Machine Vision

Academic Year: (2023 / 2024)   **Review date: 29-05-2023**

Department assigned to the subject: Systems Engineering and Automation Department

Coordinating teacher: ESCALERA HUESO, ARTURO DE LA

Type: Electives   ECTS Credits : 3.0

Year : 1 Semester : 2

OBJECTIVES

Artificial Vision, also known as Computer Vision, consists of the automatic analysis of images by computers to determine which objects are present in them. It is a technology widely used in industrial environments for quality control and robot guidance thanks to Machine Learning techniques. During the last ten years, Deep Learning has made its range of applications out of the industrial environment and there are currently numerous applications outside of controlled environments both industrial, for the Internet of Things or for mobile phones. It can be assured that it is Artificial Intelligence that has developed this technology.

During the course, the main algorithms that are currently being used both in the industrial field and outside it will be described, with special emphasis on deep learning and with a practical approach.

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 Fully-Connected Neural networks
7. 3 Loss function, gradient descent and retro-propagation

8 Convolutional Neural Networks
8.1 From Fully-Connected Layers to Convolutions
8.2 Convolutional Layers
8.3 Multiple Input and Multiple Output Channels
8.4 LeNe

9 Image classifiers
9.1   AlexNet
9.2   VGG
9.3   NiN
9.4   GoogLeNet
9.5   ResNet
9.5   DenseNet

10. Object detection
10.1   Image Augmentation
10.2   Fine-Tuning
10.3   Object Detection and Bounding Boxes
10.4   Multiscale Object Detection
10.5   R-CNNs
10.6   Yolo
10.7   Semantic Segmentation

LEARNING ACTIVITIES AND METHODOLOGY

Training activities

AF1: Theoretical presentations of synchronous teaching accompanied by electronic material, such as digital presentations
AF4: Laboratory practices
AF5: Tutorials
AF6: Group work
AF7: Individual student work
AF8: Midterm and final exams

Teaching methodology

MD1: Presentations in class of the teacher with support of computer and audiovisual media, in which the main concepts of the subject are developed and the bibliography is provided to complement the learning of the students.
MD2: Critical reading of texts recommended by the teacher of the subject:
Press articles, reports, manuals and / or academic articles, either for later discussion in class, or to expand and consolidate the knowledge of the subject.
MD3: Resolution of practical cases, problems, etc. raised by the teacher individually or in groups
MD5: Preparation of work and reports individually or in groups

ASSESSMENT SYSTEM

Continuous evaluation based on:
SE1: classes activity (30%)
SE2: personal work (40%)
SE3: two test-type exams carried out during classes (30%)

In the extraordinary call, the evaluation will be based on:
SE3: a written exam.

% end-of-term-examination: 0

% of continuous assessment (assigments, laboratory, practicals…):   100

BASIC BIBLIOGRAPHY

- Arturo de la Escalera Visión por computador: fundamentos y métodos, Prentice Hall, 2001

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

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