GUJARAT TECHNOLOGICAL UNIVERSITY

BACHELOR OF ENGINEERING SYLLABUS

Subject Code : 3174206

Subject Name : Computer Vision

WEF Academic Year:	2020-21
Semester:	7
Category of the Course:	Professional Elective V

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, and image retrieval and object tracking will be discussed.

Course Scheme:

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	**Overview of computer vision and its applications:** Computer Vision and Computer Graphics: What is Computer Vision - Low-level, Mid-level, High-level Overview of Diverse Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality	5	10%
2	**Image processing:** Image Formation and Representation: Imaging geometry, radiometry, digitization, cameras and Projections, rigid and affine transformation, pixel transforms, color transforms, histogram processing, histogram equalization, filtering, convolution, Fourier transformation and its applications in sharpening, blurring and noise removal	8	15%
3	**Feature detection:** Edge detection, corner detection, line and curve detection, active contours, PCA, SIFT and HOG descriptors, shape context descriptors, Morphological operations	7	10%
4	**Shape representation and segmentation:**	8	20%

	Contour based representation, Region based representation, Deformable curves and surfaces, Snakes and active contours, Level set representations, Fourier and wavelet descriptors, Medial representations, Multiresolution analysis, Active contours, split & merge, watershed, region splitting, region merging, graph-based segmentation, mean shift and model finding, Normalized cut		
5	**Camera models and 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	6	15%
6	**Motion representation and estimation:** 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	10%
7	**Motion tracking and object recognition** Statistical filtering; iterated estimation,observability and linear systems, the Kalman filter, Alignment, appearance-based methods, invariants, image Eigen spaces	4	10%
8	**Machine Learning for Computer Vision** Introduction to Machine Learning, Image Classification, Object Detection, Semantic Segmentation	4	10%

Reference Book:

1. Computer Vision: Algorithms and Applications, by R. Szeliski, Springer, 2016
2. Computer Vision - A modern approach, 3rd Edition, by D. Forsyth and J. Ponce, Pearson
3. Digital Image Processing, 4th Edition, by R. C. Gonzalez and R. E. Woods, Pearson
4. Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Prentice Hall
5. Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.
6. Image Processing, Analysis, and Machine Vision, by Sonka, Hlavac, and Boyle. Thomson.
7. Practical Machine Learning for Computer Vision, by Valliappa Lakshmanan, Martin Görner, Ryan Gillard, July 2021, O'Reilly Media, Inc.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Learn fundamentals of computer vision and its applications.	RM
02	Understand the basic image processing operations to enhance, segment the images.	UN
03	Analyzing and extraction of relevant features of the concerned domain problem.	AN
04	Apply the motion concepts and its relevance in real time applications.	AP
05	Solve high level vision problems like object recognition, image classification etc.	EL

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Suggested Course Practical List:

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. Construct 3D model from Images.
5. Use of Fourier transform for filtering the image.
6. Utilization of SIFT and HOG features for image analysis.
7. Performing/Implementing image segmentation.
8. Implement object detection and tracking from video
9. Implement optical flow computation algorithm.
10. Demonstrate the use of optical flow in any image processing application.
11. Object detection and Recognition on available online image datasets.
12. Character or digit or face classification project.

List of Laboratory/Learning ResourcesRequired:

1. Computer Vision. Ballard and Brown
2. Invitation to 3D Vision: From Images to Geometric Models: Y. Ma, S. Soatto, J. Kosecka and S. Sastry
3. https://www.tutorialspoint.com/dip/computer_vision_and_graphics.htm

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