AUTOPACE Project Report

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1. Abstract

AUTOPACE is an AI-powered video analytics solution that detects and estimates the speed of vehicles using real-time object detection via YOLOv8 and OpenCV. The system automatically identifies cars in traffic footage and calculates their speed by tracking the time taken to cross a reference line within a known distance frame. This project offers a cost-effective and scalable alternative to traditional traffic surveillance, aiding intelligent transport systems and law enforcement.

2. Introduction

The rising demand for intelligent traffic monitoring systems has made computer vision a critical tool in transport analytics. This project employs YOLOv8, a deep learning object detection model, to detect vehicles and compute their speeds using basic frame-based motion analysis. The relevance of this work lies in its application for smart city surveillance, rule enforcement, and road safety enhancement. Technologies used include Python, OpenCV, YOLOv8, and Google Colab for cloud-based computation. This model uses minimal hardware and processes offline video files, making it suitable for both real-time and batch analysis scenarios.

3. Project Objectives

- To detect vehicles from a video stream using the YOLOv8 object detection model.
- To track vehicle movement across a defined virtual line in the frame.
- To calculate and display the speed of each vehicle as it crosses the line.
- To annotate the processed video with detection boxes and speed overlays.
- To provide a framework that can be extended for real-time traffic monitoring and violation detection.

4. Methodology

Data Input

Traffic video uploaded by the user (.mp4 or .avi format).

Model

YOLOv8n loaded via Ultralytics and deployed on GPU (if available).

Preprocessing

Video is resized to 720p for optimal performance.

Detection

Each frame is processed to detect objects (cars specifically, class ID 2).

Tracking

Cars crossing an imaginary horizontal line are time-stamped.

Speed Calculation

Using the time difference and known distance (10 meters), speed is computed using the formula:

$$\text{Speed (km/h)} = \frac{\text{Distance (m)}}{\text{Time (s)}} \times 3.6$$

Tools Used

Python, OpenCV, YOLOv8, Google Colab, torch, shutil.

Flow Chart

1. Upload video
2. Load YOLOv8
3. Frame-wise detection
4. Draw line
5. Detect crossing
6. Time-stamp
7. Speed calculation
8. Annotate and save video

5. Data Analysis and Results

Descriptive Analysis

Each vehicle's detection confidence and position are logged. Speed of each vehicle is calculated and displayed in real-time on the video.

Visuals and Screenshots

- Bounding boxes on detected cars.
- Speed annotation (in km/h) on each vehicle.
- Red line in the middle of the frame indicating the detection threshold.

Results

Vehicles with varied speeds were successfully detected. Speeds were estimated with acceptable accuracy for use cases in traffic monitoring.

6. Conclusion

AUTOPACE successfully demonstrates the feasibility of using lightweight computer vision models for vehicle speed analysis from video. The approach is robust, fast, and can be adapted for real-time applications with minor improvements. Future work may integrate advanced tracking models and license plate recognition for enforcement systems.

Appendices

Appendix 1 – References

- Ultralytics YOLOv8: `https://docs.ultralytics.com/`
- OpenCV Documentation: `https://docs.opencv.org/`
- Torch Documentation: `https://pytorch.org/`