogeneous coordinates.
2.4. Linear perspective, the fundamental and essential matrices, homography, RANSAC and mosaic.
2.5. 3D geometry, calibration, pose, and stereo.
2.6. Point clouds and 3D reconstruction.

3. Features Extraction and segmentation
3.1. Edge detection.
3.2. Motion detection and tracking.
3.3. Region segmentation.
3.4. 2D Features (detection and matching).
3.5. 3D Features (detection and matching).
3.6. Clustering (K-means).

4. Neural Networks
4.1. Artificial Neural Networks
4.2. Application of artificial neural networks.
4.3. Perceptron and Back-Propagation.
4.4. Regulation and optimization techniques.
4.5. Convolutional networks (Deep Learning).

5. Neural Networks for object detection and classification
5.1. Images classification using classic neural networks (Back-Propagation).
5.2. Image classification using convolutional networks (Deep Learning).

6. Practices
6.1. Image Recognition (handwritten digits) using classic neural networks (Rapid Miner).
6.2. Image Recognition using Deep Learning (Tensorflow)

LEARNING ACTIVITIES AND METHODOLOGY

The course is divided into various activities as follows:
1. Theory: lectures, student presentations, individual tutorials and personal work of the student; oriented to the acquisition of theoretical knowledge
2. Practices: Sessions in computer rooms, individual tutorials and personal work of the student; oriented to the acquisition of practical skills.

ASSESSMENT SYSTEM

The evaluation of the course consists of two parts, continuous evaluation (60%) and the final exam (40%).
1. Continuous Evaluation based on the work (40%), participation in class and/or tests (20%).
2. Mandatory final exam (40%).

% end-of-term-examination:	40
% of continuous assessment (assigments, laboratory, practicals…):	60

BASIC BIBLIOGRAPHY

- Luca Massaron; Alberto Boschetti; Alexey Grigorev; Abhishek Thakur; RajalingappaaShanmugamani TensorFlow Deep Learning Projects , Packt Publishing, 2018

ADDITIONAL BIBLIOGRAPHY

- Adrian Kaehler and Gary Bradski Learning OpenCV 3: Computer Vision in C++ with the OpenCV Library, O'Reilly Media, 2017
- Jain, A., Fandango, A., and Kapoor, A. TensorFlow machine learning projects: Build 13 real-world projects with advanced numerical computations using the Python ecosystem., Packt Publishing, 2018
- Matthew Rever Computer Vision Projects with OpenCV and Python 3, Packtpub, 2018

BASIC ELECTRONIC RESOURCES

- . Tutorial para la instalación de Anaconda con Tensorflow : https://stackabuse.com/installing-tensorflow-on-windows/
- . Deep Learning. Introducción Práctica con Keras: https://torres.ai/deep-learning-inteligencia-artificial-keras/