Course guide
300079 - PAYLOAD - Payload

Last modified: 27/11/2020

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 701 - DAC - Department of Computer Architecture.

Degree: MASTER'S DEGREE IN APPLICATIONS AND TECHNOLOGIES FOR UNMANNED AIRCRAFT SYSTEMS (DRONES) (Syllabus 2017). (Compulsory subject).

Academic year: 2020 **ECTS Credits:** 4.5 **Languages:** English

LECTURER

Coordinating lecturer: Defined in the infoweb of the course

Others: Defined in the infoweb of the course

PRIOR SKILLS

Basic programming knowledge.

REQUIREMENTS

None.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE2 DRONS. (ENG) CE2 DRONS Seleccionar el tipo de instrumentación que debe constituir la carga útil de la misión, de acuerdo con los requisitos de la misma e integrar dicha instrumentación en la plataforma dron, desarrollando el hardware y software necesario para ello.

Transversal:
CT4. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
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.

Basic:
CB6 DRONS. (ENG) CB6 DRONS Poseer y comprender conocimientos que aporten una base u oportunidad de ser originales en el desarrollo y/o aplicación de ideas, a menudo en un contexto de investigación
CB9 DRONS. (ENG) CB9 DRONS Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades.
CB10 DRONS. (ENG) CB10 DRONS Que los estudiantes posean las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo.

TEACHING METHODOLOGY

The teaching methodology combines the following components:
- Class lectures that encourage students' participation through short questions and discussions.
- Problem solving related to the class lectures
- Practical activities for knowledge consolidation
- Autonomous work in a research project on advanced topics

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student should be able to:
1. Identify the appropriate payload for a specific mission
2. Understand the technical specifications of a sensor
3. Understand the parameters that define the pinhole camera model
4. Describe the main characteristics of existing positioning systems and choose which one is best suited for a specific mission
5. Design the data processing chain necessary to generate the desired product
6. Write and execute small programs for computer vision and machine learning

STUDY LOAD

Type	Hours	Percentage
Self study	85,5	76.00
Hours small group	27,0	24.00

Total learning time: 112.5 h

CONTENTS

Payload: types and applications

Description:
• Definition of payload. The payload market.
• Civil applications. Trends and challenges.
• Mission sensors. Active and passive sensors. The electromagnetic spectrum. Visible-band, near-infrared, multispectral, and hyperspectral cameras. Thermal imagers. LiDAR. Radar.

Related activities:
• Getting started with python and OpenCV
• Understanding color spaces and color space conversion

Full-or-part-time: 9h
Laboratory classes: 3h
Self study : 6h

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Imaging geometry

Description:
• Pinhole camera model. Extrinsic parameters. Intrinsic parameters.
• Lens distortion. Radial distortion. Tangential distortion.
• Camera calibration.

Related activities:
• Camera calibration using OpenCV. (8%)

Full-or-part-time: 17h
Laboratory classes: 4h
Self study : 13h

Positioning systems and sensor orientation

Description:
• Acquisition. Forward and side overlap, ground sampling distance (GSD), ground control point (GCP), and swath.
• Normalization and calibration. Direct, indirect, and integrated sensor orientation. Geometric calibration: pre-calibration and self-calibration. Radiometric calibration. Collinearity equations. LiDAR georeferencing.
• Georeferenced information. Orthophoto, DSM, DTM, and DEM. UAV photogrammetry. Point cloud generation. Camera vs LiDAR.
• Quality control. Quality check with external references.
• Indoor positioning technologies. Positioning using the infrastructure. Positioning methods. Optical tracking. Visual odometry / SLAM.

Related activities:
• Generation of digital elevation models using RPAS imagery and LiDAR. (8%)

Full-or-part-time: 36h
Laboratory classes: 9h
Self study : 27h

Image processing

Description:
• Image correction. Geometric and radiometric correction
• Mosaicking. Low-level feature-based registration. Homography. Blending methods.
• Image enhancement. Point transforms. Neighborhood operations: linear and non-linear filtering. Morphology.
• 3D reconstruction. Active and passive methods. Structure-from-Motion. Stereo Vision.

Related activities:
• Color-based object detection using OpenCV. (8%)
• Image stitching using OpenCV. (8%)
• Using the Raspberry Pi camera moduleV2 to capture and process images and video in real-time.

Full-or-part-time: 25h
Laboratory classes: 7h
Self study : 18h

Data analysis and big data

Description:
• Definition of data mining and big data. Supervised and unsupervised methods.
• Classification. Supervised algorithms. Model evaluation. Unsupervised methods: clustering.
• Image classification. Pixel-based vs. object-based classification.
• Object detection. Image recognition. Cascade classifiers. Deep learning. Convolutional neural networks.

Related activities:
• Face detection using OpenCV. (8%)
• Using the Raspberry Pi camera moduleV2 to capture and process images and video in real-time.

Full-or-part-time: 13h
Laboratory classes: 4h
Self study : 9h

Research project

Description:
Application and extension of the knowledge acquired on an assigned topic from a list of proposals made by teachers. Each proposal clearly defines the objective of the project and the expected results. The results of the research project will be documented in the form of a research paper.

Related activities:
• Preliminary version of the research paper.
• Evaluation of the preliminary version of at least two classmates.
• Final version of the research paper. (20%)

Full-or-part-time: 12h 30m
Self study : 12h 30m

GRADING SYSTEM

Assessment
- Final exam (40%)
- Activities (40%)
- Research project (20%)
Attendance is mandatory (min 80%)

BIBLIOGRAPHY

Complementary:
- "Chapter 8: Payload types". Austin, Reg. Unmanned aircraft systems : UAVS design, development and deployment. Chichester: Wiley, cop. 2010. pp. 127-141.
- "Section IV: Sensors and Sensing Strategies". Valavanis, Kimon P; Vachtsevanos, George J. Handbook of Unmanned Aerial Vehicles. Dordrecht: Springer Netherlands, 2015. pages 381-490.
- Szeliski, Richard. Computer vision : algorithms and applications [on line]. London [etc.]: Springer, cop. 2011 [Consultation: 06/11/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=973471. ISBN 9781848829343.