**PROJECT REPORT**

**ON**

**VEHICLE CUT IN DETECTION**

**TECHNICAL APPROACH**

The project focuses on vehicle cut-in detection using machine learning techniques, particularly leveraging deep learning models and computer vision algorithms. The primary goal is to detect vehicles in a video stream, track their positions, and calculate distances between them to identify potential cut-ins. A cut-in is detected if the distance between two vehicles falls below a certain threshold, triggering a warning. The following sections detail the various techniques and methods used in the implementation of this project.

The first step in our technical approach is loading a pre-trained deep learning model for object detection. In this project, we use the YOLOv5 model, a state-of-the-art object detection model known for its accuracy and speed. YOLO (You Only Look Once) is a convolutional neural network (CNN) that can detect objects in real-time.

model = torch.hub.load('ultralytics/yolov5', 'yolov5s')

By utilizing PyTorch Hub, we can easily load the YOLOv5 model. This model is pre-trained on the COCO dataset, which includes a wide variety of objects, including vehicles.

### Object Detection

Once the model is loaded, we apply it to each frame of the video to detect vehicles. YOLOv5 outputs bounding boxes around detected objects along with their confidence scores and class labels. In this project, we focus only on cars (class label 2).

### Object Tracking

To maintain continuity and track the movement of detected vehicles across frames, we implemented a simple tracking algorithm. The SimpleTracker class manages the trackers for detected vehicles and updates their positions based on new detections. The update method matches new detections to existing trackers using the Intersection over Union (IoU) metric, which measures the overlap between two bounding boxes.

### Distance Calculation

To determine potential cut-ins, we calculate the Euclidean distance between the centres of tracked vehicles. If the distance between any two vehicles falls below a predefined threshold, a warning is issued.

### Warning Mechanism

The main loop processes each frame of the video, updating vehicle tracks and calculating distances between vehicles. If the distance between any two vehicles is below the warning threshold, a warning message is displayed on the video frame.

**Tools and Technologies Used in the Project**

* **Python**: Primary programming language for its extensive libraries.
* **PyTorch**: Deep learning framework for building and training neural networks.
* **YOLOv5**: Real-time object detection model for vehicle detection.
* **OpenCV**: Computer vision library for video capture, frame processing, and writing output files.
* **NumPy**: Library for numerical operations and distance calculations.
* **PyCharm**: Integrated Development Environment (IDE) for efficient Python development.

**ISSUES FACED**

**Model Compatibility and Performance**:

* **Issue**: Integrating the pre-trained YOLOv5 model into the project.

**Video Processing Speed**:

* **Issue**: Processing each frame in real-time while maintaining performance.

**Object Tracking Accuracy**:

* **Issue**: Maintaining consistent vehicle identities across frames.

**False Positives in Vehicle Detection**:

* **Issue**: Detecting non-vehicle objects or misclassifying vehicles.

**OUTCOME**

 **Successful Vehicle Detection:**

* The system effectively detects vehicles in real-time from video feeds. The use of the SSD Mobile Net V1 model allowed for efficient processing, balancing speed and accuracy, crucial for real-time applications.

 **Accurate Distance Estimation:**

* The implemented algorithm accurately estimates the distance between detected vehicles, leveraging bounding box coordinates and a custom distance approximation formula. This capability is vital for assessing potential collision risks.

 **Real-Time Warning System:**

* The system provides timely warnings when vehicles are detected to be within a potentially dangerous proximity. The warning messages are overlaid on the video feed, enhancing driver awareness and promoting safety.