UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Course guide
205248 - AUC - Applied UAV Control

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control.

Degree: BACHELOR'S DEGREE IN ELECTRICAL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2023 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Masip Alvarez, Albert

Others: Cayero Becerra, Julián Francisco

PRIOR SKILLS

This course requires the student to have basic skills in:
- Modelling of dynamic systems (transfer functions models, transient response, etc.)
- Automatic control (Stability, PID controller tuning, etc.)
- Computer programming

TEACHING METHODOLOGY

Every session in this course is structured in two interconnected parts:
- Theory: teachers will introduce the theoretical basis, methodology and expected results. This part will be illustrated with appropriate examples to ease the learning process.
- Laboratory work: teachers will guide students in applying theoretical concepts to solve problems, always using critical reasoning in the laboratory. This work will be done throughout a small-scale drone using ROS operating system for the interaction between the aircraft and the remote control computer.
Students, consequently, will work on the materials provided by lecturers in order to assimilate and settle the contents. Lecturers will provide both syllabus and monitoring of activities throughout the virtual campus.

LEARNING OBJECTIVES OF THE SUBJECT

This course is about control strategies for indoor flight of Unmanned Aerial Vehicle (UAV) from an applied point of view. The positioning of the drone object of study will be done by means of computer vision, far from the Global Positioning Systems (GPS) used outdoor. A distributed architecture with a remote computer for the image processing and the attitude control of the drone will be used. The connection between all the elements involved in the process will be done by means of the Robot Operating System (ROS).
At the end of this course students will have an insight into the challenges associated with UAV control. They will have the ability for the use of ROS operating system to interconnect the elements involved on the (remote) control of a mobile robot, focusing on the autonomous drone example of application. Basic image processing procedures and computer vision position techniques will be settled throughout the course. Additionally, the identification and attitude control for the small-scale drone will be held. Consequently, state machine will be treated in order to pack up together the elements in this laboratory application.

STUDY LOAD

Type	Hours	Percentage
Self study	45,0	60.00
Hours large group	30,0	40.00

Total learning time: 75 h

CONTENTS

Module 1: Basics for Drone manoeuvring

Description:
Drone flight principles
Indoor drone architecture (software and hardware)
ROS fundamentals
Drone simulation model in the ROS environment

Related activities:
Theory lectures
Laboratory work in groups
Individual exam

Full-or-part-time: 25h
Theory classes: 10h
Self study : 15h

Module 2: Identification and controller design

Description:
Models for control: transfer functions
Identification of transfer functions from experimental data
Controller design based on analytic methods using transfer functions
Cascade control structure

Related activities:
Theory lectures
Laboratory work in groups
Individual exam

Full-or-part-time: 25h
Theory classes: 10h
Self study : 15h

Module 3: Mission control

Description:
Image processing
Path tracking algorithm
State machines

Related activities:
Theory lectures
Laboratory work in groups
Individual exam

Full-or-part-time: 25h
Theory classes: 10h
Self study : 15h

GRADING SYSTEM

Individual exam: 40%
Lab deliverables: 60% (equally distributed percentages, all under 50% of the global course grade)
The students who do not pass the subject can take an additional written exam that will take place the date stated in the calendar of final exams. The grade obtained in this exam will replace the one of the individual exam (40%) in case it is higher; the maximum numerical mark for the course in this retake situation will be 5.0.

EXAMINATION RULES.

The individual exam will be open book. Problems will be solved by means of the laboratory computer, that is the reason to have different turns for this exam.
The assessment will cover both theoretical and laboratory parts.

BIBLIOGRAPHY

Basic:
- Siegwart, Roland; Nourbakhsh, Illah Reza; Scaramuzza, Davide. Introduction to autonomous mobile robots [on line]. 2nd ed. Cambridge: MIT Press, cop. 2011 [Consultation: 06/05/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=3339191. ISBN 9780262015356.
- Ogata, Katsuhiko. Discrete-time control systems. Englewood Cliffs, NJ: Prentice-Hall, cop. 1987. ISBN 0132161028.
- Brogan, William L. Modern control theory. 3rd ed. Englewood Cliffs, NJ: Prentice-Hall, cop. 1991. ISBN 0135904153.
- Franklin, G. F.; Powell, J. D.; Workman, M. L. Digital control of dynamic systems. 3rd ed. Menlo Park [etc.]: Addison-Wesley, 1998. ISBN 0201820544.
- Aström, K. J.; Wittenmark, B. Computer controlled systems: theory and design [on line]. 3rd ed. Mineola, NY: Dover Publications, 2011 [Consultation: 05/04/2022]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=1893090. ISBN 9780486486130.