GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering
Subject Code: 3725412
Semester – II
Subject Name: COMPUTER VISION

Type of course: Program Elective III

Prerequisite: Programming and Mathematic course

Rationale: In this course students will learn basic principles of image formation, image processing algorithms and different algorithms for 3D reconstruction and recognition from single or multiple images (video). This course emphasizes the core vision tasks of scene understanding and recognition. Applications to 3D modelling, video analysis, video surveillance, object recognition and vision based control will be discussed.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to Image Processing and Computer Vision**: Low-level, Mid-level, High-level, Computer Graphics and Video processing, Overview of 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.	**05**
2	**Image Formation Models**: Monocular Imaging system, Fundamentals of Image Formation, Radiance, Irradiance, BRDF, color etc., Orthographic & Perspective Projection, Camera model and Camera calibration, Binocular imaging systems, Multiple views geometry, Structure determination, shape from shading, Photometric Stereo, Depth from Defocus , Construction of 3D model from images.	**07**
3	**Image Processing and Feature Extraction**: Image Preprocessing, Linear Filtering, Fourier Transform, Wavelet Transform, Geometric Transformations, Image representations (continuous and discrete) , Edge detection	**07**
4	**Motion Estimation, Shape Representation and Segmentation**: Regularization Theory, Optical Computation, Stereo Vision, Motion Estimation, Structure From Motion: Contour	**07**

	Based Representation, Region Based Representation, Deformable Curves And Surfaces, Snakes And Active Contours, Level Set Representations, Fourier And Wavelet Descriptors, Medial Representations, Multi-resolution Analysis.	
5	**Object Recognition and Image Reconstruction**: Hough Transforms And Other Simple Object Recognition Methods, Shape Correspondence and Shape Matching, Principal Component Analysis, Object detection Shape Priors For Recognition, Pattern Recognition Methods: Instance recognition, Category recognition, Context and scene understanding, Recognition databases and test sets, HMM, GMM And EM.	**07**
6	**Applications**: Face Detection, Face Recognition - Eigen faces, Active appearance and 3D shape models of faces Application, Surveillance – foreground - background separation - particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians.	**05**

Reference Books:

1. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.
2. Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Publisher: Prentice Hall.
3. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc., 1992.
4. D. H. Ballard, C. M. Brown. Computer Vision. Prentice-Hall, Englewood Cliffs, 1982.
5. Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA). Springer, 2010.
6. Image Processing, Analysis, and Machine Vision. Sonka, Hlavac, and Boyle. Thomson.
7. E. R. Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012.
8. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.
9. Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Edition, Academic Press, 2012.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Design and Implement fundamental image processing techniques	30%
CO-2	Understand and Analyse the Image formation, various Features extraction techniques.	30%

CO-3	Evaluate 3D model from Images and applications towards computer vision techniques.	20%
CO-4	Understanding Video processing, Motion Computation and 3D Vision	20%

List of Experiments:

1. **Introduction to MATLAB : Image Processing Toolbox**
2. Implement various image preprocessing techniques.
3. Implement various method of Image histogram and histogram equalization.
4. Perform the Image filtering in spatial domain.
5. Perform the Image filtering in frequency domain.
6. Implement various Image Segmentation methods.
7. Implement object detection and tracking from video.
8. Implement Pattern recognition methods: HMM, GMM and EM.
9. Implement Content based video retrieval
10. Construct 3D model from single image.

Major Equipment / software: MATLAB (Latest Version)

List of Open Source Software/learning website:

- Computer Vision. Ballard and Brown
- Invitation to 3D Vision: From Images to Geometric Models: Y. Ma, S. Soatto, J. Kosecka and S. Sastry