School of Computer and Communication Engineering

Department of Computer and Communication Engineering

Course Hand-out

Computer Vision | CC 3241 | 3 Credits | 3 0 0 3, Dr. Vijay kr. Sharma, Ms. Anshika Malsaria

Session: Jan'24 – May'24 | Course Coordinator: Dr. Vijay kr. Sharma | Class: 3rd Year / 6th Semester

A. Introduction: This is a programme elective course which introduces concepts of computer vision. Important concepts of computer vision are image formation, filtering, segmentation, and classifiers. Students will understand the concept of image formation and filtering techniques applied over images. In the next half of the course students will be understanding and applying different image segmentation techniques and image classification algorithms. Students will gain proper knowledge of image formation to image classification processes and their applications. They will be able to customize filtering, segmentation, classification techniques to solve modern day problems.

B. Course Outcomes: At the end of the course, students will be able to

[CC3241.1] Apply the fundamentals of image formation and transformation techniques over the image.

[CC3241.2] Apply image filtering techniques in image formation.

[CC3241.3] Analyze image segmentation and classification techniques to identify the object.

[CC3241.4] Evaluate segmentation and classification models for real world applications to enhance employability prospects.

C. Program Outcomes and Program Specific Outcomes

[PO.1].   Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

[PO.2].   Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.

[PO.3].   Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

[PO.4].   Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

[PO.5].   Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

[PO.6].   The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

[PO.7].   Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8].   Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9].   Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10].   Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11].   Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

[PO.12].   Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Specific Outcomes (PSOs)

At the end of the B Tech CCE program, the student:

[PSO.1] Imbibe the basic concepts and applications of computer-based Communication or networking, information sharing, signal processing, web-based systems, smart devices, and communication technology.

[PSO.2] Investigate prominent areas in the field of Computer and Communication Engineering to provide feasible solutions.

[PSO.3] Apply the contextual knowledge in the field of Computing and Communication to assess social, health, safety, and security issues relevant to the professional engineering practice.

D. Assessment Rubrics:

Criteria	Description	Maximum Marks
Internal Assessment (Formative)	Sessional Exam (Closed Book)	30
	In class Quizzes (20 Marks) and Assignments (10 Marks) (Accumulated and Averaged)	30
End Term Exam (Summative)	End Term Exam (Closed Book)	40
	Total	100
Attendance	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments	Students who misses a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that particular day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	
Homework/ Home Assignment/ Activity Assignment	There are situations where a student may have to work in home, especially before a flipped classroom. Although these works are not graded with marks. However, a student is expected to participate and perform these assignments with full zeal since the activity/ flipped classroom participation by a student will be assessed and marks will be awarded.	

E. Syllabus

Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing; Color early vision - single image: linear filters, edge detection; Texture early vision - multiple images: the geometry of multiple views, stereopsis, affine structure from motion, projective structure from motion; Mid-level vision: segmentation by clustering, segmentation by fitting a model, segmentation and fitting using probabilistic methods, Graph-Cut, Mean-Shift, Object detection.; Viola Jones face detection, Face representation: Eigen faces and 2D PCA. Deformable curves and surfaces, Snakes and active contours; High-level vision: finding templates using classifiers, recognition by relations between templates, geometric templates from spatial relations, introduction to 3D computer vision, recent trends and practical applications.

References:

1. D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, (2e), Pearson Education, 2008.

2. R. Hartley, A. Zisserman, Multiple View Geometry in Computer Vision, (2e), Cambridge University Press, 2004.

3. R. Szeliski, Computer Vision: Algorithms and Applications, Springer, 2011.

4. J. Leskovec, A. Rajaraman, J. D. Ullman, Mining of massive dataset, (2e), Cambridge university press, 2014.

5. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

F. Lecture Plan:

Lect. No	Topics	Session Objective	Mode of Delivery	Corresponding CO	Mode of Assessing the Outcome
1	Introduction to the subject, course plan, course outcomes and assessment plan.	To acquaint and clear teacher's expectations and understand student expectations	Lecture	NA	NA
2	Image formation and Projection First principles of cv youtube	To understand image formation	Lecture	CC3241.1	Class Quiz/ Sessional Exam / End Term Exam
3-4	Transformation: Orthogonal, Euclidean, Affine, Projective,	Understand the transformation and its type	Lecture	CC3241.1	Class Quiz/ Sessional Exam / End Term Exam
5	Fourier Transform, Convolution and Filtering	Apply the Fourier transformation and Understand the filtering of the image.	Lecture	CC3241.1	Class Quiz Sessional Exam/ End Term Exam
6-8	Image Enhancement, Restoration, Histogram Processing	Understand the image enhancement and restoration concept Do histogram questions	Lecture	CC3241.2	Class Quiz Sessional Exam/ End Term Exam
9-11	Color early vision - single image: linear filters, edge detection;	Understand and apply filtering and edge detection process over image	Lecture	CC3241.2	Class Quiz/ Sessional Exam / End Term Exam
12-14	Texture early vision - multiple images: the geometry of multiple views, stereopsis	Understand and apply texture vision on multiple images	Lecture	CC3241.2	Home Assignment Class Quiz Sessional Exam I / End Term Exam
15-16	Affine structure from motion, projective structure from motion	Apply and customize different image structures.	Lecture	CC3241.2	Home Assignment Sessional Exam// Class Quiz End Term Exam
17-19	Mid-level vision: segmentation by clustering	Understand and apply image segmentation	Lecture	CC3241.3	Class Quiz/ Sessional Exam / End Term Exam
20-21	Segmentation by fitting a model	Understand and apply image segmentation	Lecture	CC3241.3	Home Assignment Sessional Exam/ End Term Exam

22-24	Segmentation and fitting using probabilistic methods, Graph-Cut, Mean-Shift,	Understand and apply image segmentation	Lecture	CC3241.3	Sessional Exam/ Class Quiz / End Term Exam
Sessional Exam					
25-26	Object detection, Viola Jones face detection, Face representation: Eigen faces and 2D PCA.	Apply different detection using Face and 2D PCA with example	Lecture	CC3241.3	Class Quiz/ End Term Exam
27-28	Deformable curves and surfaces, Snakes and active contours	Apply different geometric methods in high level vision	Lecture	CC3241.4	Class Quiz/ End Term Exam
29-30	High-level vision: probabilistic and Inferential methods	Apply different geometric methods in high level vision	Lecture	CC3241.4	Class Quiz/ End Term Exam
31-32	Finding templates using classifiers	Understand and customize image classifiers	Lecture	CC3241.4	Class Quiz End Term Exam
33-35	Recognition by relations between templates, Geometric templates from spatial relations	Understand and customize image classifiers and templates	Lecture	CC3241.4	Class Quiz End Term Exam
36-38	introduction to 3D computer vision, recent trends and practical applications	Understand the concept of 3D computer vision fundamental	Lecture	CC3241.4	Class Quiz End Term Exam
End Term Exam					

G. **Course Articulation Matrix: (Mapping of COs with POs)**

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

												10				
CC3241.1	Apply the fundamental of image formation and transformation techniques over the image.	3	1							1	2		1	2	1	
CC3241.2	Apply image filtering techniques in image formation.	3	2		1					1	2		1	2	1	1
CC3241.3	Analyse image segmentation and classification techniques to identify the object.	3	3	1	2		1		1				1	2	2	1
CC3241.4	Evaluate segmentation and classification models for real world applications to enhance employability prospects.	3	3		2	1			1	1	1		1	2	2	1

1- **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**