# Problem Statement

# Vehicle cut-in detection and Collision warning system

Ensuring the safety of autonomous vehicles is a critical challenge as they navigate complex road environments. The AUTOBOTS team has developed an innovative solution that combines object detection, vehicle tracking, and real-time collision risk analysis to provide timely warnings and enhance overall driving safety

# Unique Idea Brief (Solution)

Our solution leverages the YOLOv8 deep learning model for real-time detection of various vehicles, including cars, buses, two-wheelers, and pushcarts, and integrates DeepSORT for robust tracking, maintaining consistent vehicle tracks to calculate speed and trajectory. Designed to adapt to diverse scenarios, our system ensures reliable performance across varying road conditions, lighting, and vehicle types. By estimating speed using the Euclidean distance formula and a pixels-per-meter ratio, we propose two methods to trigger collision warnings: static lines in front of the vehicle to calculate time to collision, and lane detection to identify cut-in maneuvers, both aiming to trigger warnings for a time to collision (TTC) between 0.5 to 0.7 seconds.

# Features Offered

## Accurate Speed Estimation

### Distance Calculation

The system leverages the Euclidean distance formula and a pre-determined pixels-per-meter ratio to accurately measure the distance traveled by each tracked vehicle.

### Speed Computation

Using the calculated distance and a time constant, the vehicle's speed is estimated and displayed, providing vital information for cut-in detection and collision warning.

### Continuous Monitoring

The speed estimation process is continuously updated, ensuring real-time tracking of vehicle dynamics and enabling timely detection of abrupt cut-in maneuvers.

# Cut-in Detection and Warnings

## Predefined Boundary Lines

The system defines two virtual lines on the camera feed, representing potential cut-in boundaries. Vehicles crossing these lines trigger the cut-in detection event.

## Intersection Check

The tracked vehicle trajectories are continuously checked for intersection with the predefined lines, enabling the system to identify and alert on cut-in maneuvers.

## Visual Indicators

Upon detecting a cut-in event, the system displays visual cues, such as bounding boxes and labels, to provide immediate feedback to the driver or autonomous system.

# Collision Risk Assessment

## Distance Monitoring

The system continuously calculates the distances between tracked vehicles, using predefined thresholds to identify potential collision risks.

## Relative Speed Analysis

By analyzing the relative speeds of nearby vehicles, the system can determine the time-to-collision (TTC) and trigger appropriate collision warnings.

## Timely Alerts

When a potential collision is detected, the system immediately generates visual and/or auditory alerts to notify the driver or autonomous system, enabling proactive collision avoidance.

# Key Features

1. **Vehicle Detection**

   **Robust detection of diverse vehicle types, including cars, buses, two-wheelers, and pushcarts.**

2. **Accurate Speed Estimation**

   **Real-time calculation of vehicle speeds using the Euclidean distance formula and pixels-per-meter ratio.**

3. **Cut-in Detection**

   **Identification of abrupt vehicle cut-ins using predefined boundary lines and trajectory analysis.**

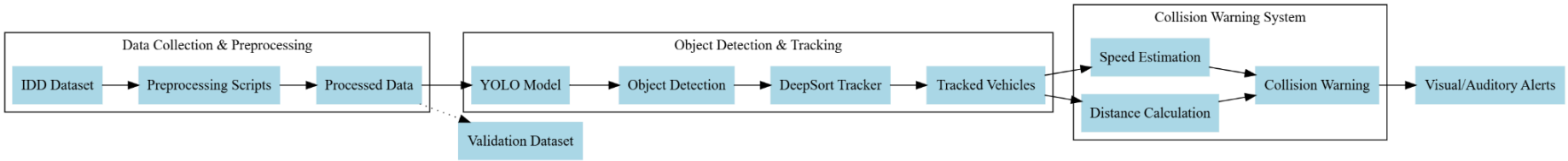
4. **Collision Warning**

   **Predictive collision risk assessment based on inter-vehicle distances and relative speeds.**

# Process-flow

The process flow begins with YOLOv8 detecting and classifying vehicles in real-time video frames. DeepSort then tracks these detected vehicles across subsequent frames. Speeds of the vehicles are estimated by analyzing changes in their positions over time, and distances between vehicles are calculated using bounding box coordinates. A collision detection function assesses the risk by comparing these distances and speed differences against predefined thresholds. If the conditions indicate a potential collision, the system triggers an alert, providing visual or audio feedback to warn the driver. This integrated approach ensures continuous monitoring and timely collision warnings, enhancing vehicle safety.

# Architecture Diagram



# Technologies and Tools Used

## Programming Language:

Python

## Libraries and Frameworks:

OpenCV: Image and video processing
YOLO (You Only Look Once): Real-time object detection
DeepSort: Object tracking algorithm
Pandas: Data manipulation
Numpy: Numerical computing
Matplotlib: Data visualization
Scikit-learn: Machine learning tasks

# Team members and contribution:

**TEAM NAME:** AUTOBOTS
**TEAM SIZE:**2
**MENTOR:** Dr. Akilandeswari P

1. **A.LALITH RAHUL(LEADER):**

MODEL SPEED ESTIMATION ,IDD CUTIN APPROACH,LANE DETECTION,CUTIN DETECTION ,REPORT.

2. **DISHA KUMAR:**

OBJECT DETECTION,YOLOV8,OBJECT TRACKING,IDD DATASET PREPARATION,PPT.

# Conclusion

The AUTOBOTS' intelligent cut-in detection and collision warning system represents a significant stride towards enhanced safety for autonomous vehicles. By seamlessly integrating object detection, tracking, speed estimation, and real-time event analysis, the system provides a comprehensive solution to mitigate the risks associated with dynamic driving scenarios. This innovative approach enables autonomous driving systems to make more informed decisions, respond promptly to potential hazards, and ultimately contribute to a safer and more reliable transportation future.