Universidad de Alcalá

TEACHING GUIDE

Computer vision

Degree in
Industrial Electronics and Automatics Engineering

Universidad de Alcalá

Academic Year 2021/2022

4th Year - 2nd Semester

Approved by the School Board on July 6, 2021

TEACHING GUIDE

Course Name:	**Computer vision**
Code:	**600034**
Degree in:	**Industrial Electronics and Automatics Engineering**
Department and area:	**Automática** **Systems Engineering and Automation**
Type:	**Optional (Generic)**
ECTS Credits:	**6.0**
Year and semester:	**4th Year, 2nd Semester**
Teachers:	Ignacio Parra Alonso / Noelia Hernández Parra
Tutoring schedule:	Consultar al comienzo de la asignatura
Language:	English

1. COURSE SUMMARY

Computer Vision is an optional 6 ECTS subject (600034) included in the eight semester - fourth year of the Degree in Industrial Electronics and Automation Engineering. The main goal is to study and understand the main ideas and techniques related with image adquisition and image processing problems in the context of industrial applications.

The basic concepts of this course are the following: integration of images adquisition systems, photometric basis, camera calibration, image processing and segmentation techniques, fundamentals on patter recognition, and application examples in the industry. Other important topics will be to develop fundamental skills in programming computer vision applications.

Prerequisites & Recommendations

For an optimal performance on the course, previous knowledge about fundamentals of physics, applied maths and programming are required.

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/351/2009:

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/351/2009:

Learning Outcomes

The expected learning outcomes, expressed in the form of knowledge and skills and abilities that students should have achieved are as follows:

RA1. to identify and recognize the main and fundamental elements of industrial computer vision systems.

RA2. to identify, recognize and make use of the main and fundamental photometric and geometric principles involved in the image formation process.

RA3. to identify, recognize and implement basic and advanced computer vision and image processing algorithms.

RA4. to implement image recording software to record images from digital cameras, and camera calibration procedures.

RA5. to implement computer vision solutions.

3. CONTENTS

Contents Blocks	Total number of hours
Introduction; computer vision and image processing industrial applications	2 hours
Digital imaging acquisition systems integration; fundamentals of photometric; human vision; color formation & representation; artificial illumination; fundamental of optics; camera settings; communication interfaces; camera sensors and lenses;	22 hours
Camera calibration and modeling; intrinsic parameters; lenses distortion; pin-hole projection modeling;	8 hours
Basic image processing techniques (filtering, morphological operators; thresholding techniques; histogram analysis; edge detection; corners detection; lines detection and modeling; contours representation; geometrical representation of objects;	12 hours
Computer vision segmentation algorithms (motion history images; background subtraction; frame differencing; split and merge; region growing; optical flow) and introduction to machine learning and pattern recognition.	12 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	58 hours (56 hours on-site +2 exams hours)
Number of hours of student work:	92
Total hours	150

4.2. Methodological strategies, teaching materials and resources

Theoretical sessions	Methodology: master classes where the teacher presents and explains the theoretical aspects, complemented by practical examples. Student participation will be encouraged from the theoretical concept developments, to the resolution of the proposed practical examples and the discussion of real cases. Resources: blackboard, audiovisual media, Internet, bibliography.
Practical problem solving sessions	Methodology: master classes of troubleshooting workshops combined with group and individual workshops. Small group discussion to reach the problem approaching and to look for the relation with theory. Written and oral presentation of alternative resolutions. Sharing of proposed resolutions. Resources: blackboard, audiovisual, bibliography.
Practical laboratory sessions	Methodology: groups of 2 people maximum to work. Initial explanation and general discussion of the practice, collaborative work in each group with the teacher's guidance, management and good use of the material, obtaining results, interpretation and presentation. Resources: blackboard, audiovisual, instrumentation and laboratory equipment.
Tutorial and seminars	Individual and/or group tutorials on the theoretical and practical subject contents.
Other type of activities	Troubleshooting and practices applying theoretic concepts, literature search, group work.

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:

Based on the accomplishment and passing the laboratory practices, the accomplishment of a mid-term tests, a lab tests and a final-term test.

Assessment through final exam:

It will consist of the realization and passing of a final test. In order to stick for the final evaluation process, the student must notify it in writing to the dean of the center within the first two weeks of its incorporation, indicating the reasons that prevent the continuous assessment system. The dean of the center will communicate the resolution in a maximum of 15 days. In the case of lack of answer, this request is considered as estimated.

Extraordinary Call

Students who have not passed the ordinary call will face a final test. The grade obtained in the laboratory practices and tests will be taken into account.

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. The student shows ability and initiative to solve mathematical problems related with photometric and geometry of imaging formation.

CE2. The student shows ability to program code related with imaging recording from digital cameras, as well as implementing camera calibration.

CE3. The student shows ability to understand and manage data sheets concerning image sensors and optical devices, being capable of performing computation of all the involved parameters when integrating a computer vision system.

CE4. The student is capable of understanding and programming basic image processing algorithms.

CE5. The student is capable of programming solutions to deal with basic computer vision problems.

GRADING TOOLS

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

1. Mid Term Exam (PEI): practical and theory questions referred to the contents of both theory and laboratory classes.
2. Development of Laboratory Practices (SL): continuous assessment of practical work at the laboratory. The student behavior, interest, and motivation will be also taken into account.
3. Global Laboratory Evaluation (PL): practical computer vision problem to be solved at the laboratory.
4. Final Exam (PEF): practical and theory questions referred to the contents of both theory and laboratory classes.

GRADING CRITERIA

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

Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
RA1, RA2	CE1	PEI	30%
RA3-RA5	CE2-CE5	SL	20%
RA5	CE5	PL	20%
RA1-RA4	CE1-CE4	PEF	30%

Students who do not participate in the continuous assessment will be marked as not presented. A student will be considered as absent if he or she does not attend the mid term exam or does not attend the laboratory classes during the first four weeks.

The student will pass the continuous assessment if he or she obtains a global weight mark equal to or higher than 5 over 10.

The students that are not satisfied with the mark obtained in the mid term exam (PEI), will have the opportunity to change this mark by carrying out an additional evaluation test that will take place after the final exam (PEF). This additional test will have the same weight as the mid term exam (PEI).

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

Learning Outcomes	Evaluation criteria	Grading Tool	Contribution to the final mark
RA1-RA4	CE1-CE4	PEF	100%

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 PL or maintaining the mark obtained in the EL (continuous evaluation) or in the PEF (final evaluation). The final calification of the final exam of the extraordinary call will be given by the following equation: max(PEF, 0.6PEF+0.2SL+0.2PL1).

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Lecture Notes elaborated by the teaching staff and provided via Blackboard.
- David A. Forsyth and Jean Ponce. Computer vision: A Modern Approach. Prentice Hall. Pearson Education International.
- Gary Bradski and Adrian Kaehler. Learning OpenCV. Computer Vision with the OpenCV Library. O'Reilly.

6.2. Additional Bibliography

- E. Trucco and A. Verri. Introductory Techniques for 3-D Computer Vision. Prentice Hall.

- Richard Hartley and Andrew Zisserman. Multiple View Geometry in Computer Vision. Cambridge University Press.
- Oliver Faugeras. Three- Dimensional Computer Vision. A geometric View point. The MIT press.

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.