GUJARAT TECHNOLOGICAL UNIVERSITY
Bachelor of Engineering
Subject Code: 3171614
COMPUTER VISION
B.E. 7th Semester

Type of course: Professional Elective

Prerequisite: Calculus, Linear algebra, Probability, Programming knowledge

Rationale: In this course students will learn basic principles of image formation, image processing algorithms and recognition from single or multiple images (video). This course emphasizes the core vision tasks of scene understanding and recognition. Applications to object recognition, image analysis, image retrieval and object tracking will be discussed.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Contents:

Sr. No.	Content	Total Hrs
1	**Overview of computer vision and its applications**: Image Formation and Representation: Imaging geometry, radiometry, digitization, cameras and Projections, rigid and affine transformation	7
2	**Image Processing:** Pixel transforms, color transforms, histogram processing, histogram equalization, filtering, convolution, Fourier transformation and its applications in sharpening, blurring and noise removal	9
3	**Feature detection:** edge detection, corner detection, line and curve detection, active contours, SIFT and HOG descriptors, shape context descriptors, Morphological operations	7
4	**Segmentation:** Active contours, split & merge, watershed, region splitting, region merging, graph-based segmentation, mean shift and model finding, Normalized cut	6
5	**Camera calibration:** 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.	5
6	**Motion representation:** the motion field of rigid objects; motion parallax; optical flow, the image brightness constancy equation, affine flow; differential techniques; feature-based techniques; regularization and robust estimation	4
7	**Motion tracking:** statistical filtering; iterated estimation; observability and linear systems; the Kalman filter	4
8	**Object recognition and shape representation:** alignment, appearance-based methods, invariants, image eigenspaces	4

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Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**15**	**5**	**5**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

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 from above table.

Books:

1. Computer Vision: Algorithms and Applications, R. Szeliski, Springer, 2011.
2. Computer Vision: Algorithms and Applications, R. Szeliski, Springer, 2011.
3. Introductory techniques for 3D computer vision, E. Trucco and A. Verri, Prentice Hall, 1998.

Course Outcomes: Students will be able to

Sr. No.	**CO Statement**	**Marks % Weightage**
1	Learn fundamentals of computer vision and its applications	20
2	Understand the basic image processing operations to enhance, segment the images.	25
3	Understand the analyzing and extraction of relevant features of the concerned domain problem.	25
4	Understand and apply the motion concepts and its relevance in real time applications	15
5	Apply the knowledge in solving high level vision problems like object recognition, image classification etc.	15

List of Experiments:

1. Implementing various basic image processing operations in python/matlab/open-CV: Reading image, writing image, conversion of images, and complement of an image
2. Implement contrast adjustment of an image. Implement Histogram processing and equalization.
3. Implement the various low pass and high pass filtering mechanisms.
4. Use of Fourier transform for filtering the image.
5. Utilization of SIFT and HOG features for image analysis.
6. Performing/Implementing image segmentation
7. Implement optical flow computation algorithm.
8. Demonstrate the use of optical flow in any image processing application
9. Object detection and Recognition on available online image datasets
10. Character or digit or face classification project