INT345:COMPUTER VISION

L:2 T:0 P:2 Credits:3

Course Outcomes: Through this course students should be able to

CO1 :: learn fundamentals of image processing, image enhancement and filtering.

CO2 :: familiar with various camera models such as pinhole camera model, camera calibration and lens distortion correction.

CO3 :: illustrate the concept of epipolar geometry including the epipolar constraint and fundamental matrix.

CO4 :: identify and extract relevant features from images using appropriate feature descriptors.

CO5 :: apply various processing techniques on color images and range images.

CO6 :: apply various machine learning algorithms for image classification and clustering.

Unit I

Fundamentals of Image Processing : image acquisition and representation, image file formats and color models, Overview of computer vision and its applications

Image Enhancement : Histogram equalization, contrast enhancement, Thresholding, The EM Algorithm, frequency domain techniques

Image Filtering : spatial filtering, fourier transforms, geometric transformations

Unit II

2-D Projective Geometry : planar geometry, the 2D projective plane, projective transformations, homography properties

Camera Geometry : pinhole cameras, cameras with lenses, CCD cameras, general projective cameras, affine cameras

Unit III

Stereo Geometry : epipolar geometry, fundamental matrix, motion of camera, normalized 8-point algorithm, algebric minimization algorithm, geometric distance, experimental evaluation of the algorithms, linear triangulation methods, geometric error cost function

Unit IV

Feature Detection and Description : feature detection, Harris operator, feature matching, scale invariant feature transform, speeded up robust features, hessian operator, FAST, BRIEF, ORB, HOG, texture descriptor, image descriptor, applications of descriptors

Feature Matching and model Fitting : weighted distance function, similarity measures, EMD, efficient computation of feature matching, K-D tree, LSH, model fitting techniques

Unit V

Color Processing : The physics of color, Human Color Perception, representing color, model for image color, surface color from image color

Range Image Processing : active range sensors, range data segmentation, range image registration and model acquistion, object recognition

Unit VI

Clustering and Classification : overview of classification, probabilistic approach, distance based, discriminant analysis, ANN, clustering techniques, llyod algorithm, k-means clustering

Dimensionality Reduction and Sparse Representation : PCA, LDA, sparse representation, OMP algorithm, BP algorithm

List of Practicals / Experiments:

Practicals

- Implementing basic image processing operations, such as image filtering, edge detection, and image enhancement..
- Performing geometric transformations on images, including rotation, scaling, and translation.
- Implementing feature detection algorithms like Harris corner detection or SIFT (Scale-Invariant Feature Transform) and matching features between images.

- Calibrating a camera using chessboard patterns or other calibration patterns to estimate the intrinsic and extrinsic camera parameters.
- Implementing stereo matching algorithms for estimating depth from stereo image pairs.
- Estimating optical flow between consecutive video frames to understand motion in videos.
- Implementing image segmentation algorithms, such as thresholding, region growing.
- Building object detection systems using techniques like Haar cascades.

Text Books:

1. COMPUTER VISION: A MODERN APPROACH by DAVID A. FORSYTH, Pearson Education India

References:

1. PROGRAMMING COMPUTER VISION WITH PYTHON: TOOLS AND ALGORITHMS FOR ANALYSING IMAGES by JAN ERIK SOLEM, O'REILLY