

Banasthali Vidyapith
Department of Computer Science
Course Handout: M.Tech. (AI) I Semester/ M.Sc. (DS) III Semester
July – December 2025

Date: 9 July 2025

Course Code: AI 505
Credit Points: 4

Course Name: Computer Vision
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

Introduction: Introduction to Computer Vision, Image Formation and Representation, Human Eye, Human colour perception, Colour models, Camera calibration, camera models.

Image Processing: Spatial domain operations and Frequency domain operations, histogram processing, histogram equalization, filtering, convolution, Image transforms, Fourier transformation and its applications in sharpening, blurring and noise removal.

Transformations in 2D: translation, rotation, scaling, shearing; affine and rigid transformations, Perspective projection, Epipolar Geometry, Multiple View Reconstruction, Stereo Images.

Section B

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.

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

Feature detection: edge detection, corner detection, line and curve detection, active contours, SIFT and HOG descriptors, shape context descriptors, Morphological operations.

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, Stereopsis, Stereo correspondence algorithms, Shape from X.

Object Recognition: Classification principles, Support Vector Machines, Artificial Neural Networks.

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

Applications: Intelligent video surveillance, Mobile robots, medical imaging, Human object identification, 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.htmlE2. 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	Introduction: Introduction to Computer Vision, Image Formation and Representation, Human Eye	R1/R3
3-6	Human colour perception, Colour models, Camera calibration, camera models	R1
7-9	Translation, rotation, scaling, shearing, Affine and rigid transformations, Perspective projection	R4
10-11	Epipolar Geometry, Multiple View Reconstruction, Stereo Images	R3
12-13	Threshold based segmentation, Edge based segmentation, Border detection	R1
14-15	Hough transform, Region based segmentation, Watershed segmentation	R1
16-17	Evaluation issues in segmentation, Mean shift segmentation	R1
18-22	Spatial domain operations and Frequency domain operations, Histogram processing, histogram equalization, filtering, convolution, Image transforms, Fourier transformation and its applications in sharpening, blurring and noise removal	R3
23-25	Active contour models, Level sets and Geodesic active contours	R1/R4
26-28	Region identification, Contour based shape representation and description	R1
29-31	Boundary description, B-splines, Shape invariants, Moments, Shape classes	R1
32-36	Feature detection: edge detection, corner detection, line and curve detection, active contours, SIFT and HOG descriptors, shape context descriptors, Morphological operations	R1
37-38	Object Recognition: Classification principles, Support Vector Machines, Artificial Neural Networks	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,	R1
43-45	Stereopsis, Stereo correspondence algorithms, Shape from X	R1
46-48	Tracking: Object tracking, Motion models, Kalman Filtering, Feature fusion in a Particle filter, Appearance based methods, Multi target tracking.	R1
49-50	Applications: Intelligent video surveillance, Mobile robots, medical imaging, Human object identification, Deep Learning for Computer Vision.	R4/E2

Ms. Aishvarya Garg