National University of Engineering (UNI)
School of Computer Science
Syllabus 2024-II

1. COURSE

CS361. Computational Vision (Elective)

2. GENERAL INFORMATION

2.1 Course	:	CS361. Computational Vision
2.2 Semester	:	8^{th} Semester.
2.3 Credits	:	4
2.4 Horas	:	2 HT; 4 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	CS262. Machine learning. (7^{th} Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course covers fundamental techniques for automated analysis of digital images, essential for applications like medical diagnosis, autonomous vehicles, and surveillance systems. Aligns with ACM/IEEE-CS standards for computer vision.

5. GOALS

- Implement feature extraction and object recognition algorithms using OpenCV/Python.
- Evaluate deep learning methods for semantic segmentation (e.g., Mask R-CNN).

6. COMPETENCES

1) Analyze a complex computing problem and apply principles of computing and other relevant disciplines to identify solutions. (Usage)

2) Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline. (Usage)

6) Apply computer science theory and software development fundamentals to produce computing-based solutions. (Familiarity)

AG-C08) Problem Analysis: Identifies, formulates, and analyzes complex computing problems. (Usage)

AG-C09) Solution Design and Development: Designs, implements, and evaluates solutions for complex computing problems. (Usage)

AG-C11) Tool Usage: Applies modern computing tools in problem-solving. (Familiarity)

7. TOPICS

Unit 1: Digital Image Fundamentals (16 hours)	
Competences Expected: 1,6,AG-C08,AG-C11	
Topics	**Learning Outcomes**
• Spatial filtering (Gaussian, Sobel) • Geometric and morphological transformations • Color spaces (RGB, HSV, LAB)	• Apply basic image processing operations [Usar] • Calibrate filter parameters for real-world cases [Evaluar]
Readings : [Sze10], [GW18]	

Unit 2: Epipolar Geometry and Reconstruction (16 hours)	
Competences Expected: 2,AG-C09	
Topics	**Learning Outcomes**
• Fundamental and essential matrices • Triangulation and structure-from-motion • Point clouds with Open3D	• Implement 3D reconstruction pipelines [Usar] • Document technical results in reports [Evaluar]
Readings : [HZ04], [**Forsyth22**]	

Unit 3: Neural Networks for Vision (16 hours)	
Competences Expected: 2,AG-C09	
Topics	**Learning Outcomes**
• CNN architectures (ResNet, YOLO) • Transfer learning with TensorFlow • Semantic segmentation (U-Net)	• Train models for image classification [Usar] • Collaborate in teams for integrated projects [Usar]
Readings : [**Goodfellow16**], [He+17]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

********* EVALUATION MISSING ********

10. BASIC BIBLIOGRAPHY

[HZ04] Richard Hartley and Andrew Zisserman. *Multiple View Geometry in Computer Vision*. Cambridge University Press, 2004. DOI: 10.1017/CBO9780511811685.

[Sze10] Richard Szeliski. *Computer Vision: Algorithms and Applications*. Springer, 2010. DOI: 10.1007/978-1-84882-935-0. URL: https://szeliski.org/Book/.

[He+17] Kaiming He et al. "Mask R-CNN". In: *IEEE ICCV* (2017). URL: https://arxiv.org/abs/1703.06870.

[GW18] Rafael Gonzalez and Richard Woods. *Digital Image Processing*. 4th. Pearson, 2018.