Topic 1: Image Processing Fundamentals

Guidelines:

1. **Understanding Digital Images**:
   - Explain how digital images are represented as matrices of pixels.
   - Describe different image types (e.g., grayscale, RGB, binary).
2. **Basic Image Operations**:
   - Demonstrate how to perform basic image operations such as resizing, cropping, and rotating.
   - Explain the effects of these operations on the image quality and resolution.
3. **Filtering and Enhancement**:
   - Apply various filters (e.g., Gaussian, median) to remove noise from images.
   - Use techniques like histogram equalization to enhance image contrast.
4. **Edge Detection**:
   - Implement edge detection algorithms such as Sobel, Prewitt, and Canny.
   - Explain the importance of edge detection in image analysis.
5. **Practical Exercises**:
   - Provide sample images for students to practice the above techniques.
   - Ask students to submit their code and a report explaining the results.

Topic 2: Feature Extraction and Description

Guidelines:

1. **Introduction to Features**:
   - Explain the concept of features in images and their importance in computer vision tasks.
   - Differentiate between low-level features (e.g., edges, corners) and high-level features (e.g., shapes, objects).
2. **Feature Detection Methods**:
   - Introduce various feature detection algorithms such as Harris corner detection, FAST, and SIFT.
   - Describe the working principles and use cases for each algorithm.
3. **Feature Descriptors**:
   - Explain how feature descriptors (e.g., SIFT, SURF, ORB) are used to describe and match features.
   - Discuss the importance of invariance to scaling, rotation, and illumination changes.
4. **Feature Matching**:
   - Demonstrate how to match features between images using techniques like brute-force matching and FLANN.
   - Explain the concepts of homography and its application in image stitching.
5. **Practical Exercises**:
   - Provide images for students to detect and match features.
   - Assign a project where students need to create a panorama from multiple overlapping images.

Topic 3: Object Detection and Recognition

Guidelines:

1. **Introduction to Object Detection**:
   - Explain the difference between object detection, localization, and recognition.
   - Discuss the significance of object detection in real-world applications.
2. **Classical Methods**:
   - Introduce classical methods for object detection such as the Viola-Jones algorithm.
   - Explain the concept of sliding window and image pyramids.
3. **Deep Learning Approaches**:
   - Discuss the impact of deep learning on object detection.
   - Introduce popular object detection architectures like YOLO, SSD, and Faster R-CNN.
4. **Evaluation Metrics**:
   - Explain common metrics for evaluating object detection performance (e.g., precision, recall, mAP).
   - Provide examples to illustrate how these metrics are calculated.
5. **Practical Exercises**:
   - Assign a project where students need to implement and evaluate an object detection algorithm on a given dataset.
   - Ask students to submit their code, results, and a report discussing their approach and findings.

Topic 4: Image Segmentation

Guidelines:

1. **Introduction to Image Segmentation**:
   - Define image segmentation and its importance in computer vision.
   - Differentiate between semantic segmentation, instance segmentation, and panoptic segmentation.
2. **Classical Segmentation Techniques**:
   - Explain classical segmentation methods like thresholding, region growing, and clustering (e.g., K-means).
   - Discuss their advantages and limitations.
3. **Deep Learning for Segmentation**:
   - Introduce deep learning architectures for segmentation, such as Fully Convolutional Networks (FCNs), U-Net, and Mask R-CNN.
   - Explain the significance of skip connections and multi-scale processing in segmentation.
4. **Evaluation Metrics**:
   - Describe metrics for evaluating segmentation performance (e.g., IoU, Dice coefficient).
   - Provide examples to illustrate the calculation of these metrics.
5. **Practical Exercises**:
   - Provide a labeled dataset for students to practice segmentation.
   - Assign a project where students need to implement and evaluate a segmentation model on the dataset.

Topic 5: Motion Analysis and Tracking

Guidelines:

1. **Introduction to Motion Analysis**:
    - Explain the importance of motion analysis in computer vision.
    - Discuss applications such as video surveillance, autonomous driving, and human-computer interaction.
2. **Optical Flow**:
    - Introduce the concept of optical flow and its computation using methods like Lucas-Kanade and Horn-Schunck.
    - Explain the assumptions and limitations of these methods.
3. **Feature-Based Tracking**:
    - Describe feature-based tracking techniques such as KLT tracker and object tracking using SIFT/SURF features.
    - Discuss the importance of feature selection and matching in tracking.
4. **Model-Based Tracking**:
    - Introduce model-based tracking approaches such as Kalman filters and particle filters.
    - Explain how these models can be used to predict and update object positions over time.
5. **Practical Exercises**:
    - Provide video sequences for students to practice motion analysis and tracking.
    - Assign a project where students need to implement and evaluate a tracking algorithm on a given video sequence.