Object Detection and Tracking

Introduction

Object detection and tracking play a crucial role in various applications, including surveillance systems, autonomous vehicles, and robotics. This project aims to develop a model that can effectively detect and track objects in real-time video feeds. The model utilizes the pre-trained SSD MobileNet v3 Large architecture for object classification and localization, coupled with a centroid tracking algorithm for object tracking.

Methodology

The project implementation involves the following steps:

1. **Library Loading:** Import the necessary libraries, including OpenCV, cv2, and matplotlib.pyplot, to handle image processing, model loading, and visualization tasks.

2. **Model Loading:** Load the pre-trained SSD MobileNet v3 Large model from the specified configuration (.pbtxt) and frozen model (.pb) files. This model provides the ability to identify and classify objects within an image or video frame.

3. **Class Label Loading:** Read the class labels from the corresponding text file. These labels correspond to the object classes that the model can detect and classify.

4. **Model Input Parameters:** Set the model input parameters, including input size, input scale, input mean, and swap RB channels, to ensure compatibility with the model's expectations.

5. **Image or Video Input:** Read the input image or video frame. For images, a single frame is loaded, while for videos, frames are captured from a video stream.

6. **Object Detection:** Detect objects in the input image or frame using the loaded SSD MobileNet v3 Large model and a specified confidence threshold. The model outputs bounding boxes around the detected objects and their corresponding confidence scores.

7. **Bounding Box Visualization:** Draw bounding boxes around the detected objects and display their corresponding class labels using OpenCV drawing functions. This provides a visual representation of the detected objects.

8. **Object Tracking:** For video frames, track the detected objects using a centroid tracking algorithm. This algorithm tracks objects based on their centroids, enabling the identification of objects across multiple frames.

9. **Output Display:** Display the processed image or frame, showing the detected objects, bounding boxes, and class labels. For video streams, continuously process and display frames until the user presses ‘q’ to quit.

Results

The project successfully demonstrates the ability to detect and track objects in real-time video feeds. The model accurately identifies and classifies objects, and the centroid tracking algorithm effectively tracks objects across multiple frames.

Applications

The object detection and tracking system developed in this project can be applied to various real-world scenarios, including:

- Surveillance Systems: Monitor and analyze activities in real-time for security purposes, enabling the identification of suspicious behavior or potential threats.
- Autonomous Vehicles: Detect and track objects in the surroundings, such as pedestrians, vehicles, and traffic signs, to enable safe navigation and obstacle avoidance.

- Robotics: Enable robots to interact with their environment by identifying and tracking objects of interest, facilitating tasks such as object manipulation and autonomous navigation.

Future Enhancements

The project can be further enhanced by:

- Implementing more sophisticated object tracking algorithms for improved tracking accuracy and robustness, especially in complex or challenging environments.
- Integrating the object detection and tracking system into real-world applications, such as surveillance systems or autonomous vehicles, to evaluate its effectiveness in practical settings.
- Exploring the use of deep learning techniques for object detection and tracking, potentially achieving higher accuracy and adaptability to diverse object categories and environmental conditions.

Conclusion

The object detection and tracking system developed in this project demonstrates the feasibility of using a pre-trained SSD MobileNet v3 Large model and a centroid tracking algorithm for real-time object detection and tracking in video feeds. The project provides a foundation for further development and integration into practical applications.