69156 - Simultaneous Localization and Mapping

Syllabus Information

Academic year: 2024/25
Subject: 69156 - Simultaneous Localization and Mapping
Faculty / School: 110 - Escuela de Ingeniería y Arquitectura
Degree: 615 - Máster Universitario en Robótica, Gráficos y Visión por Computador / Robotics, Graphics and Computer Vision
ECTS: 6.0
Year: 1
Semester: Second semester
Subject type: Compulsory
Module:

1. General information

The objective of the course is to study the main techniques of Simultaneous Localization and Map Building (SLAM), understand their mathematical and algorithmic foundations, and be able to apply them in real examples.

2. Learning results

The student must be able to:

- Know the different types of SLAM systems.
- Understand the main perception algorithms for tracking and recognizing places and their fundamentals.
- Know, operate and calibrate standard sensors for SLAM.
- Design and develop SLAM systems for different applications.
- Evaluate the performance of a SLAM system under realistic operating conditions.
- Propose and evaluate the benefits of new algorithms that address unresolved aspects of the operation of a SLAM system.

3. Syllabus

1. Fundamentals
    1. Basic concepts, theory and estimation methods
2. Robustness
    1. Sensors, features
    2. Data association, tracking, loop detection and closure, relocalisation
    3. Complex and dynamic environments
3. Accuracy and Scaling
    1. Non-linearity, computational cost
4. Algorithms for large scale SLAM
    1. Vision based SLAM systems
    2. Visual SLAM as an optimization problem. Bundle Adjustment (BA)
    3. Tracking. Visual odometry (VO). Pose-only BA
    4. Mapping. Local BA. Lie groups and optimisation algorithms
    5. Relocation and loop closing
5. Advanced Visual SLAM, visual-inertial SLAM, Multi-mapping

4. Academic activities

The course consists of 6 ECTS credits that represent an estimated dedication by the student of 150 hours, divided into the following activities:

- Lectures, theory: 25 hours
- Lectures, problems: 5 hours
- Computer Lab Sessions: 20 hours
- Assignments: 34 hours
- Study: 60 hours
- Assessment tests: 6 hours

5. Assessment system

The evaluation of the course consists of three elements: T - a written/laboratory test (E01), L - directed practical laboratory work (E02) and P - oral presentations/discussions/participation(E03).

There is the option of continuous evaluation, in which the student can deliver implemented solutions for the directed works proposed during the semester on specific dates. This will exempt from the final written test. The grade for continuous evaluation is calculated as $1.0L + 0.1P$, provided that L meets the requirement of at least 5 points. Otherwise, the overall grade will be the minimum between 4 and the result of the above formula.

In the global evaluation, or in the second call if the subject is not passed in the first call, it will be mandatory to take both the written test and the delivery of the directed works. The grade for global evaluation is calculated as $0.4T + 0.6L$, provided that T and L meet the requirement of at least 5 points. Otherwise, the overall grade will be the minimum between 4 and the result of the above formula.

6. Sustainable Development Goals

3 - Good Health & Well-Being
8 - Decent Work and Economic Growth