Gyanmanjari Innovative University

Syllabus
Gyanmanjari Institute of Technology
Semester-5th (B.Tech.)

Subject: Computer Vision BETCE14401

Type of course: Minor Course

Prerequisite: Basic knowledge of calculus, linear algebra, probability, and programming (preferably Python). Familiarity with image processing concepts and algorithms will also be beneficial.

Rationale:

This course introduces computer vision through core principles, algorithms, and hands-on applications. Key topics include image formation, processing, object detection, segmentation, and video analysis. Students will explore binary image processing, filtering, transformations, feature detection, and AI-driven techniques like image classification, object tracking, and pose estimation using OpenCV. Practical projects—such as panorama creation, filters, and QR code detection—prepare learners for real-world computer vision challenges.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
CI	T	P	C	Theory Marks		Practical Marks		CA	
				ESE	MSE	V	P	ALA	
4	0	2	5	60	30	10	20	30	150

Legends: CI-Class Room Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Course Content:

Sr. No	Course content	Hrs.	% Weightage
1	**Introduction to OpenCV and Basics** Overview of Computer Vision and its applications, Difference between Image Processing and Computer Vision, Digital images: Formation, representation, and manipulation, Basic image operations: Cropping, resizing, masking, and creating new images, Splitting and merging color channels, Mathematical operations: Contrast and brightness adjustment, Assignment: Build a simple image filter	8	20%
2	**Working with Videos and GUI** Reading, displaying, and writing videos, Keyboard and mouse interactions for annotations, Trackbars as controllers for real-time applications, Assignment: Implement video annotation using mouse	7	15%
3	**Binary Image Processing** Thresholding: Binary and adaptive, Morphological operations: Erosion, dilation, opening, and closing, Contour detection and connected components, Assignment: Detect shapes in binary images	8	15%
4	**Image Enhancement and Filtering** Color spaces: RGB and HSV, Image filtering: Gaussian blur, median blur, Edge detection using Sobel and Canny, Histogram equalization for contrast adjustment, Assignment: Enhance and filter a noisy image	9	20%
5	**Feature Detection and Geometric Transforms** Camera models; intrinsic and extrinsic parameters; radial lens distortion; direct parameter calibration; camera parameters from projection matrices; orthographic, weak perspective, affine, and perspective camera models.Geometric transforms: Affine transformation and perspective warp, ORB feature detection and feature matching, Assignment: Create a panorama from images	8	15%

6	**Object Detection and Recognition** Object detection: Basics of HAAR cascades and HOG descriptors, Face detection using OpenCV, Project: Build a simple face detection application	8	15%

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Simple Image Annotation** Students will take an image, annotate it by drawing shapes (circle, rectangle, line) using OpenCV, and write a brief explanation of their work. They will upload the annotated image and a short description to the GMIU portal.	10
2	**Basic Color Space Conversion** Students will take an image and convert it to different color spaces (like RGB, HSV, Grayscale) using OpenCV. They will upload the images on the GMIU portal after conversion and explain the differences between these color spaces.	10
3	**Face Detection with HAAR Cascade** Students will use a pre-trained HAAR Cascade classifier to detect faces in a provided image or video. They will submit the image or video with detected faces on the GMIU portal, along with a simple report on how they performed the task.	10
	Total	30

Suggested Specification table with Marks (Theory):60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	20%	20%	15%	5%	5%	5%

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from the above table.

Course Outcome:

After learning the course, the students should be able to:	
CO1	Understand the fundamentals of computer vision, image processing, and basic image annotation techniques.
CO2	Analyze and apply basic image processing operations like resizing, cropping, thresholding, and segmentation.
CO3	Identify and extract relevant features for image classification and object recognition tasks.
CO4	Apply motion analysis concepts, object tracking, and video stabilization in real-time applications.
CO5	Implement deep learning models for image classification and object detection using OpenCV.
CO6	Develop practical computer vision projects such as QR code detection or object tracking applications.

List of Practical:

Sr. No	Descriptions	Unit No	Hrs.
1	Implement basic image processing operations like reading, writing, and manipulating images using OpenCV (cropping, resizing, and bitwise operations).	1	2
2	Implement image annotation techniques (drawing lines, circles, rectangles, and text) on images using OpenCV.	1	2
3	Apply various image enhancement techniques such as brightness and contrast adjustment, and mathematical operations on images.	2	2
4	Implement video IO operations in OpenCV, including reading, displaying, and writing video frames.	2	2
5	Apply morphological operations like dilation and erosion on binary images and analyze connected components.	3	4
6	Perform thresholding operations on images and implement connected component analysis in OpenCV.	3	2

7	Implement filtering techniques including Gaussian blur, median blur, and bilateral filter for image smoothing and noise reduction.	4	4
8	Demonstrate edge detection techniques like Canny Edge Detection on various images and analyze the results.	4	2
9	Implement geometric transformations such as affine transform and homography in OpenCV for image alignment.	5	2
10	Create and implement a feature matching system using ORB, and use RANSAC for object recognition and alignment.	5	4
11	Use GrabCut for image segmentation to separate foreground and background, and apply it to real-world images.	6	2
12	Build a basic face detection system using HAAR cascades or deep learning-based methods for real-time applications.	6	2
		Total	30

Instructional Method:

The course delivery method will depend upon the requirement of content and the needs of students. The teacher, in addition to conventional teaching methods by black board, may also use any tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory.

The internal evaluation will be done on the basis of Active Learning Assignment.

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in the laboratory.

Reference Books:

[1] Computer Vision By Dr. H. M. Nimbark and Aneri H. Khadodara

[2] Computer Vision By Dr. Ishwarya M.V.

[3] Learning OpenCV 4: Computer Vision with Python by Adrian Kaehler and Gary Bradski

[4] Computer Vision: Algorithms and Applications by Richard Szeliski

[5] Practical Python and OpenCV by Adrian Rosebrock

[6] Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods

[7] Multiple View Geometry in Computer Vision by Richard Hartley and Andrew Zisserman