

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 : 1

OBJECTIVES

Autonomous vehicles are a field of study where Robotics and Artificial Intelligence come together and that has great interest for its wide range of applications. This course will present the main technologies that are needed to develop Autonomous Vehicles in two major scenarios: land and air. The former, autonomous vehicles are already being tested on the roads of several countries and the latter, UAVs are already a reality to which the legislation will give them greater and greater autonomy. In both cases, the main hardware elements they carry, the sensors they carry, and the needs for perception, planning and control will be seen.

DESCRIPTION OF CONTENTS: PROGRAMME

Part I Autonomous Vehicles

1. Introduction

- a. Importance and problems of transport
- b. What they are and advantages of autonomous vehicles
- c. History of autonomous vehicles

2. Software architecture

- a. Definition
- b. Elements

3. Sensors

- a. Necessity of perception
- b. Ultrasound
- c. Radar
- d. Cameras
- e. LiDAR
- f. GNSS/IMU

4. Perception of the environment

- a. Understanding of the road environment
- b. Calibration
- c. Computer Vision: classical approach.
- d. Computer Vision: Deep Learning

5. Maps and Location

- a. Types of maps
- b. Road map
- c. Location Map
- d. Occupancy map
- e. Localization algorithms

6. Planning

- a. Introduction
- b. Mission or route planner
- c. Behavior Planner
- d. Local or movement planner
- e. Collision check

7. Kinematic modeling and control of a vehicle

- a. Kinematic and dynamic modeling
- b. Bicycle model
- c. Lateral control
- d. Longitudinal control

8. Free resources

Part II Unmanned Aerial Vehicles

9. Introduction

- a. Importance and problems of air transport
- b. What they are and advantages of UAVs
- c. Regulation of UAVs and future shared airspace

10. Aircraft control architectures

- a. Definition and classification of aircraft
- b. On-board autopilots and control devices
- c. Basic control architectures
- d. Systems for the detection and avoidance of dynamic obstacles in flight
- e. Intelligent decision-making systems: safe navigation

11. 3D trajectory planning

- a. Autonomous aircraft navigation
- b. Planning trajectories in urban environments
- c. Vertipuertos and autonomous landing maneuvers in urban environments
- d. Trajectory planning using GNSS receivers with differential correction
- e. Automatic approach and automatic landing systems

12. Use cases

- a. Parcel delivery in cities using vertipuertos
- b. Inspection of cables and high voltage electrical towers
- c. Inspection of photovoltaic solar plant installations
- d. Extinguishing forest fires in hard-to-reach environments

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 (assignments, laboratory, practicals...):	100