Universidad Intercontinental de la Empresa

TEACHING GUIDE

1. BASIC INFORMATION

Subject	**Computer Vision**
Degrees	**Intelligent Systems Engineering (GISI)**
Faculties	**Faculty of Engineering and Business Technology**
ECTS	**6**
Character	**Mandatory**
Language	**English**
Mode	**In-person/Synchronous In-person**
Semester	**Fifth**
Subject Coordinator	**Eladio Dapena Gonzalez**

2. PRESENTATION

The Computer Vision course provides a comprehensive introduction to the fundamentals and applications of computer vision. Students will learn theoretical foundations and practical implementations of image processing, feature detection, camera models, deep learning for vision tasks, advanced topics in 3D vision and generative AI. Using Python and OpenCV, students will develop skills in implementing computer vision algorithms and understanding their real-world applications.

3. COMPETENCIES AND LEARNING OUTCOMES

Type	Code	Competencies
Basic	**CB02**	Students should know how to apply their knowledge to their work or vocation in a professional manner and possess the competencies typically demonstrated through the development and defense of arguments and problem solving within their field of study in computer vision.
General	**CG02**	Effectively determine objectives, priorities, methods, and controls to perform tasks by organizing activities within available timeframes and means in the engineering field of computer vision.
	CG03	Demonstrate ability to analyze, synthesize, and evaluate data and information in the field of computer vision engineering.
	CG04	Work in an international and intercultural context in the field of engineering.
	CG05	Use cutting-edge technologies to contribute to improving business or organizational competitiveness in the field of engineering.
	CT03	Demonstrate oral and written communication ability in a foreign language.
Transversal	**CT05**	Solve problems and make decisions applying knowledge, methods, and tools in their academic and professional field of computer vision.
	CT07	Demonstrate skills and attitudes for autonomous work and teamwork in computer vision projects.
	CT08	Use knowledge, skills, abilities, and attitudes to communicate in digital environments related to computer vision.
	CT09	Demonstrate ability to write and present reports with academic and professional rigor.

Type	Code	Competencies
Specific	**CE19**	The graduate will be able to develop projects and applications using computer vision in the field of engineering and business.

Code	Description
LO01	Understand fundamental concepts of computer vision and image processing
LO02	Implement basic image processing operations using Python/OpenCV
LO03	Apply feature detection and matching techniques
LO04	Understand camera models and calibration
LO05	Implement motion tracking and segmentation algorithms
LO06	Understand and implement basic deep learning models for vision tasks
LO07	Develop practical computer vision applications
LO08	Evaluate computer vision system performance

4. CONTENT

Unit I Digital Image Fundamentals (Week 1-4)

1.1 Introduction to Computer Vision
1.2 Image Formation and Representation
1.3 Basic Image Operations
1.4 Image Processing Fundamentals
1.5 Color Spaces and Filtering
1.6 Edge Detection Techniques
1.7 Corner Detection
1.8 Blob Detection
1.9 SIFT and SURF Features
1.10 Feature Matching

Unit II Geometry/Cameras and Motion/Segmentation (Week-5-8)

2.1 Image Transformations
2.2 Camera Models
2.3 Camera Calibration
2.4 Multiple View Geometry
2.5 Stereo Vision
2.6 Optical Flow
2.7 Motion Detection and Tracking

2.8 Image Segmentation Methods
2.9 Region Growing
2.10 Graph-based Segmentation

Unit III Deep Learning for Vision (Week 9-12)

3.1 Neural Networks Fundamentals
3.2 Convolutional Neural Networks
3.3 Object Detection
3.4 Semantic Segmentation
3.5 Advanced Topics

Unit IV: Generative AI for Images (Weeks 13-15)

4.1 Autoencoders and VAEs
4.2 Generative Adversarial Networks
4.3 Diffusion Models
4.4 Text-to-Image Models
4.5 Image-to-Image Translation

5. TEACHING AND LEARNING METHODOLOGIES

UIE develops an innovative academic model centered on the learner, combining different philosophical approaches to Teaching-Learning (T-L), a wide variety of learning activities—especially those in which students take an active role in knowledge construction—continuous guidance, and the intensive use of technology as a facilitating tool, creating a unique and innovative learning ecosystem.

The training is conducted in an in-person modality, including synchronous virtual learning, supported by a cutting-edge virtual campus that provides flexibility and personalization within a ubiquitous learning (U-Learning) model.

Additionally, in alignment with its founding and corporate principles of social responsibility, UIE not only encourages the participation of its entire university community in volunteer and social service activities but also incorporates the Service-Learning (ApS) approach as a formal component of its teaching-learning strategies.

Code	Activity	Type	Introductory	Mode
MD01	First Contact and Motivation	**I**	Introductory	PR
MD02	Presentation, Course Plan and Commitment	**I**		
MD03	Lecture	**T**	Expository and Participatory	PR
MD04	Guest Lectures by Experts	**T**		
MD07	Activity in the Virtual Campus UIE	**T/P**	Guided / Autonomous	PR / NP

Code	Activity	Type	Introductory	Mode
MD08	Content Study	**T**	Guided / Autonomous	NP
MD09	Project and Assignment Development	**T/P**		
MD16	Use of Software Tools	**P**	Guided	PR
MD17	Laboratory Practices	**P**		
MD20	Tutoring	**T/P**	Personalized (Individual/Group)	PR
MD21	Learning Agreement	**I/T/P**		
MD22	Portfolio Assessment	**T/P**	Autonomous	NP
MD23	Discussion Forums	**T/P**		
MD24	Analysis and Synthesis of Documentary Material	**T**		
MD25	Monitoring and Completion	**C**	Continuous Self-Assessment	NP

I: Informativa **T**: Teórica **P**: Práctica **C**: Complementaria
PR: Presencial **NP**: No presencial

6. TRAINING ACTIVITIES

The following identifies the types of educational activities that will be carried out:

Code	Name	Modality	Type of activity
AF01	Introductory	IP	Motivational/Informative
AF02	Expository and Participatory	IP	Theoretical
AF03	Guided	IP	Theoretical / Practical
AF04	Personalized (Individual / Group)	IP	Theoretical / Practical
AF05	Autonomous	NP	Theoretical / Practical
AF06	Service-Learning	IP	Service-Learning
AF07	Continuous self-assessment	NP	Quality Assessment

IP: In-person NP: Non-in-person

7. EVALUATION

The model also includes the continuous assessment process as an essential part of verifying the competencies acquired. For UIE, and in line with the proposed improvement of the teaching-learning process for the European Higher Education Area (EHEA), the assessment system, called Learning Outcomes Review (LOR), is developed as a more humanized process, distancing itself from traditional systems where students risk their fate in exams (sessions), sometimes with high and decisive percentage weights, leading to stress, frustration, and occasionally, dropout.

The UIE LOR system is continuous, shared, and progressive, allowing for the monitoring of learning throughout the entire period, making it a natural process to which students turn without negative emotions and aware of the need to understand their own progress.

Code	Assessment Activity	Weight %	Type
AE01	Partial Test	**20**	Discrete
AE03	Final CV Project	**25**	Continuous
AE04	Project Defense	**16**	Discrete
AE05	Participation in the virtual campus	**13**	Continuous
		1	Pass/Fail
AE06	Participation, Daily Activities, and Volunteering	**2**	Pass/Fail
		2	Pass/Fail
		1	Pass/Fail
AE08	Service-Learning		
AE09	Digital Portfolio (20%)	**20**	Continuous
AE10	Retake Partials (10%)		Discrete
		100	

O: Oral E: Escrito CD: Carpeta Digital

8. BIBLIOGRAPHY

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- Elgammal, A., & Liu, B. (2023). The art of generative AI: A comprehensive guide to diffusion models and GANs. MIT Press.
- He, K., et al. (2022). Handbook of Deep Learning. Chapman and Hall/CRC.
- Howard, J., & Gugger, S. (2020). Deep Learning for Coders with fastai and PyTorch. O'Reilly Media.

- Saharia, C., Chan, W., Saxena, S., Li, L., Whang, J., Denton, E., ... & Fleet, D. (2022). Photorealistic text-to-image diffusion models with deep language understanding. Advances in Neural Information Processing Systems, 35*, 14156-14171.

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- Zhang, A., Lipton, Z. C., Li, M., & Smola, A. J. (2023). Dive into deep learning: Generative models. Cambridge University Press. https://d2l.ai/chapter_generative-adversarial-networks/

9. TUTORIALS

MD20 Tutorial (2%): Students must attend at least three personalized tutorials throughout the semester. This is an all-or-nothing activity ("Pass-Fail"), meaning that all three tutorials must be completed.

10. QUALITY SURVEYS

MD25 Quality Management (2%): Students must complete four forms throughout the semester related to UIE's quality management. This is an all-or-nothing activity ("Pass-Fail"), meaning that all four forms must be completed within the deadlines specified in the course activity plan. The activity aims to timely assess the development of the teaching-learning process and the transversal competence related to critical and self-critical thinking.