Training Course on Image Segmentation and Feature Extraction Techniques

Professional Development Training Course Outline

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

Course Introduction

Training Course on Image Segmentation and Feature Extraction Techniques is designed to equip professionals with cutting-edge skills in **computer vision** and **image processing**, leveraging both traditional and **deep learning** approaches. Participants will gain practical expertise in segmenting images for **object detection**, **medical imaging analysis**, **autonomous systems**, and **quality control** , mastering techniques from **thresholding** to advanced **Convolutional Neural Networks (CNNs)** and **U-Nets**. The curriculum emphasizes **real-world applications**, ensuring learners can immediately apply their knowledge to solve complex **data science** and **AI challenges**.

The increasing demand for intelligent systems across industries makes proficiency in **image segmentation** and **feature extraction** indispensable. This training will delve into fundamental concepts such as **edge detection**, **region growing**, and **texture analysis**, progressing to advanced topics like **semantic segmentation**, **instance segmentation**, and **panoptic segmentation**. By exploring diverse **feature descriptors** (e.g., SIFT, HOG) and state-of-the-art **neural network architectures**, attendees will develop a robust understanding of how to transform raw visual data into actionable insights, driving innovation and efficiency in their respective fields.

Programme Curriculum

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Course Objectives

Upon completion of this training, participants will be able to:

1. Understand foundational concepts of digital image processing and computer vision.
2. Master various image segmentation techniques, including thresholding, region-based methods , and edge detection.
3. Apply advanced deep learning models for semantic segmentation and instance segmentation (e.g., U-Net, Mask R-CNN).
4. Extract robust features using both traditional methods (e.g., SIFT, HOG, GLCM) and learned features from CNNs.
5. Implement practical solutions for object detection and recognition in diverse applications.
6. Utilize image segmentation for medical image analysis and diagnosis.
7. Apply feature extraction in autonomous vehicles for environmental understanding.
8. Enhance quality control and industrial inspection processes through automated image analysis.
9. Work with popular libraries and frameworks like OpenCV, TensorFlow, and PyTorch.
10. Evaluate the performance of various segmentation and feature extraction algorithms.
11. Address challenges related to noisy images, illumination variations, and occlusion.
12. Develop custom solutions for specific image analysis problems using acquired techniques.
13. Stay updated with trending advancements in AI-driven image analysis.

Organizational Benefits

- Automate visual inspection, quality control, and data extraction tasks, reducing manual effort and errors.
- Gain deeper insights from visual data in areas like medical diagnostics, agricultural monitoring, and urban planning.
- Empower teams to develop and deploy cutting-edge AI solutions for computer vision challenges, fostering a competitive edge.
- Minimize waste and optimize resource allocation through precise object identification and analysis in manufacturing and inventory.
- Implement robust systems for critical applications such as autonomous navigation and security surveillance, leading to safer and more dependable operations.
- Equip employees with highly sought-after skills in a rapidly evolving field, improving internal capabilities and reducing reliance on external consultants.
- Leverage advanced image analysis to build smarter products and services, creating new revenue streams and market opportunities.

Target Audience

1. AI/ML Engineers.
2. Data Scientists.
3. Computer Vision Researchers.
4. Software Developers.
5. Biomedical Engineers.
6. Robotics Engineers.
7. Quality Control Engineers.
8. GIS Analysts/Remote Sensing Specialists.

Course Outline

Module 1: Introduction to Digital Image Processing & Computer Vision

- Fundamentals of Digital Images
- Image File Format.
- Basic Image Operation.
- Introduction to OpenCV.
- **Case Study**: Analyzing different image modalities (e.g., medical vs. natural scene) and their characteristics.

Module 2: Image Preprocessing for Segmentation

- Noise Reduction Techniques.
- Image Enhancement
- Geometric Transformations.
- Image Warping and Registration.
- **Case Study**: Preprocessing medical MRI scans to remove noise and enhance tissue contrast for better segmentation.

Module 3: Traditional Image Segmentation Techniques I

- Thresholding: Global, Adaptive, Otsu's Thresholding.
- Connected Component Labeling: Identifying distinct regions in a binary image.
- Region Growing: Expanding regions based on similarity criteria.
- Region Splitting and Merging: Hierarchical segmentation approach.
- **Case Study**: Segmenting objects from a conveyor belt in an industrial quality control setting using adaptive thresholding

Module 4: Traditional Image Segmentation Techniques II

- Edge Detection Algorithms: Sobel, Prewitt, Roberts, Canny Edge Detector.
- Hough Transform: Detecting lines, circles, and other shapes.
- Clustering-based Segmentation: K-Means, Mean Shift for image partitioning.
- Watershed Algorithm: Segmenting touching objects.
- **Case Study**: Detecting road lanes in autonomous vehicle navigation using Canny edge detection and Hough Transform.

Module 5: Morphological Operations

- Erosion and Dilation: Fundamental operations for shape analysis.
- Opening and Closing: Removing small objects and filling gaps.
- Morphological Gradient and Top Hat/Black Hat: Highlighting boundaries and enhancing features.
- Hit-or-Miss Transform: Pattern matching in binary images.

- **Case Study**: Cleaning up segmented regions of cells in microscopic images to remove noise and refine cell boundaries.

Module 6: Introduction to Feature Extraction

- What are Image Features?: Importance and types (low-level vs. high-level).
- Color Features: Color Histograms, Color Moments.
- Texture Features: Gray-Level Co-occurrence Matrix (GLCM), Local Binary Patterns (LBP).
- Shape Features: Area, Perimeter, Eccentricity, Hu Moments.
- **Case Study**: Using GLCM to classify different types of land cover (e.g., forest, urban, water) in satellite imagery.

Module 7: Local Feature Descriptors

- Harris Corner Detector: Identifying distinctive points.
- Scale-Invariant Feature Transform (SIFT): Robust keypoint detection and description.
- Speeded Up Robust Features (SURF): Faster alternative to SIFT.
- Oriented FAST **and Rotated BRIEF (ORB)**: Efficient alternative for real-time applications.
- **Case Study**: Object recognition in augmented reality applications using SIFT features for robust object tracking.

Module 8: Histogram of Oriented Gradients (HOG) and Object Detection

- Understanding HOG: Gradient computation, cell and block normalization.
- HOG for Pedestrian Detection: Training and applying HOG features with SVMs.
- Sliding Window Approach: Scanning images for object detection.
- Non-Maximum Suppression: Refining detection results.
- **Case Study**: Building a pedestrian detection system for surveillance applications using HOG and SVM.

Module 9: Introduction to Deep Learning for Image Analysis

- Neural Network Fundamentals: Neurons, Activation Functions, Backpropagation.
- Convolutional Neural Networks (CNNs): Convolutional layers, Pooling layers, Fully Connected layers.
- Transfer Learning: Leveraging pre-trained models.
- Setting up Deep Learning Environments: TensorFlow and PyTorch basics.
- **Case Study**: Understanding how pre-trained CNNs (e.g., VGG, ResNet) can extract powerful features for image classification tasks.

Module 10: Semantic Segmentation with Deep Learning

- Fully Convolutional Networks (FCNs): Architecture for pixel-wise classification.
- U-Net Architecture: Encoder-decoder structure for medical image segmentation.
- Dilated Convolutions: Expanding receptive fields without losing resolution.
- Loss Functions for Segmentation: Cross-entropy, Dice Loss.
- **Case Study**: Segmenting brain tumors from MRI scans using a U-Net architecture for precise boundary detection.

Module 11: Instance Segmentation with Deep Learning

- Introduction to Instance Segmentation: Differentiating individual objects of the same class.
- Mask R-CNN: Combining object detection with pixel-level segmentation masks.
- Feature Pyramid Networks (FPNs): Enhancing multi-scale feature representation.
- Anchor Boxes and RoIAlign: Key components of Mask R-CNN.

- **Case Study**: Counting and identifying individual fruits on a tree for automated harvesting using Mask R-CNN.

Module 12: Panoptic Segmentation and Advanced Architectures

- Understanding Panoptic Segmentation: Unifying semantic and instance segmentation.
- Panoptic FPN and other state-of-the-art models: Overview and applications.
- Attention Mechanisms in Segmentation: Integrating attention for better feature focus.
- Transformer-based Models for Vision: Introduction to Vision Transformers for segmentation.
- **Case Study**: Comprehensive scene understanding for autonomous vehicles, identifying both "stuff" (road, sky) and "things" (cars, pedestrians) simultaneously.

Module 13: Evaluation Metrics and Model Optimization

- Segmentation Metrics: IoU (Jaccard Index), Dice Coefficient, Pixel Accuracy, F1-score.
- Feature Evaluation: Robustness, Discriminability.
- Model Training Strategies: Data Augmentation, Regularization.
- Hyperparameter Tuning: Optimizing model performance.
- **Case Study**: Comparing the performance of different segmentation models for a satellite imagery application and selecting the best model based on relevant metrics.

Module 14: Real-world Applications & Case Studies Deep Dive

- Medical Imaging: Organ segmentation, disease detection, pathology analysis.
- Autonomous Driving: Scene understanding, pedestrian detection, lane detection.
- Industrial Inspection: Defect detection, object counting, quality assessment.
- Agriculture: Crop health monitoring, yield prediction.
- Security & SurveillanceUpcoming 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
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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