Intel Unnati Industrial Training Program 2024

Karunya Institute of Technology and Science

VEHICLE-CUT IN DETECTION.

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Vehicle Cut-in Detection

Problem Statement:

Detecting vehicle cut-ins in real-time is crucial for preventing accidents and optimizing traffic flow. Abrupt lane changes pose significant risks to road safety, necessitating robust detection systems capable of accurately identifying and warning about such events.

Abstract:

Detecting vehicle cut-ins is pivotal for road safety systems and traffic management, aiming to mitigate collision risks and enhance traffic flow efficiency. This project proposes a comprehensive solution leveraging advanced computer vision techniques and deep learning models to accurately detect instances where vehicles abruptly change lanes, termed "cut-ins". The system integrates real-time video processing, vehicle detection using YOLOv5, lane detection algorithms, and trajectory analysis to identify and warn about potential lane intrusion events. The methodology includes preprocessing of video data, detection of lane boundaries, vehicle tracking across frames, distance measurement between vehicles, collision warning generation, and performance evaluation using precision, recall, and F1 score metrics. The system outputs a video highlighting detected vehicles, lane markings, and warnings, contributing to improved road safety and traffic management strategies.

Unique Solution:

The proposed solution employs a combination of computer vision algorithms and deep learning models to detect vehicle cut-ins effectively. It utilizes YOLOv5 for vehicle detection, integrates lane detection techniques to identify lane boundaries, and applies trajectory analysis to pinpoint instances where vehicles cross into adjacent lanes unexpectedly. This approach aims to provide timely alerts to drivers and traffic control centers, enhancing safety and operational efficiency on roadways.

Methodology:

1. Video Preprocessing

- **Re-encoding:** Convert input videos into a suitable format for processing.
- **Ground Truth Data:** Utilize annotated vehicle positions from CSV files for evaluation.

2. Frame Processing

- **Lane Detection:**
  - **Canny Edge Detection:** Identify potential lane markings.
  - **Hough Transform:** Convert detected edges into lane boundaries.
- **Vehicle Detection (YOLOv5):**
  - Detect various vehicle types (e.g., cars, buses) using deep learning.
  - Draw bounding boxes around detected vehicles for visualization.
- **Cut-in Detection:**
  - Analyze vehicle trajectories to detect sudden lane changes (cut-ins).
  - Evaluate vehicle positions relative to lane boundaries for intrusion detection.
- **Distance Measurement:**
  - Calculate distances between vehicles to assess collision risks.
  - Generate warnings for unsafe proximity between vehicles.
- **Collision Warning:**
  - Issue real-time alerts for potential collisions based on proximity and lane intrusion.
  - Implement safety rules to determine critical situations.
- **Vehicle Tracking:**
  - Track vehicles across frames to monitor movement patterns.
  - Predict trajectories and analyze behavior over time.

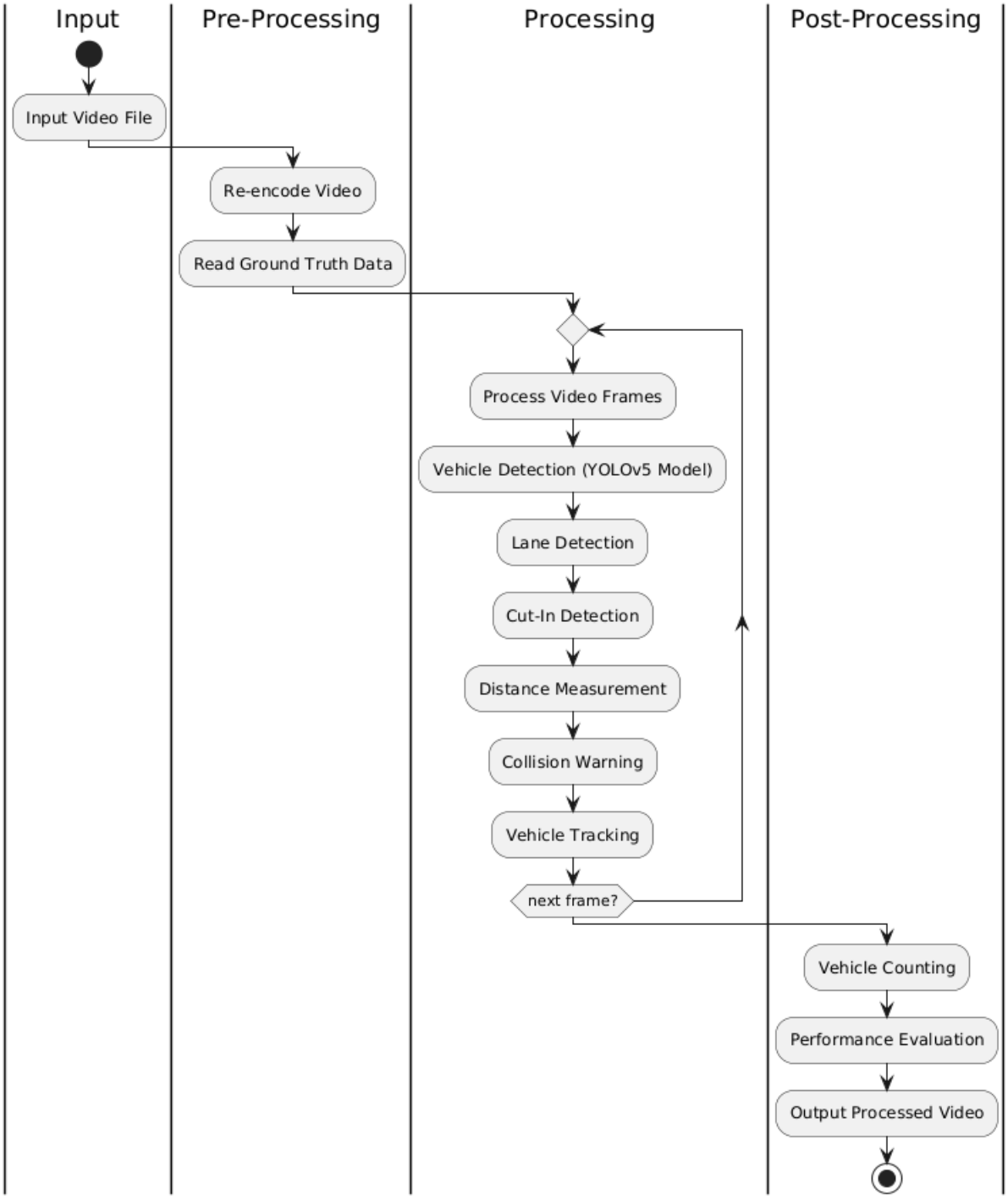
3. Performance Evaluation

- **Metrics Calculation:**
  - Compute precision, recall, and F1 score to evaluate detection accuracy.
  - Validate system performance against ground truth data.

4. Video Processing

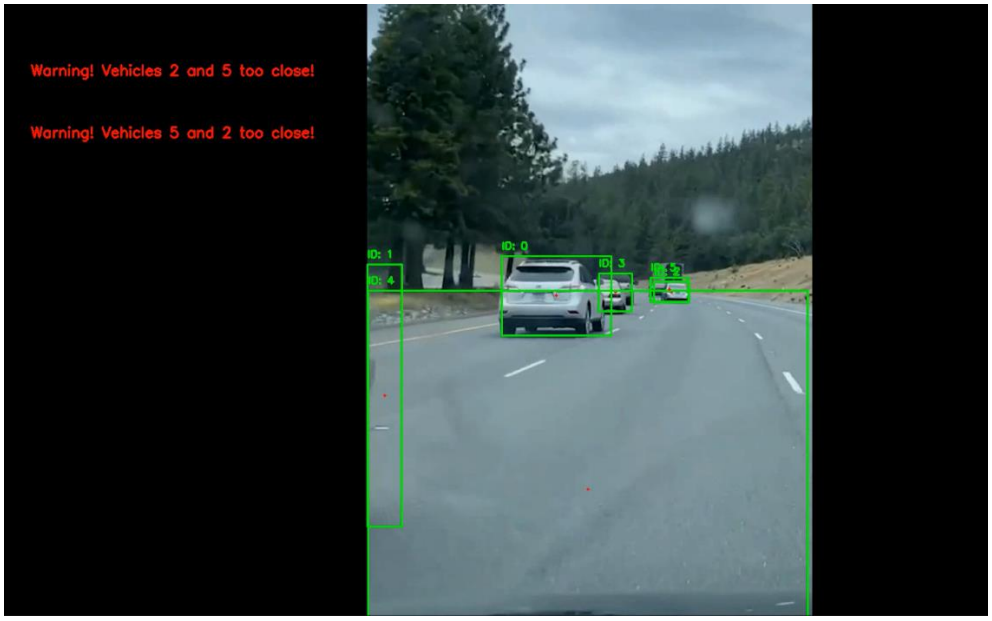
- **Output Generation:**
  - Generate processed videos highlighting detected vehicles and warnings.
  - Provide visual insights into traffic dynamics and safety risks.

Architecture Diagram:

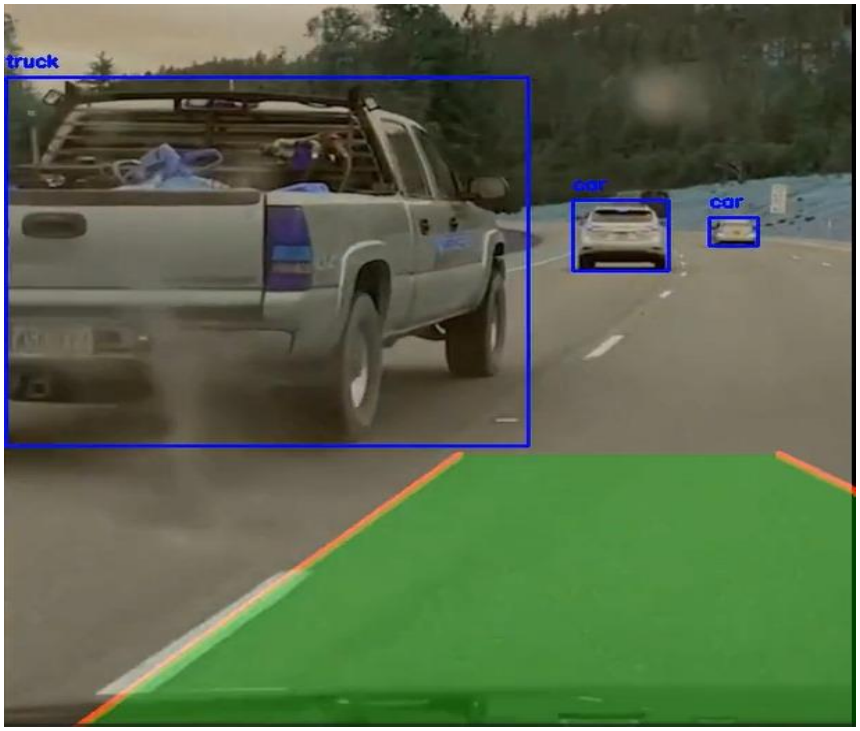


Output Screenshots:

- **Collision Avoidance Warning:**



- **Lane and vehicle Detection :**



Code and Output Links:

https://drive.google.com/drive/u/1/folders/1IZ4ZayKIRLJAZjg41mpHdEy1-nMU3ei3

https://github.com/Meerasrilekha/Vehicle-Cut-in-detection---Code-Crusaders

Conclusion

The developed system integrates advanced computer vision techniques and deep learning capabilities to address the challenge of detecting and alerting about vehicle cut-ins in real time. By leveraging video analysis and precise detection algorithms, the system contributes to safer road environments by proactively identifying and mitigating collision risks caused by sudden lane changes. Continuous refinement and evaluation are essential for optimizing detection accuracy and ensuring effective deployment in various traffic scenarios. This approach not only enhances road safety but also supports traffic management efforts by providing actionable insights into vehicle behavior and lane dynamics on roadways.