Training Course on Image Processing and Computer Vision Algorithms

Professional Development Training Course Outline

Category	Engineering	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

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This intensive training course provides a comprehensive exploration of Image Processing and Computer Vision Algorithms, equipping participants with the theoretical understanding and practical skills to analyze, interpret, and manipulate visual data for a wide range of applications. Training Course on Image Processing and Computer Vision Algorithms delves into fundamental concepts such as image enhancement, feature extraction, segmentation, and object recognition, laying a robust foundation for building intelligent systems that can "see" and understand the world. Attendees will gain hands-on experience with core algorithms, preparing them to tackle challenges in areas like medical imaging, industrial inspection, robotics, and security systems.

In today's rapidly evolving technological landscape, where Artificial Intelligence (AI) and Machine Learning (ML) are driving innovation, expertise in Computer Vision is paramount for developing cutting-edge solutions. This course goes beyond traditional techniques to cover trending topics such as deep learning for image analysis, 3D vision, video processing, and the application of vision algorithms in augmented reality (AR) and autonomous systems. Through practical coding exercises using popular libraries like OpenCV and Python, real-world case studies, and exposure to state-of-the-art methodologies, participants will be empowered to design and implement sophisticated vision systems that deliver significant value across diverse industries.

Programme Curriculum

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Course Objectives

1. Understand the fundamental principles and applications of digital image processing.
2. Apply various image enhancement techniques for improved visual quality and analysis.
3. Perform effective image segmentation to isolate objects of interest within an image.
4. Extract meaningful features from images for recognition and analysis tasks.
5. Comprehend the core concepts of computer vision and its role in intelligent systems.
6. Implement object detection and recognition algorithms using traditional and deep learning approaches.
7. Work with 3D vision concepts, including camera calibration, stereo vision, and point clouds.
8. Process and analyze video sequences for motion detection and tracking.
9. Apply machine learning techniques for image classification and pattern recognition.
10. Design and optimize computer vision pipelines for real-world applications.
11. Evaluate the performance of image processing and vision algorithms using appropriate metrics.
12. Utilize popular programming libraries (e.g., OpenCV, Python) for practical implementation.
13. Contribute to the development of AI-powered vision systems for various industries.

Organizational Benefits

1. Enhanced Automation Capabilities: Enabling smarter, vision-guided robots and systems.
2. Improved Quality Control: Automated defect detection and precision inspection.
3. Increased Efficiency and Throughput: Faster processing of visual data and reduced manual labor.
4. Data-Driven Insights: Extracting valuable information from images and videos.
5. Development of Innovative Products: Integrating advanced vision features into new solutions.
6. Safer Operations: Enabling autonomous navigation and surveillance.
7. Competitive Advantage: Adoption of cutting-edge AI and computer vision technologies.
8. Cost Reduction: Minimizing errors, waste, and manual intervention.

9. Skilled Workforce: Empowered employees proficient in image and vision algorithm development.
10. Accelerated Digital Transformation: Driving the adoption of intelligent vision systems.

Target Participants

- Software Developers
- Data Scientists
- AI/ML Engineers
- Robotics Engineers
- Automation Engineers
- Research Scientists
- Quality Control Engineers
- Image Analysts
- Computer Science Graduates
- Electrical and Electronics Engineers

Course Outline

Module 1: Fundamentals of Digital Image Processing

- **Image Representation:** Pixels, intensity, color models (RGB, HSV, Grayscale).
- **Image File Formats:** JPEG, PNG, TIFF, and their characteristics.
- **Image Acquisition:** Digital cameras, sensors, and sampling.
- **Basic Image Operations:** Histograms, brightness, contrast adjustment.
- **Case Study:** Analyzing image histograms to identify over/under-exposed areas in a photograph.

Module 2: Image Enhancement Techniques

- **Spatial Domain Filtering:** Smoothing (Gaussian, Median), Sharpening (Laplacian, Sobel).
- **Frequency Domain Filtering:** Fourier Transform, ideal, Butterworth, Gaussian filters.
- **Noise Models:** Gaussian, Salt-and-Pepper, Speckle noise.
- **Noise Reduction Methods:** Wiener filter, Non-local Means.
- **Case Study:** Applying different filters to reduce noise and enhance details in a medical X-ray image.

Module 3: Image Segmentation

- **Thresholding:** Global, adaptive, Otsu's method.
- **Edge Detection:** Sobel, Canny, Prewitt operators.
- **Region-Based Segmentation:** Region growing, split-and-merge.
- **Watershed Transform:** Segmenting touching objects.
- **Case Study:** Segmenting individual cells from a microscopic biological image using watershed.

Module 4: Feature Extraction and Description

- **Corners and Interest Points:** Harris corner detector, SIFT, SURF.
- **Blob Detection:** LoG, DoG, MSER.

- **Hough Transform:** Detecting lines, circles, and ellipses.
- **Feature Descriptors and Matching:** Brute-force, FLANN.
- **Case Study:** Using SIFT features to match panoramic images for image stitching.

Module 5: Introduction to Computer Vision

- **Overview of Computer Vision Tasks:** Object recognition, tracking, 3D reconstruction.
- **Image Understanding vs. Image Processing:** Higher-level interpretation.
- **Camera Models:** Pinhole camera model, intrinsic and extrinsic parameters.
- **Geometric Transformations:** Affine, projective transformations for image alignment.
- **Case Study:** Projecting 3D points onto a 2D image plane using camera parameters.

Module 6: Object Detection and Recognition (Traditional Methods)

- **Template Matching:** Correlation-based object localization.
- **Haar Cascades:** Viola-Jones object detection framework (e.g., face detection).
- **Histograms of Oriented Gradients (HOG):** Feature descriptor for object detection.
- **Support Vector Machines (SVM) for Classification:** Training classifiers on extracted features.
- **Case Study:** Implementing a simple pedestrian detection system using HOG features and SVM.

Module 7: Deep Learning for Image Classification

- **Neural Network Fundamentals:** Perceptrons, activation functions, backpropagation.
- **Convolutional Neural Networks (CNNs):** Convolutional layers, pooling layers, fully connected layers.
- **CNN Architectures:** LeNet, AlexNet, VGG, ResNet.
- **Transfer Learning:** Fine-tuning pre-trained models for new tasks.
- **Case Study:** Classifying different types of plants from images using a pre-trained ResNet model.

Module 8: Deep Learning for Object Detection

- **Region Proposal Networks (RPN):** Generating candidate object locations.
- **Two-Stage Detectors:** R-CNN, Fast R-CNN, Faster R-CNN.
- **One-Stage Detectors:** YOLO (You Only Look Once), SSD (Single Shot Detector).
- **Performance Metrics:** Intersection over Union (IoU), Mean Average Precision (mAP).
- **Case Study:** Detecting and localizing multiple objects (e.g., cars, pedestrians) in street scene images using YOLO.

Module 9: Image Classification and Semantic Segmentation with Deep Learning

- **Semantic Segmentation:** Pixel-level classification of image regions.
- **Fully Convolutional Networks (FCN):** Architectures for semantic segmentation.
- **U-Net and Mask R-CNN:** Advanced architectures for medical image segmentation and instance segmentation.
- **Loss Functions for Segmentation:** Cross-entropy, Dice loss.
- **Case Study:** Segmenting different tissue types in MRI scans using a U-Net architecture.

Module 10: 3D Vision and Stereo Perception

- **Stereo Vision Principles:** Disparity, depth estimation from two images.
- **Stereo Matching Algorithms:** Block matching, semi-global matching.

- **Structured Light 3D Scanners:** Projecting patterns for depth sensing.
- **Point Clouds:** Representation, processing, and applications (e.g., 3D object recognition).
- **Case Study:** Reconstructing a 3D scene from a pair of stereo images and generating a point cloud.

Module 11: Video Processing and Motion Analysis

- **Video Representation:** Frames, temporal coherence.
- **Motion Estimation:** Optical flow, block matching.
- **Motion Tracking:** Kalman filters, particle filters, Mean-Shift tracking.
- **Background Subtraction:** Detecting moving objects in a static scene.
- **Case Study:** Implementing a system to detect and track moving vehicles in surveillance video.

Module 12: Image Registration and Stitching

- **Image Registration Techniques:** Aligning multiple images of the same scene.
- **Feature-Based Registration:** Using extracted features for alignment.
- **Intensity-Based Registration:** Aligning images by optimizing intensity similarity.
- **Image Stitching:** Creating panoramas from overlapping images.
- **Case Study:** Stitching multiple aerial drone images to create a larger, seamless map.

Module 13: Applications of Computer Vision

- **Medical Imaging Analysis:** Tumor detection, disease diagnosis.
- **Industrial Automation and Quality Control:** Defect inspection, assembly verification.
- **Robotics and Autonomous Navigation:** SLAM (Simultaneous Localization and Mapping), obstacle avoidance.
- **Biometrics and Security:** Face recognition, fingerprint recognition.
- **Case Study:** Designing a vision system for automated inspection of electronic circuit boards for manufacturing defects.

Module 14: Practical Implementation with OpenCV and Python

- **OpenCV Fundamentals:** Basic image loading, display, and manipulation.
- **NumPy for Image Operations:** Efficient array manipulation.
- **Integrating Deep Learning Frameworks:** TensorFlow/Keras or PyTorch with OpenCV.
- **Building a Complete Vision Pipeline:** From image acquisition to result visualization.
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Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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