SYLLABUS
Academic year 2024-2025

Dean,
Prof. Vasile-Ion Manta, PhD.

1. Program data

1.1 Higher education institution	Technical University "Gheorghe Asachi" Iasi
1.2 Faculty	Automatic and Computer Engineering
1.3 Department	Computers
1.4 Field of studies	Computers and information technology
1.5 The cycle of studies[1]	Masters
1.6 Study program	Artificial Intelligence

2. Discipline data

2.1 Name of the subject/Code				Computer Vision / AI.114			
2.2 Holder of course activities				Assoc. Prof. Simona Caraiman, PhD.			
2.3 Owner of Application Activities				Lect. eng. Otilia Zvorișteanu, PhD., Lect. eng. Ștefan Achirei, PhD.			
2.4 Year of studies[2]	1	2.5 The semester[3]	2	2.6 Type of assessment[4]	exam	2.7 Type of discipline[5]	DS

3. Estimated total time of daily activities(hours per semester)

3.1 Number of hours per week	4	of which 3.2 course	2	3.3rd sem.		3.3b laboratory	2	3.3c project	
3.4 Total hours from the education plan[6]	56	of which 3.5 course	28	3.6th sem.		3.6b laboratory	28	3.6c project	

Distribution of the time fund[7]	No. hours
Study by textbook, course support, bibliography and notes	40
Additional documentation in the library, on specialist electronic platforms and in the field	30
Preparation of seminars/labs/projects, assignments, reports and portfolios	20
tutorial[8]	
EXAMINATION[9]	4
Other activities:	

3.7 Total hours of individual study[10]	94
3.8 Total hours per semester[11]	150
3.9 Number of Credits	6

4. Prerequisites(where applicable)

4.1 curriculum[12]	
4.2 skills	

5. Conditions(where applicable)

5.1 conducting the course[13]	• Blackboard, video projector
5.2 conducting the seminar / laboratory / project[14]	• Laboratory room with computers and internet access

[1] *Bachelor / Master*
[2] *1-4 for bachelor's, 1-2 for master's*
[3] *1-8 for Bachelors, 1-3 for Masters*
[4] *Exam, colloquium or VP A/R – from the curriculum*
[5] *DF - fundamental discipline, DID - discipline in the field, DS - specialized discipline or DC - complementary discipline - from the education plan*
[6] *It is equal to 14 weeksx number of hours from point 3.1 (similar for 3.5, 3.6abc)*
[7] *The lines below refer to the individual study; the total is completed at point 3.7.*
[8] *Between 7 and 14 hours*
[9] *Between 2 and 6 hours*
[10] *The sum of the values on the previous lines, which refer to the individual study.*
[11] *The sum of the number of hours of direct teaching activity (3.4) and the number of hours of individual study (3.7); must be equal to the number of credits allocated to the discipline (point 3.9)x 25 hours per credit.*
[12] *Mention the subjects that must be passed previously or equivalent*
[13] *Blackboard, video projector, flipchart, specific teaching materials, etc.*
[14] *Computing technique, software packages, experimental stands, etc.*

	• Visual Studio Programming Environment (Academic License), Python, Google Colaboratory

6. The specific skills accumulated[15]

Number of credits allocated to the discipline[16]:			6	Distribution of credits by skills[17]
Professional skills	CP1	Demonstrate an understanding of advanced theoretical frameworks and models in artificial intelligence, including machine learning algorithms, neural networks, and deep learning architectures.		1.2
	CP2	Employ advanced artificial intelligence algorithms and decision-making frameworks to analyze and resolve practical challenges and effectively manage uncertainties inherent in real-world artificial intelligence applications.		1.9
	CP3	Critically analyze and interpret the results of artificial intelligence models, employing domain-specific evaluation metrics and considering interpretability and explainability in decision-making processes.		1.2
	CP4	Apply ethical principles and considerations in the development and deployment of artificial intelligence systems, considering societal impact, fairness, and accountability.		1
competences CROSS	CT1	Applying, in the context of compliance with the legislation, intellectual property rights (including technological transfer), the product certification methodology, the principles, norms and values of the code of professional ethics within the framework of one's own rigorous, efficient and responsible work strategy.		0.1
	CT2	Application of communication techniques and effective group work; developing empathic interpersonal communication skills and assuming leadership roles/functions in a multi-specialized team.		0.3
	CT3	Creating opportunities for continuous training and the effective utilization of learning resources and techniques for personal development.		0.3

7. The objectives of the discipline(resulting from the grid of specific skills accumulated)

7.1 The general objective of the discipline	• Understanding the fundamental concepts of Computer Vision
7.2 Specific objectives	• Understand basic concepts of image processing, image analysis and Computer Vision • Learn to develop machine learning/deep learning solutions for computer vision problems • Learn to evaluate and interpret image segmentation results

8. Contents

8.1 Course[18]	teaching methods[19]	Remarks
1. Introduction to Computer Vision (2h) Trends in restoration and manipulation of images and videos; Perception; Applications; Light ***2. Color and Texture, Unitarity Tansforms (2h)*** Color and color models; Texture and texture characteristics, Fourier features; Coocurrence matrices; Filter banks; Principal Component Analysis(PCA) ***3. Sampling and Quantization. Image Enhancement (2h)*** Discretization of continuous signals; Signal representation in the frequency domain; Effects of sampling and quatization; Noise supression, de-blurring, contrast enhancement ***4. Feature Extraction (2h)*** Examples; Matching; Features selection; Interest points; Harris corner detector; Deformations ***5. Segmentation (I, II) (4h)*** Basics of image segmentation; Segmentation methods: thresholding, edge-based	lecture with Powerpoint presentation, explanations and answers to questions	

[15] *Competencies from the G1 and G1bis Grids of the study program, adapted to the specifics of the discipline, for which credits are allocated (www.rncis.ro or the faculty website)*

[16] *From the education plan*

[17] *The credits allocated to the discipline are distributed on professional and transversal skills according to the specifics of the discipline*

[18] *Chapter and paragraph headings*

[19] *Exposition, lecture, blackboard presentation of the studied issue, use of video projector, discussions with students (for each chapter, if applicable)*

(Hough transform, Active contour models), region-based, statistical pattern recognition-based, Supervised generative models ***6. Traditional object detection (2h)*** Specific object detection : model-based, image-based, hybrid models, visual words and indexing, geometric constraints with RANSAC; Object category recognition: classification (Bag of words) and detection (sliding windows, generalized Hough Transform) ***7. Tracking (I, II) (4h)*** Application Examples; Requirements; Feature tracking (region, point and template tracking); model-based tracking (tracking by detection, model-based body articulation, online learning) ***8. Deep Learning for Computer Vision (6h)*** Review basic concepts of deep learning (neural networks, machine learning for visual perception – supervised and unsupervised learning, cost functions, initialization, over-fitting); Convolution and Convolutional Neural Networks; Dilated convolution; Multi-scale context agregation; CNN (LeNet, AlexNet, VGG, ResNet); Transfer learning (concept and applications in computer vision); RNN (applications of RNNs for sequential data); Generative Models (image synthesis and style transfer); Attention mechanisms; Object detection architectures; Semantic segmentation architectures; Datasets and benchmarks. ***9. Course review (2h)*** Review of key concepts and techniques covered in the course; Future directions.		

Course bibliography:

1. Ferber, J. (1999). Multi-Agent Systems: An Introduction to Distributed Artificial Intelligence, Addison-Wesley Professional.
2. Leon, F. (2006). Intelligent agents with cognitive capabilities, Ed. Tehnopress, Iasi.
3. Lin, FO, ed. (2005). Designing Distributed Learning Environments with Intelligent Software Agents, Information Science Publishing.
4. Padgham, L., Winikoff, M. (2004). Developing Intelligent Agent Systems: A Practical Guide, Wiley Series in Agent Technology, Wiley.
5. Russell, SJ, Norvig, P. (2002). Artificial Intelligence: A Modern Approach, Prentice Hall, 2nd Edition.
6. Shoham, Y., Leyton-Brown, K. (2008). Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press.
7. Sugumaran, V., ed. (2007). Application of Agents and Intelligent Information Technologies, Advances in Intelligent Information Technologies, IGI Global.
8. Vidal, JM (2007). Fundamentals of Multiagent Systems. Retrieved from http://jmvidal.cse.sc.edu/papers/mas.pdf
9. Weiß, G., ed. (2000). Multiagent Systems - A Modern Approach to Distributed Artificial Intelligence, The MIT Press, Cambridge, Massachusetts.
10. Wooldridge, M. (2002). An Introduction to MultiAgent Systems, John Wiley & Sons.

8.2a Seminar	teaching methods[20]	Remarks

8.2b Laboratory	teaching methods[21]	Remarks
1. Introduction in Computer Vision (2h) Computer Vision domain and its applications, example of systmes/applications that use CV, examples of projects developed in AC TUIASI ***2. Basics of image manipulation and processing (2h)*** Image manipulation and processing, image channels manipulation, transforming between different representations, contrat enhancement, image histogram and histogram matching, image filtering ***3. Image convolution. Camera calibration (2h)*** Convolution operation, Camera pipeline, Bayer pattern filter and demosaicing, Camera calibration, Image distorsion ***4. Features extraction (2h)*** Gabor filter, Harris corner detector, Features extraction and matching ***5-6. Image segmentation (4h)*** Mean Shift Algorithm, k-NN algorithm, region growing, Expectation maximization	general and individual explanations, individual computer work	

[20] *Discussions, debates, presentation and/or analysis of papers, solving exercises and problems*

[21] *Practical demonstration, exercise, experiment*

7. Disparity estimation (2h) Stereo matching, disparity estimation ***8. Object recognition (2h)*** Object category recognition: Bag of words, SVM ***9-10. Tracking (4h)*** Tracking by detection (Viola Jones), region tracking (Mean Shift Tracking), point-based tracking (Lucas-Kanade Optical Flow) ***11. Neural networks (2h)*** Training, Testing, activatin function, optimizer, hyperparameter, cross validation, PCA ***12-13. Convolutional Neural Networks (4h)*** Feature extraction using CNNs, Data normalization, CNN autoencoder for image compression, Data augmentation, VGG architecture, ResNet architecture, SDG and Adam optimization ***14. Generative Adversarial Networks (2h)***		
8.2c Project	teaching methods[22]	Remarks

Applications bibliography (laboratory / project):

1. R.C. Gonzalez, Digital Image Processing- 3rd Edition, editura Prentice Hall, New Jersey, SUA, pag. 568-572, 2008
2. Nixon M.S., Aguado A.S., Feature Extraction and Image Processing for Computer Vision (3ed., AP, 2012)
3. Richard, H. and A. Zisserman. Multiple View Geometry in Computer Vision. Cambridge: Cambridge University Press, 2000
4. Dorin Comaniciu and Peter Meer, "Mean Shift: A robust approach toward feature space analysis". IEEE Transactions on Pattern Analysis and Machine Intelligence. 2002. pp. 603-619
5. Ingemar J. Cox, Sunita L. Hingorani, Satish B. Rao, Bruce M. Maggs, A Maximum Likelihood Stereo Algorithm, Computer Vision and Image Understanding, Volume 63, Issue 3, 1996, Pages 542-567, ISSN 1077-3142,

9. Corroboration of the contents of the discipline with the expectations of representatives of the epistemic community, professional associations and representative employers in the field related to the program[23]

Intelligent agents belong to the more general field of distributed artificial intelligence, which in turn lies at the border between artificial intelligence and distributed computing, the study of which is the main focus of the curriculum. Distributed artificial intelligence mainly consists of the study of distributed problem solving and the study of multiagent systems. Unlike classic programs, intended for a certain well-defined purpose, agents are especially suited to operate in complex, sometimes unpredictable environments. In a distributed environment, it is very difficult for a programmer to predict all possible situations that an agent may end up in during its execution. One solution is to add intelligent dynamic adaptive capabilities resulting from a learning process,

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods		10.3 Weight of the final grade
10.4a Exam	Acquired theoretical and practical knowledge (quantity, correctness, accuracy)	Tests along the way[24]:		50% (minimum 5)
		Homework:		
		Other activities[25]:		
		Final Rating:	100%	
10.4b Seminar	Frequency/relevance of interventions or responses	Record of interventions, portfolio of works (references, scientific summaries)		
10.4c Laboratory	Knowledge of equipment, how to use specific tools; evaluation of tools or achievements, processing and interpretation of results	• Written questionnaire • Oral answer • Practical demonstration		50% (minimum 5)

[22] *Case study, demonstration, exercise, error analysis, etc.*

[23] *The connection with other disciplines, the usefulness of the discipline on the labor market*

[24] *The number of tests and the weeks in which they will be held will be specified.*

[25] *Scientific circles, professional competitions, etc.*

10.4d Project	The quality of the completed project, the correctness of the project documentation, the justification of the chosen solutions		
10.5 Minimum Performance Standard[26]: grade 5 in the exam and practical papers (average between laboratory and project)			

Date of completion,

05 December 2024

Course owner's signature,

Assoc. Prof. Simona Caraiman, PhD.

Signature of the application holder,

Lect. eng Otilia Zvorișteanu, PhD.

Lect. eng. Ștefan Achirei, PhD.

Date of approval in the department,

07 December 2024

Department manager,

Assoc. Prof. Andrei Stan, PhD.

[26] *The minimum performance standard from the skills grid of the study program is customized to the specifics of the discipline, if applicable.*