COURSE DETAILS

"IMAGE AND VIDEO PROCESSING FOR AUTONOMOUS DRIVING"

SSD ING-INF/03 *

DEGREE PROGRAMME: AUTONOMOUS VEHICLE ENGINEERING (MOVE)

ACADEMIC YEAR 2022-2023

GENERAL INFORMATION – TEACHER REFERENCES

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GENERAL INFORMATION ABOUT THE COURSE

INTEGRATED COURSE (IF APPLICABLE): NO
MODULE (IF APPLICABLE): -
CHANNEL (IF APPLICABLE): -
YEAR OF THE DEGREE PROGRAMME (I, II, III): II
SEMESTER (I, II): II
CFU: 6

REQUIRED PRELIMINARY COURSES (IF MENTIONED IN THE COURSE STRUCTURE "REGOLAMENTO")

None

PREREQUISITES (IF APPLICABLE)

None

LEARNING GOALS

The aim of the course is to provide students with basic notions and algorithms for processing digital images and videos, with special focus on autonomous driving vehicles. Beyond providing the mathematical and conceptual tools, the course aims to provide the knowledge needed to develop the main algorithms for image processing in Python.

EXPECTED LEARNING OUTCOMES (DUBLIN DESCRIPTORS)

Knowledge and understanding

The student needs to show ability to know and understand methodological tools for image analysis and processing. Such tools will allow the student to solve more complex problems such as working in the space domain and in the temporal domain.

Applying knowledge and understanding

The student needs to show ability to solve problems regarding the image analysis and processing and to choose the most suitable technique for solving a practical problem.

COURSE CONTENT/SYLLABUS

[2 CFU] Basics of Image/video processing. Enhancement in the spatial domain. Basic intensity transformations: linear and non-linear pixelwise operations. Equalization of the histogram. Bit-plane slicing. Arithmetic operations. Geometric operations. Basics of spatial filtering. Smoothing and sharpening filters. Median filter. RGB representation.

[0,5 CFU] Segmentation. Edge based techniques. Point detection and line detection. Roberts, Prewitt and Sobel filters. Gradient thresholding. Zero-crossing of the Laplacian. Canny edge detector. Class-based techniques. K-means algorithm.

[0,5 CFU] Texture analysis and image classification. Local and global descriptors. Local Binary Pattern and its variants.

[2 CFU] Deep learning for image processing. Basics of Convolutional Neural Networks (CNNs), Backpropagation, Loss function, Learning rate. Image classification by fine-tuning, CNNs pretrained on ImageNet. Augmentation strategies. Main CNNs models: LeNet, AlexNet, VGG, InceptionNet, ResNet, DenseNet, XceptionNet, EfficientNet. Detection and localization of objects by semantic segmentation. Encoder-Decoder architectures. U-Net. Attention mechanisms. Interpretability. Generative models, Generative Adversarial networks (GANs). Security issues in deep learning, adversarial examples.

[1 CFU] Applications. Examples of advanced applications for autonomous driving. Approaches based on deep learning for object recognition (pedestrian, car, traffic sign), semantic segmentation and objects tracking in videos of streets.

READINGS/BIBLIOGRAPHY

Recommended books

- R.C.Gonzalez, R.E.Woods: "Digital image processing", 3nd edition, Prentice Hall, 2008.
- R. Szeliski, "Computer Vision: Algorithms And Applications", Springer, 2nd edition, 2022.
- M. Nielsen: "Neural Networks and Deep learning", available on-line, Dec. 2019.

TEACHING METHODS

Teacher will use: a) lectures for approx. 60% of total hours; b) laboratories for approx. 40% with guided exercises for the development of software applications in Python to better understand the studied techniques. The topics of the lectures and exercises are explained with the help of electronic blackboards and/or detailed transparencies, made available to the student in the teaching material via the official website. Recording of the lectures is also provided.

EXAMINATION/EVALUATION CRITERIA

a) Exam type:

Exam type	
written and oral	X
only written	
only oral	
project discussion	
Other	

b) Evaluation pattern:

The exam consists of a written and an oral test. The written test consists in the development of a practical project in Python on advanced image processing applications. The oral exam consists of two questions on problems/algorithms explained during the course.