DSPE3003 COMPUTER VISION (3-0-0)

Course Objectives:

- To introduce the foundational principles and techniques in computer vision.
- To equip students with practical knowledge to build applications involving image and video analysis.
- To understand image processing, feature extraction, object detection, and deep learning-based vision systems.

Module-I: (08 hours)

Introduction to Computer Vision

Overview and Applications of Computer Vision , Human vs Computer Vision, Imaging geometry and camera model, Digital image formation and representation, Color spaces and conversions.

Image formation:

Geometric Camera Models, Intrinsic and Extrinsic Parameters, Geometric Camera Calibration – Linear and Non – linear approach, Light and Shading - Inference from, Modeling Inter reflection, Human Color Perception

Module-II: (08 hours)

Image Processing and Filtering

Image Enhancement (smoothing, sharpening),Edge detection (Sobel, Prewitt, Canny), Morphological operations, Histograms and thresholding (global, adaptive)

Early vision:

Linear Filters - Convolution, Fourier Transforms, Sampling and Aliasing, Filters as Templates, Correlation, Local Image Features - Computing the Image Gradient, Gradient Based Edge Detectors, Orientations, Texture - Local Texture Representations Using Filters, Shape from Texture

Module-III: (08 hours)

Feature Detection and Matching

Corner detection (Harris, FAST), SIFT, SURF, ORB, Feature descriptors and matching, RANSAC and Homography.

Mid-level vision:

Segmentation by Clustering - Basic Clustering Methods, The Watershed Algorithm, Segmentation Using K-means, Grouping and Model Fitting - Fitting Lines with the Hough Transform, Fitting Curved Structures, Tracking - Tracking by Detection, Tracking Translations by Matching, Tracking Linear Dynamical Models with Kalman Filters

Module-IV: (08 hours)

Object Recognition and Segmentation

Object detection techniques (Haar cascades, HOG+SVM) , Image segmentation (region growing, watershed, graph-cut) , Introduction to CNNs for object detection (YOLO, SSD), Semantic and instance segmentation .

Object detection and recognition:

Detecting Objects in Images - The Sliding Window Method, Face Detection, Detecting Humans, Boundaries and Deformable Objects, Object Recognition – Categorization, Selection, Applications – Tracking People, Activity Recognition

Module-V: (08 hours)

Motion Analysis and 3D Vision

Optical flow (Lucas-Kanade, Horn-Schunck), Structure from motion (SfM), Stereo vision and depth estimation, 3D reconstruction basics.

Course Outcomes (COs):

1. Understand the theoretical concepts and models behind image analysis and computer vision.
2. Apply image processing techniques for real-world applications.
3. Extract and match features to recognize and track objects.
4. Implement modern object detection and segmentation pipelines using deep learning.
5. Analyze motion and depth from video/image sequences to interpret the 3D environment.

Text Books:

1. Forsyth, Jean Ponce David A. "Computer Vision: A Modern Approach", Second Edition, Pearson Education Limited 2015.
2. Szeliski, Richard, “Computer vision: algorithms and applications”, Springer Science & Business Media, 2010.

Reference Books:

1. Hau, Chen Chi, “Handbook of pattern recognition and computer vision”, World Scientific, Fifth Edition, 2015.
2. Muhammad Sarfraz, “Computer Vision and Image Processing in Intelligent Systems and Multimedia Technologies”, IGI Global, 2014.
3. Theo Gevers, ArjanGijsenij, Joost van de Weijer, Jan-Mark Geusebroek “Color in Computer Vision: Fundamentals and Applications”, Wiley, 2012.
4. Kale, K. V, Mehrotra S.C, Manza. R.R., “Advances in Computer Vision and Information Technology”, IK International Pvt Ltd, 2013.