DeCAIR Course Syllabus Form

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Work Package Number & Title	Work Package 2: Development of new MSc and BSc programs in AIR		
Activity Number & Title	Activity 2.2: Designing and developing syllabi and content for the agreed upon courses in the new programs		
Work Package Leader	Francesco Masulli, University of Genoa		
Due Date of Delivery	1/2/2022	**Project Month**	M14
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Revision History

Version	Date	Author	Description	Action *	Page(s)
1	1/11/2021	Iyad Jafar	Computer Vision syllabus drafted	C	1-6
2	8/12/2021	Iyad Jafar	Revised based on 27/11/2021 meeting	U	1-6
3					
4					

(*) Action: C = Creation, I = Insert, U = Update, R = Replace, D = Delete

Disclaimer

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<table>
<tr><td>Course title</td><td>Computer Vision</td></tr>
<tr><td>Course number</td><td>0907752</td></tr>
<tr><td>Credit hours (lecture and lab)</td><td>3 (3+0)</td></tr>
<tr><td>ECTS (weekly contact and self-study load)</td><td>6 (3+3)</td></tr>
<tr><td>Prerequisites/co-requisites by course number and name</td><td>Applied Machine Learning (0907743)</td></tr>
<tr><td>Prerequisites by topic (other than the formal prerequisites above)</td><td>Students are assumed to have good background in mathematics, particularly, calculus, linear algebra, statistics, probability, good background in machine learning and Python/MATLAB programming skills</td></tr>
<tr><td>Level and type (compulsory, elective)</td><td>First year, compulsory</td></tr>
<tr><td>Year of study and semester</td><td>First year, second semester</td></tr>
<tr><td>Catalogue description</td><td>Introduction to computer vision including fundamentals of computer vision at the low, medium and high levels. Topics include image formation, camera imaging geometry, feature detection and matching, stereo, motion estimation and tracking, video processing, deep-learning algorithms for image classification, object recognition, object detection and scene understanding. The course focuses on the practical aspects and implementation of these topics through homework assignments and term project.</td></tr>
<tr><td>Objectives</td><td>1. Introduce students to the computer vision concepts at different levels.
2. Introduce students to the practical techniques and tools used in computer vision (Python, Scikit-Learn, Keras, TensorFlow and Opencv).
3. Enable the students to gain practical skills in computer vision problems.</td></tr>
<tr><td>Intended learning outcomes</td><td>Upon successful completion of this course, students will be able to:
<table>
<tr><th>No</th><th>Intended learning Outcome (ILO)</th><th>Program learning outcome (PLO)*</th></tr>
<tr><td>1</td><td>Demonstrate a sound understanding of the main topics in computer vision.</td><td>1</td></tr>
<tr><td>2</td><td>Solve real world problems in the computer vision domain.</td><td>2,3,4</td></tr>
<tr><td>3</td><td>Communicate the development of a solution for a computer vision problem through a detailed technical report and a short presentation.</td><td>4,5,6</td></tr>
<tr><td>4</td><td>Use appropriate and common tools and libraries to solve real-world problems in computer vision.</td><td>2,3,5</td></tr>
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(*) The PLOs are listed in the appendix</td></tr>
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Teaching and learning methods	Development of ILOs is promoted through the following teaching and learning methods: • The student attends the class presentations and participates in the discussions. • The student joins the related online team/group and participates in its discussions. • The student studies the reference material, including books and videos. • The student solves the programming assignments in computer vision. • The student carries out a term project for solving a problem in the computer vision domain. • The student develops a professional report for the term report. • The student presents the term project in class. • The AI lab is open for the students to practice the practical aspects and solve the programming homework assignments.
Learning material type	Textbook, class handouts, some instructor keynotes, selected YouTube videos, and access to a personal computer and the internet.
Resources and references	A- Required book(s), assigned reading and audio-visuals: 1. Richard Szeliski , Computer Vision: Algorithms and Applications, 2nd Edition, Springer, 2021. 2. Jan Erik Solem, Programming Computer Vision with Python, O'Reilly Media, 2012. 3. M. Elgendy, Deep Learning for Vision Systems, 1st Edition, Manning, 2020. 4. S. Khan et. al., A Guide to Convolutional Neural Networks for Computer Vision, Morgan & Claypool, 2018. B- Recommended book(s), material and media: 5. D. Forsyth and J. Ponce Andries, Computer Vision: A Modern Approach, 22nd Edition, Pearson India ,2011. 6. François Chollet, Deep Learning with Python, Manning Pub. 2018. 7. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow: Concepts: Tools, and Techniques to Build Intelligent Systems, 2nd Edition, O'Reilly Media, Oct 2019.

Topic outline and schedule

Week	Topic	ILO	Resources
1	**Introduction**	1	
2-3	**Image formation** (Geometric primitives and transformations, Photometric image formation, The digital camera)	1,4	1,2
3-4	**Image processing** (Point Operators, Linear Filtering, Non-linear Filtering, Geometric Transformations)	1,4	1,2
5-6	**Feature Detection and Matching** (Points and Patches, Edges and Contours, Contour Tracking, Lines and Vanishing Points, Segmentation)	1,4	1,2
7	**Motion Estimation** (Translational Alignment, Parametric Motion, Optical Flow, Layered Motion)	1,2,4	1,2
8	**Structure from Motion** (Geometric intrinsic calibration, Pose estimation, Two-frame structure from motion, Multi-frame structure from motion, Simultaneous Localization and Mapping)	1,2,4	1,2
9	**Depth Estimation** (Epipolar geometry, Sparse correspondence, Dense correspondence, Local methods, Global optimization, Monocular depth estimation, Multi-view stereo)	1,2,4	1,2
	3D Reconstruction (Shape from X, 3D Scanning, Point-based Representation, Volumetric representation, Model-Based reconstruction, recovering texture maps and albedos)	1,2,4	1,2
10	**Deep Learning - Review**	1,2,4	1-4, 7
10-14	**Recognition** (Instance recognition, Image classification, Object detection, Semantic segmentation, Video understanding, Vision and language)	1,2,4	1-4, 7
15	Project Presentations	2,3,4	1-4, 7

Evaluation tools

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment tools:

Assessment tool	Mark	Topic(s)	Time
Homework assignments	10%	Programming aspects	W2-W14
Midterm exam	30%	Introduction through SLAM	W8
Term project report and presentation	20%	Practical and presentation aspects	W15

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<tr><td>Final exam</td><td>40%</td><td>All material</td><td>W16</td></tr>
<tr><td>Total</td><td>100%</td><td></td><td></td></tr>
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</td></tr>
<tr><td>Student requirements</td><td>The student should have a computer and internet connection.</td></tr>
<tr><td>Course policies</td><td>A- Attendance policies:
Attendance is required. Class attendance will be taken every class and the university polices will be enforced in this regard.
B- Absences from exams and not submitting assignments on time:
A makeup exam can be arranged for students with acceptable absence causes.
Assignments submitted late, but before announcing or discussing the solution can be accepted with 25% penalty.
The project report must be handed in in time.
C- Health and safety procedures:
All health and safety procedures of the university and the school should be followed.
D- Honesty policy regarding cheating, plagiarism, misbehavior:
Open-book exams
All submitted work must be of the submitting student.
Other text or code must be properly quoted with clear source specification.
Cheating will not be tolerated.
E- Available university services that support achievement in the course:
Microsoft Teams team and Moodle course page
AI Lab for practicing the practical aspects and solving the programming assignments.
Program announcements Facebook group</td></tr>
<tr><td>Additional information</td><td>None</td></tr>
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Appendix

Learning Outcomes for the MSc in Artificial Intelligence and Robotics

Students who successfully complete the MSc in Artificial Intelligence and Robotics (AIR) will be able to:

1. Demonstrate a sound understanding of the main areas of AIR including artificial neural networks, machine learning, data science, industrial and service robots, and intelligent and autonomous robots.

2. Apply a critical understanding of essential concepts, principles and practices of AIR, and critically evaluate tools, techniques and results using structured arguments based on subject knowledge.

3. Apply the methods and techniques of the AIR fields in the design, analysis and deployment of AIR solutions and solving practical problems.

4. Demonstrate the ability to produce a substantial piece of research work from problem inception to implementation, documentation and presentation.

5. Demonstrate life-long learning, independent self-learning and continuous professional development skills in the AIR fields.

6. Demonstrate a sound understanding of the ethical, safety and social impact issues of AIR solutions and products.