Banasthali Vidyapith
Department of Computer Science
Course Handout: M.Tech. (CS) I Semester
July – December 2025

Date: 9 July 2025

Course Code: CS 441 **Course Name: Computer Vision**
Credit Points: 4 **Max. Marks: 100 (CA: 40 + ESA: 60)**

Course Instructor:
Ms. Aishvarya Garg, Research Associate, Computer Science

Course Outcomes:
On completion of the course, the student will be able to:

CO 1 Learn fundamentals of computer vision and its applications.
CO 2 Understand the basic image processing operations to enhance, segment the images.
CO 3 Understand the analyzing and extraction of relevant features of the concerned domain problem.
CO 4 Understand and apply the motion concepts and its relevance in real time applications.
CO 5 Apply the knowledge in solving high level vision problems like object recognition, image classification etc.

Syllabus:

Section A

Section A

Introduction: Motivation, Introduction to Computer Vision and Image Analysis, Human Eye, Camera model, CCD camera, Human colour perception, Colour models.

Segmentation: Threshold based segmentation, Edge based segmentation, Border detection, Hough transform, Region based segmentation, Watershed segmentation, Evaluation issues in segmentation, Mean shift segmentation, Active contour models, Level sets and Geodesic active contours, Optimal single and multiple surface segmentation

Section B

Shape Representation and Description: Region identification, Contour based shape representation and description, Boundary description, B- splines, Shape invariants, Moments, Shape classes.

Object Recognition: Classification principles, SVM, Neural nets, Syntactic pattern recognition

Image Understanding: Image understanding control strategies, Hierarchical control, Bottom-up control, Model-based control, Classification based segmentation, Contextual image classification, Scene labelling, Semantic image segmentation, Hidden Markov models, Bayesian belief network.

Section C

3D Vision: Marr's theory, Active and Purposive vision, A single perspective camera, Camera Calibration from a known scene, Scene reconstruction from multiple views, Two camera, Stereopsis, Relative motion of the camera, Fundamental matrix, Stereo correspondence algorithms, Photometric stereo, Shape from motion, Shape from texture, 3Dmodel based vision, Multi view representation.

Tracking: Object tracking, Motion models, Kalman Filtering, Feature fusion in a Particle filter, Multi target tracking.

Applications: Intelligent video surveillance, Mobile robots, medical imaging, Human object identification, digital libraries, image based rendering, Deep Learning for Computer Vision

Suggested Books:

R1. Sonka, M., Hlavac, V., & Boyle, R. (2014). Image processing, analysis, and machine vision. Cengage Learning.
R2. Szeliski, R. (2010). Computer vision: algorithms and applications. Springer Science & Business Media.
R3. Forsyth David, A., & Jean, P. (2002). Computer Vision: a modern approach. PHI
R4. Cipolla, R., Battiato, S., & Farinella, G. M. (Eds.). (2010). Computer Vision: Detection, recognition and reconstruction (Vol. 285). Springer.

R5. Ikeuchi, K. (2014). Computer vision: A reference guide. Springer Publishing Company, Incorporated.
R6. Nixon, M., & Aguado, A. (2019) Feature extraction and image processing for computer vision. Academic press.

Suggested E-Learning Material:

E1. Computer Vision: Foundations and Applications – http://vision.stanford.edu/teaching/cs131_fall1415/schedule.html
E2. Deep Learning in Computer Vision - https://www.coursera.org/learn/deep-learning-in-computer-vision

Assessment Schedule:

Component	Marks	Submission/ Examination date	Allotment
Home assignment 1**	10	17 August, 2025	Topics shall be allotted in the class by 1 August 2025
Periodical test I	10	29 August - 1 September, 2025*	Lecture No. 01 to 22
Home assignment II**	10	19 September, 2025	Topics shall be allotted in the class by 3 September, 2025
Periodical test II	10	12-16 October, 2025*	Lecture No. 23 to 40
Semester Examination	60	1-19 December, 2025*	Lecture No. 01 to 50 (Entire Syllabus)

**Subject to change*
***Evaluation is based on written document, test, viva and any other component(s) as decided by the instructor(s) on regular basis*

Lecture-Wise Schedule:

Lec. No.	Topics to be covered	Text/Ref. Books
1-2	Motivation, Introduction to Computer Vision and Image Analysis, Human Eye	R1/R3
3-6	Camera model, CCD camera, Camera calibration	R1
7-9	Human colour perception, Colour models.	R4
10-11	Threshold based segmentation, Edge based segmentation, Border detection	R3
12-13	Hough transform, Region based segmentation, Watershed segmentation	R1
14-15	Evaluation issues in segmentation, Mean shift segmentation	R1
16-17	Active contour models, Level sets and Geodesic active contours	R1
18-22	Optimal single and multiple surface segmentation	R3
23-25	Region identification, Contour based shape representation and description, Boundary description, B- splines, Shape invariants, Moments, Shape classes	R1/R4
26-28	Image Understanding: Image understanding control strategies, Hierarchical control, Bottom-up control, Model-based control	R1
29-31	Classification based segmentation, Contextual image classification	R1
32-36	Scene labelling, Semantic image segmentation, Hidden Markov models, Bayesian belief network	R1
37-38	Object Recognition: Classification principles, SVM, Neural nets, Syntactic pattern recognition	R1/E1
39-40	3D Vision: Marr's theory, Active and Purposive vision	R1
41-42	A single perspective camera, Camera Calibration from a known scene, Scene reconstruction from multiple views, two camera	R1
43-45	Stereopsis, Relative motion of the camera, Fundamental matrix, Stereo correspondence algorithms, Photometric stereo, Shape from motion, Shape from texture, 3D model based vision, Multi view representation.	R1
46-48	Tracking: Object tracking, Motion models, Kalman Filtering, Feature fusion in a Particle filter, Multi target tracking.	R1
49-50	Applications: Intelligent video surveillance, Mobile robots, medical imaging, Human object identification, digital libraries, image based rendering, Deep Learning for Computer Vision.	R4/E2

Ms. Aishvarya Garg