Course guide
205059 - 205059 - Mobile Robots

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

Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Optional subject).

Academic year: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Ely Repiso Polo

Others: Jordi Damunt Masip

TEACHING METHODOLOGY

The course is divided into:

Practical classes, and Self-study for doing exercises and activities.

In the practical classes (laboratory), teachers will introduce the necessary theoretical concepts and methods, as well as guide students in applying theoretical concepts to solve practical problems of mobile robots. We propose that students solve exercises in and outside the classroom, to promote contact and use the basic tools needed to solve problems for Autonomous vehicles. Students, independently, need to work on the materials provided by teachers and the outcomes of the sessions of exercises/problems, in order to fix and assimilate the concepts.

This course is based in the practical development of a "hands-on" project of a robotized system applied to a real case study. The project is divided in 4 highly guided min-projects that will be evaluated. The projects can be based on different mobile robots platforms and could consider some different programming languages (ROS using C/C++ and/or python). The students through all mini-projects will explore how to allow mobile robots to detect their environment, localize it selves, navigate (including obstacle avoidance), build environment maps, and all simultaneously (Active-SLAM). Furthermore, we give the bases for using the Robot Operating System (ROS) that it is commonly used for these types of robots. The modular system of ROS based in independent self-contained packages of code is the ideal platform to build flexible and incremental applications for mobile robots. All mini-projects have a base-code where students will need to fulfill only concrete and delimited pieces of code to apply the theoretical concepts and solve the practical problems for mobile robots. This study methodology allows students to easily introduce themselves in the world of the problems for mobile robots.

Projects will be developed by groups or individually, and teachers will assess each student's teamwork in order to help them in the project development. Nevertheless, students, organized in teamwork, need to work on the used equipment in order to develop solutions according to the project goals. Students could be asked to prepare written reports and demonstration of the project functionality.

The teachers provide the syllabus and monitoring of activities through ATENEA.

LEARNING OBJECTIVES OF THE SUBJECT

This subject allows students to acquire abilities about implementation of applications and use of the autonomous vehicles for the Industry 4.0, aeronautics and spatial. The knowledge acquired in this subject can be used: in NASA for space exploration using rovers or humanoid-robots; in aeronautics for localization and path planning of autonomous flying vehicles (by increasing one degree of freedom of the current studied algorithms); and Industry 4.0 for automation of logistics process (inside warehouses, shops, urban areas, so on). The subject also allows acquiring skills in the use of the Robot Operating System (ROS), which is very useful, considering that it is expected that by 2024 approximately the 55% of all the robots in the world will be using ROS packages.

Academically, this subject allows students to acquire concrete abilities in:
• Gain proficiency on implementing applications for mobile robots focused on: environment perception, localization, navigation, exploration, and map-building techniques.
• Gain proficiency in programming algorithms for mobile robots.
• Gain proficiency in using Robot Operating System ROS for mobile robots.
• Understand the criteria and requirements for implementing these algorithms in real-world autonomous mobile robots.
• Acquire a solid initial basis in mobile robots to work with real-life industrial, aeronautics and NASA Autonomous Vehicles.

STUDY LOAD

Type	Hours	Percentage
Hours large group	27,0	36.00
Self study	48,0	64.00

Total learning time: 75 h

CONTENTS

Module 1: Mobile Robots: real case study and implementation

Description:
This course is based in the practical development of a "hands-on" application of a mobile robot applied to a real case study. The four mini-projects must be proposed by lecturers and cover all the problems to be solved by real mobile-robots, such as detect their environment, localize it selves, navigate autonomously (including obstacle avoidance), build maps of their environment, and all simultaneously (Active-SLAM). Furthermore, the 4 mini-projects can include a different set of technologies all of them integrated inside different types of mobile robot platforms (Ubuntu, ROS, c/c++ or Python, turtlebot, turtlebot3-burger, so on).

The 4 mini-projects will be developed by groups or individually, and teachers will assess and supervise each students' teamwork in order to help them in the project development and to solve possible doubts.

Related activities:
Students, organized in teamwork or individually need to work also in autonomous way, on the used equipment in order to develop solutions according to each of the 4 mini-project goals.

Full-or-part-time: 75h
Theory classes: 27h
Self study : 48h

GRADING SYSTEM

4 Programming tasks, 25% of the final grade each.

Then, there is NO final exam because the content of the subject is better evaluated thought the 4 guided mini-projects to achieve competences in mobile robots' field.

BIBLIOGRAPHY

Basic:
- Siegwart, R.; Nourbakhsh, I.R.; Scaramuzza, D. Introduction to autonomous mobile robots [on line]. 2nd ed. Cambridge: MIT Press, cop. 2011 [Consultation: 03/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=3339191. ISBN 9780262015356.
- Ollero Baturone, A. Robótica: manipuladores y robots móviles. Barcelona: Marcombo Boixareu, [2005]. ISBN 8426713130.

Complementary:
- Siciliano, B.; Khatib, O. Springer handbook of robotics [on line]. Berlin: Springer, cop. 2008 [Consultation: 03/05/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/referencework/10.1007/978-3-540-30301-5. ISBN 9783540239574.