Universidad de Alcalá

TEACHING GUIDE

Road safety technologies

Master in Telecommunication Engineering

Universidad de Alcalá

Academic Year 2021/2022

2nd Year - 1st and 2nd Semester

Approved by the School Board on July 6, 2021

TEACHING GUIDE

Course Name:	**Road safety technologies**
Code:	**201836**
Master in:	**Telecommunication Engineering**
Department and area:	**Electrónica** **Tecnología Electrónica**
Type:	**Optional (Specialized)**
ECTS Credits:	**6.0**
Year and semester:	**2nd Year, 1st and 2nd Semester**
Teachers:	Por definir
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	English

1. COURSE SUMMARY

Road safety technologies is an elective course of 6 ECTS. It is included in the first semester of the second year of the Master studies in Telecommunication Engineering. This subject belongs to the Intelligent Transportation Systems specialization, included in this Master. The main goal of this course is to study information and communication techniques (ICTs), used in road transportation, in order to improve safety. This course involves theoretical concepts and practical exercises in the Lab, programming multiple algorithms in C/C++ by using OpenCV. The main chapters are: general concepts in e-safety, sensorial systems for e-safety, 2D feature detection techniques in images, machine learning techniques, motion detection and object tracking methods, practical examples of e-safety systems. To study this subject, it is recommended to have some basics in C/C++ programing and computer vision.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following generic skills, which are defined in the Section 3 of the Annex to the Orden CIN/355/2009:

en_CGT1 - Skill of analysis and synthesis.

en_CGT3 - Skill to analyze and search for information from diverse sources

en_CGT5 - Skill to adapt to new situations.

en_CB6 - To have and understand knowledges that provide a basis or opportunity to be original in the development and/or application of ideas, often in a research context

en_CB7 - That students know how to apply the acquired knowledge and problem-solving abilities in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.

en_CB9 - That students be able to communicate their findings and the ultimate knowledge and reasons behind them to specialized and non-specialized audiences in a clear and unambiguous manner.

en_CB10 - That students have the learning skills that will enable them to continue studying in a way that will be largely self-directed or autonomous.

en_CT1 - Troubleshooting skill

en_CT3 - Skill to work in a team

en_CT6 - Ability to integrate knowledge from different scientific areas

Professional Skills

This course contributes to acquire the following professional skills, which are defined in the Section 5 of the Annex to the Orden CIN/355/2009:

Learning **Outcomes**

After succeeding in this subject the students will be able to:

RA1. Knowledge and understanding of ICT techniques in advanced driving assistance systems and road transport systems.

RA2. Ability to apply ICT techniques and sensory devices in the vehicle and infrastructure to solve specific road safety problems.

RA3. Ability to design a practical application of road safety through a standard programming language and libraries of processing functions.

3. CONTENTS

Contents Blocks	Total number of hours
T1. Introduction to e-safety. • E-safety concept. • Regulations on safety and sustainability. • Active and passive vehicle safety. • Accidentology and human factors. • Eco-driving. • Smart HMI.	4 hours
T2. Sensors for road safety • Sensors modelling. • Spatial information representation • Sensors for infrastructure and vehicles • Sensorial fusion • CAN bus	8 hours
T3. Features detection in images. • Interest points detection. • Shape and appearance descriptors. • Descriptors invariance. • Different descriptors: SIFT, SURF, FAST, ORB, AKAZE. • Descriptors comparison. • Recognition based on descriptors.	8 hours
T4. Machine Learning techniques. • Machine Learning basic concepts. • Classical classifiers: Neural Networks, Euclidean distance, Mahalanobis distance, KNN, SVM, etc. • Deep Learning foundations. • Convolutional Neural Networks (CNNs) classifiers.	8 hours

T5. Motion detection and object tracking techniques on images. • Introduction • Background subtraction • Tracking (KF, EKF, UKF, PF). • Optical flow • Visual Odometry	8 hours
T6. Some examples of E-safety systems • Roads e-safety systems. • Urban e-safety systems. • Driver behavior monitoring. • E-call system. • Eco-driving.	6 hours
Coursework. Road safety system design	12 hours
Evaluation (Presentation of the coursework + Test)	2 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	60 hours (theoretical classes + laboratory/seminary + assessment).
Number of hours of student work:	90
Total hours	150

4.2. Methodological strategies, teaching materials and resources

The teaching strategy of the course is divided into 3 sections: classroom learning, learning in small groups and finally the working sessions in the laboratory.

Sessions of large group in the classroom:

Working sessions in the classroom, in large groups, will consist of lectures where the main concepts of the theory of circuits will be presented. The aim is to introduce students to the theoretical foundations of circuit analysis in a guided and reflective way. The understanding of these concepts will culminate with the use of them in both the laboratory and the problem solving sessions in small groups.

Teaching materials will be essential to create reflective learning environments, where students and teachers can undertake a critical analysis that allows the student to autonomously relate concepts.

The order of presentation of the contents will evolve from the simple to the complex, in order to avoid a high degree of abstraction that might cause a student lack of interest in the course. In any case, it is very convenient, during the working sessions in the classroom, to establish linkages with other subjects in the curriculum, and to provide possible experience on the contents, which will help to attract students' attention and will encourage their interest in the subject.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary Call

Continous Assessment:

The main assessment tools will be:

1. **Evaluation Tests (ET)**, consisting of a set of questions covering the basic theoretical knowledge of the subject.
2. **Laboratory Practices (LP)**. These practices cover the knowledge acquired in the theoretical part of the course and have guided content, with small sections that students must complete on their own. Students will use the following tools: a) C/C++ framework under Linux OS. b) Computer vision OpenCV library.
3. **A coursework (CW)** consisting of an e-safety system design with application in the intelligent transportation systems, using all the knowledge acquired in the subject by the student. A work report will be presented and an oral presentation will be made.

Students must attend the laboratory sessions and deliver the corresponding reports to all laboratory practices. The students, as a group, will deliver the reports of the laboratory practices following the established schedule. These practices will be evaluated by the professor responsible for the laboratory group, to assess if the objectives indicated in the script of the same have been met.

Assessment through final exam:

In the case of evaluation by means of a final exam, the evaluation elements to be used will be the following:

Extraordinary Call

The procedure will be the same as that described for the assessment by means of an evaluation test (ET) and a corsework (CW) in the ordinary call.

5.2. EVALUATION

EVALUATION CRITERIA

The assessment criteria measure the level in which the competences have been acquired by the student. For that purpose, the following are defined::

CE1. Students should be able to correctly solve mathematical problems related to perception systems.

CE2. Students have to integrate conceptual knowledge explained in the different theoretical classes to solve in a creative and original way the problems that could arise.

CE3. Students have to implement in practice perception algorithms that provide solutions to the proposed problems. It will be carried out by integrating the acquired knowledge about the operation of perception systems, using library resources and software tools at their availability.

CE4. Students should be able to make clear and accurate reports on the work done in the laboratory.

CE5. Students have to present and explain their proposals for resolving problems in a clear and reasonable way.

GRADING TOOLS

The work of the student is graded in terms of the assessment criteria above, through the following tools:

1. Ordinary call
   a. Continuous assessment, with three assessment items (ET,LP,CW).
   b. Final assessment (ET,CW)
2. Extraordinary call. Final assessment (ET,CW)

GRADING CRITERIA

In the ordinary call-continuous assessment the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB6-10, CGT1, CGT3, CGT5, CT1, CT6	RA1-RA2	AC1, AC2	ET	30%
CB6-10, CGT1, CGT3, CGT5, CT1, CT3, CT6	RA1-RA3	AC1-AC3	LP	30%
CB6-10, CGT1, CGT3, CGT5, CT1, CT3, CT6	RA1-RA3	AC1-AC3	CW	40%

In the ordinary call-final evaluation, the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
CB6-10, CGT1, CGT3, CGT5, CT1, CT6	RA1-RA2-RA3	AC1, AC2	ET	50%
CB6-10, CGT1, CGT3, CGT5, CT1, CT3, CT6	RA1-RA2-RA3	AC1-AC5	CW	50%

Extraordinary call

In the case of the extraordinary call, the same percentages that have been established in the case of the evaluation by means of a final exam will be maintained, giving the option of making the CW,ET or maintaining the mark obtained in the continuous evaluation (ET, LP. CW) or in the final evaluation (ET, CW), according to the student's decision. In any case, the CW, ET will be made by those students who have not done it in the final exam option in the ordinary call.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Documentation specifically prepared by the subject’s teaching staff, which will be supplied directly to the students, or will be published on the subject’s webpage.
- European Commission, Mobility and Transport. Esafety
- Jimenez, F. (Ed.). (2017). Intelligent Vehicles: Enabling Technologies and Future Developments. Butterworth-Heinemann.
- Robert Laganière. OpenCV 2 Computer Vision Application Programming Cookbook. PACKT Publising. 2011

6.2. Additional Bibliography

Books:

- Ljubo Vlacic, Michel Parent, Fumio Harashima. Intelligent Vehicle Technologies. Theory and Applications. Butterworh-Heinemann. 2001
- David A. Forsyth and Jean Ponce. Computer vision: A Modern Approach. Prentice Hall. Pearson Education International.
- Rafael C. Gonzalez and Richard E. Woods. Digital Image Processing. Prentice Hall.
- William K. Pratt. Digital Image Processing. Wiley Interscience.
- Kenneth R. Castleman. Digital Image Processing. Prentice Hall.
- Dona H. Ballard and Christopher M. Brown. Computer Vision. Prentice Hall
- Robert M. Haralick and Shapiro. Computer and Robot Vision (vol I y II).
- Shervin Emami, Khvedchenia Ievgen, Naureen Mahmood. Mastering OpenCV with Practical Computer Vision Projects. PACKT Publising. 2012

Web sites:

- The computer vision home page (http://www.cs.cmu.edu/~cil/vision.html)
- IEEE Xplore (http://ieeexplore.ieee.org)

Disclosure Note

The University of Alcalá guarantees to its students that, if due to health requirements the competent authorities do not allow the total or partial attendance of the teaching activities, the teaching plans will achieve their objectives through a teaching-learning and evaluation methodology in online format, which will return to the face-to-face mode as soon as these impediments cease.