

Image Processing

Course Learning Objectives	<ul style="list-style-type: none">• Learn the fundamentals of digital image processing.• Understand simple image enhancement techniques in Spatial and Frequency domain.• Analyse the concepts of degradation function and restoration techniques.• Learn the image segmentation and representation techniques.• Implement the various image compression and recognition methods
Course Outcomes	<ul style="list-style-type: none">• Comprehend the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.
	<ul style="list-style-type: none">• Operate on images using the techniques of smoothing, sharpening and enhancement.• Perform the restoration concepts and filtering techniques.• Implement the basics of segmentation, features extraction, compression and recognition methods for color models.• Deploy the image compression concepts.

Course Duration: 45 Hours

Detailed Curriculum

Week 1:

- Types of Images, Data Types, Images as Arrays
- Import – Visualize and Extract Information from Images – Sampling & Quantisation of Images – Introductions to Pixels & Operations on Pixels
- Image Enhancement – Image Blurring – Image De blurring – Transformation – RGB Conversion – Grey Scale Conversion of Images – Discrete Wavelet Transform – Discrete Fourier Transform – Algorithmic Applications on Images
- Get into Matlab Programming

Hands on:

- Hands on examples with data types and operations
- Hands on Matrices and Vectors in script mode
- Hands on with basic plotting in MATLAB
- Examples codes on data base loading with different format
- Box plot graphs (colors, slice percent, charge legend and labels)

Week 2:

- Overview of Matlab and Image Processing Techniques – library, Importing, Exporting and Visualizing images, Image Transformations, Type Conversions, Contrast Adjustment and Zooming & Pixel Info Analysis, Placing Lines Circles Texts In a Image
- Image conversions - Image Plane Separation, Image Gray and B&W, HSV Conversions,
- Image block separation and fixing
- Image filtering - Types of Noises in a Image, Blur in images, Median Filtering on noise removal
- Region detection - Image Contour detection, Accessing Video and Storing, accessing camera and storing, HSV Conversion based color detection, Remote camera accessing

Hands on image processing basics:

- Codes on image acquisition with different formats.
- Example codes on image resize, image conversions with live coding part.
- Displaying of multiple images at a time
- Displaying of images in single figure using sub-plotting
- Example codes on segmentation using transformation techniques
- Example codes on segmentation using region based techniques

Week 3:

- Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement

- Image Restoration - degradation model, Properties, Noise models –
- Filtering - Mean Filters, Order Statistics, Adaptive filters, Band reject Filters, Band pass Filters, Notch Filters, Optimum Notch Filtering, Inverse Filtering, Wiener filtering

Week 4:

A Clear analysis and the image processing compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching. Introduction to machine learning, types of machine learning, applications and advantages. Working on Matlab for GUI Creation.

- Import data and read base of excel sheet
- Apply pre-process for the excel data to clean the data.
- Display the cleaned data in output window
- Cleaning the data base and feature analysis
- Visualize the data using graphical representation.
- Apply train and test split part of the data in MATLAB
- Apply machine learning algorithm and evaluation of accuracy.
- Show the application output using evaluation process

Hands on

- Creation of neural network models
- Model creation of deep learning with examples
- Collect the data set and load the dataset in program
- Do the pre-process for the whole dataset

Week5:

- Neural Networks, Pixel Working, distance marking, GUI
- Edge Detection, Datasets, Gesture Training
- Image Classification, Segmentation, Enhancement and Image Training
- Classification, filtering techniques, SVM Algorithm
- Deep learning techniques, CNN, edge detection from a video, distance analysis, matrix calculation

Hands on

- Do the segmentation and feature extraction for whole dataset
- Apply deep learning algorithm and get training of whole data.
- Load the input picture using image acquisition tool and do the pre-process using MATLAB
- Apply segmentation and feature extraction
- Compare input features with data base using deep learning of CNN and get results.

Test Projects:

Use case:

Industry Use Case 1 Realtime Image Processing Application

Task 1: Image Acquisition using MATLAB

Task 2: Image Segmentation using Matlab and Neural Networks Algorithm

Task 3: Feature Extraction of Segmented Images

Task 4: Image Restoration using Multiple Thresh holds

Task 5: Image Visualization and Analysis of the Breast Cancer images

Industry Use Case 2 Enhancement of Image Processing for Crop Monitoring and Disease Detection

Task1: Image Acquisition & Classification of Crop datasets

Task2: Pre-processing of crop datasets

Task3: Image Segmentation & Feature Extraction of processed crop images

Task4: Algorithm development to process the disease detection

Task5: Project Implementation of Crop Monitoring and Disease Detection

Industry Use Case 3 Surveillance Systems using real time object detection

Task 1: Acquire images for the project and implement a classification system to categorize them based on predefined criteria.

Task 2: Prioritize the pre-processing of acquired images, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task 4: Devote efforts to the development and refinement of robust algorithms tailored to the real time object detection

Task 5: Execute the Complete project, integrating the developed algorithms seamlessly to achieve the desired image processing outcomes

Industry Use Case 4 Traffic Lane Detection for driverless vehicle application

Task1: Image Acquisition & Classification of traffic lane and the vehicle movement

Task2: Pre-processing of datasets Traffic Lane Path

Task3: Image Segmentation & Feature Extraction of processed images of Traffic Lane Path

Task4: Algorithm development to process the lane images and the vehicle movement

Task5: Project Implementation of Traffic Lane Detection for driverless Vehicle Application

Industry Use Case 5 Secured Communication Systems using Cryptographic Concepts

Task 1: Acquire images for the project and implement a classification system to categorize them based on predefined criteria.

Task 2: Prioritize the pre-processing of acquired images, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task 4: Image Compression using Clustering Techniques

Task 5: Implementation of Cryptographic Algorithms for Secured data transmission

Industry Use Case 6 Brain Tumour Segmentation using back propagation Algorithm for Medical Applications

Task 1: Acquire images for the project and implement a classification system to categorize them based on predefined criteria.

Task 2: Prioritize the pre-processing of acquired brain images, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task4: Development of Back Propagation Algorithm

Task5: Brain Tumour Segmentation using back propagation Algorithm

Industry Case 7 Detecting of stone area in kidney using Neural network with deep learning

Task 1: Acquire images for the project and implement a classification system to categorize them based on predefined criteria to Medical Grade Images.

Task 2: Prioritize the pre-processing of acquired CT Scan images, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task4: Apply deep learning algorithm – neural network

Task5: Kidney stone detection using NN

Industry Case 8 Predicting of leaf diseases and pests' detection based on deep learning

Task 1: Acquire images for the project and implement a classification system to categorize them based on predefined criteria.

Task 2: Prioritize the pre-processing of acquired plant leaf images, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task4: Apply deep learning algorithm – neural network

Task5: Leaf Disease detection using NN

Industry Case 9 Gesture Recognition using MATLAB

Task 1: Acquire images for the project and implement a classification system to categorize them based on predefined criteria.

Task 2: Prioritize the pre-processing of acquired plant leaf images, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task4: Development of Algorithm for gesture recognition

Task5: Implementation of gesture recognition

Industry Case 10 Advancement of Image Enhancement for Tuberculosis Detection Using Deep Learning

Task 1: Datasets collection and implement a classification system to categorize them based on predefined criteria.

Task 2: Pre-processing of acquired scan images, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Apply segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task4: Development of Algorithm for tuberculosis detection

Task5: Implementation of Image Enhancement for Tuberculosis Detection Using Deep Learning

Industry Case 11 Fog Removal Using Enhanced Cycle Consistent Adversarial Networks

Task 1: Acquire images for the project and implement a classification system to categorize them based on predefined criteria.

Task 2: Prioritize the pre-processing of acquired fog images, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task4: Development of Algorithm for fog detection and classification

Task5: Implementation of Fog Removal Using Enhanced Cycle Consistent Adversarial Networks

Industry Use Case 12 Social Distance Detection using Deep Learning Techniques

Task 1: Create a datasets and implement a classification system to categorize them based on predefined criteria.

Task 2: Apply the Pre-process technique for the datasets, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task4: Development an Algorithm for detecting a distance between the human to human.

Task5: Implementation of social distance detection using Matlab

Industry Use Case 13 Image Retrieval Development for Medical Applications

Task 1: Create a medical datasets and implement a classification system to categorize them based on predefined criteria.

Task 2: Apply the Pre-process technique for the datasets, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task4: Development an Algorithm to retrieve an image from the medical datasets

Task5: Implementation of Medical Image Retrieval using Matlab

Industry Use Case 14 Face Emotion recognition for Entertainment Application

Task 1: Create a datasets and implement a classification system to categorize them based on predefined criteria.

Task 2: Apply the Pre-process technique for the datasets, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task4: Development an Algorithm to recognize and expression of the face. Task5:

Implementation of Face Emotion recognition for Entertainment Application

Industry Use Case 15 Leaf Disease Detection using Neural Networks

Task 1: Create a leaf datasets and implement a classification system to categorize them based on predefined criteria.

Task 2: Apply the Pre-process technique for the datasets, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task4: Development an NN Algorithm to recognize and expression of the disease part in the leaf.

Task5: Implementation of leaf disease detection using neural network

Industry Use Case 16 Covid Disease detection using X-ray Images for medical applications

Task 1: Create a x ray image datasets and implement a classification system to categorize them based on predefined criteria.

Task 2: Apply the Pre-process technique for the datasets, focusing on techniques such as noise reduction, contrast adjustment, and normalization.

Task 3: Implement advanced segmentation methods and extract relevant features from segmented regions for comprehensive analysis.

Task4: Development an Algorithm to detect a covid disease from the processed datasets

Task5: Implementation of Covid Disease detection using X-ray Images for medical applications

Industry Use Case 17 Object recognition from pre-trained model

Task 1: Project Planning, Setup, Select Pre-trained Model and Identify Deployment Environment.

Task 2: Data Preparation and Split Data for Training and Testing.

Task3: Integrate the selected pre-trained model into your project. This may involve using a deep learning MATLAB

Task 4: Deploy the object recognition model. This might involve integrating it into existing systems, deploying it on edge devices, or setting up a server for remote recognition and configure the system for real-time object recognition.

Task 5: Implement a monitoring system to track the model's performance in the deployed environment

Industry Use Case 18: Person re-identification through face detection from videos using Deep Learning

Task 1: Choose a deep learning-based face detection model suitable for video analysis. This could include models like MTCNN, SSD, or YOLO.

Task 2: Model Training for Face Detection Preprocess the video data to extract individual frames, resize them, and normalize pixel values. Ensure that the data is prepared for training the face detection model.

Task 3: Face Recognition Model Selection Choose a deep learning-based face recognition model suitable for person re-identification.

Models like ArcFace, FaceNet, or VGGFace are common choices.

Task 4: Train Face Recognition Model

Use the deep learning framework to train the face recognition model on the prepared dataset. Implement loss functions suitable for person re-identification, considering contrastive or triplet loss.

Task 5: Develop algorithms that utilize the detected faces to re-identify individuals across video frames. Consider factors like tracking and feature matching for accurate re-identification.

Industry Use Case 19: Optical Character Recognition using py-Tesseract and Classification

Task 1: Project Planning and Data Collection

Choose an OCR model or algorithm suitable for your project. MATLAB provides built-in functions and tools for OCR, including the Optical Character Recognition Toolbox.

Task 2: Utilize MATLAB's OCR functions or implement custom OCR algorithms to train the model on the prepared dataset. Fine-tune parameters to optimize recognition accuracy.

Task 3: Evaluate the trained OCR model on a separate validation dataset to assess its accuracy and generalization capabilities. Fine-tune hyperparameters if needed.

Task 4: Implement a mechanism to acquire images or documents for OCR. This could involve loading images from files, capturing images through a camera, or processing scanned documents.

Task 5: Integrate the trained OCR model into your MATLAB project. Utilize the OCR functions provided by MATLAB or integrate custom algorithms, depending on the complexity of your OCR requirements.

Industry Use Case 20: Finding person with Helmet Detection for MVD using Deep learning

Task 1: Selecting a deep learning-based object detection model suitable for your project.

Task 2: Preprocess the collected dataset by resizing images, normalizing pixel values, and organizing annotations into suitable formats for training the selected object detection model.

Task 3: Evaluate the trained object detection model on a separate validation dataset to assess its accuracy and generalization capabilities. Fine-tune hyperparameters if needed.

Task 3: Implement a mechanism to acquire video frames, either from surveillance cameras or recorded footage, for helmet detection. This could involve capturing frames at regular intervals or processing video streams.

Task 4: Integrate the trained object detection model into your project. Use the model to identify people within the video frames.

Task 5: Test the entire system on video frames that were not part of the training or

validation datasets. Assess its performance in real-world scenarios and identify any potential challenges.

Industry Use Case 21: Gender Recognition using MATLAB

Task 1: Gather a dataset of images or video frames containing faces with annotated gender labels. Annotate the dataset with the corresponding ground truth gender information.

Task 2: Utilize MATLAB's deep learning capabilities to train the gender recognition model on the prepared dataset. Fine-tune the model for optimal performance on your specific use case.

Task 3 Evaluate the trained gender recognition model on a separate validation dataset to assess its accuracy and generalization capabilities. Fine-tune hyperparameters if needed.

Task 4: Implement a mechanism to acquire images, either from a database or real-time capturing, for gender recognition. This could involve loading images from files, capturing images through a camera, or processing video streams.

Task 4: Integrate the trained gender recognition model into your MATLAB project. Utilize the model to predict gender from the preprocessed images.

Task 5: Test the entire system on images or video frames that were not part of the training or validation datasets. Assess its performance in real-world scenarios and identify any potential challenges.