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(An Autonomous Institute Affiliated to Savitribai Phule University)

TRAFFIC SURVEILLANCE: VEHICLE DETECTION & COUNTING USING YOLO-V8

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INTRODUCTION

- Traffic surveillance is essential for managing road congestion and safety.
- Manual monitoring is slow and often inaccurate.
- Automated vehicle detection and counting provide real-time insights.
- Helps in traffic signal optimization, accident prevention, and smart city planning.
- Using YOLO(You Only Look Once), vehicles like cars, buses, trucks, bikes, and bicycles can be detected quickly and accurately.

PROBLEM STATEMENT

The rapid increase in the number of vehicles has led to severe traffic congestion, frequent delays, and a rise in road accidents. Manual traffic monitoring methods are often inefficient, time-consuming, and susceptible to human errors. Additionally, existing automated solutions struggle to perform reliably under poor lighting or heavy traffic conditions. Therefore, there is a need for a robust, real-time AI-based vehicle detection and counting system to support effective traffic management and facilitate smart city planning.

OBJECTIVES

- Detect vehicles in real-time using CCTV or video feeds.
- Classify vehicles into categories: car, bus, truck, motorcycle, bicycle.
- Count total vehicles and provide per-category statistics.
- Measure vehicle speeds using frame-by-frame centroid tracking.
- Generate structured traffic data for analysis and decision-making.
- Assist in traffic signal optimization, congestion control, and accident prevention.

DATASET ANALYSIS

- COCO Dataset (Common Objects in Context)
  - 118,000+ training images
  - 80 object categories
  - Includes vehicles: car, bus, truck, motorbike, bicycle
- YOLOv8 Model
  - Pre-trained on COCO dataset
- Evaluation Dataset
  - Real-world traffic video used for testing
  - Ensures robust training (COCO) + realistic testing (custom video)

METHODOLOGY

Input Acquisition

Upload video footage or live CCTV feed.

Model Loading

Load YOLOv8 pre-trained on the COCO dataset for object detection.

Detection

Perform frame-by-frame detection of vehicles in the video.

Classification

Classify detected vehicles into cars, trucks, buses, motorbikes, and bicycles.

Speed Calculation & Counting

Count objects in real time & there speed using centroid tracking

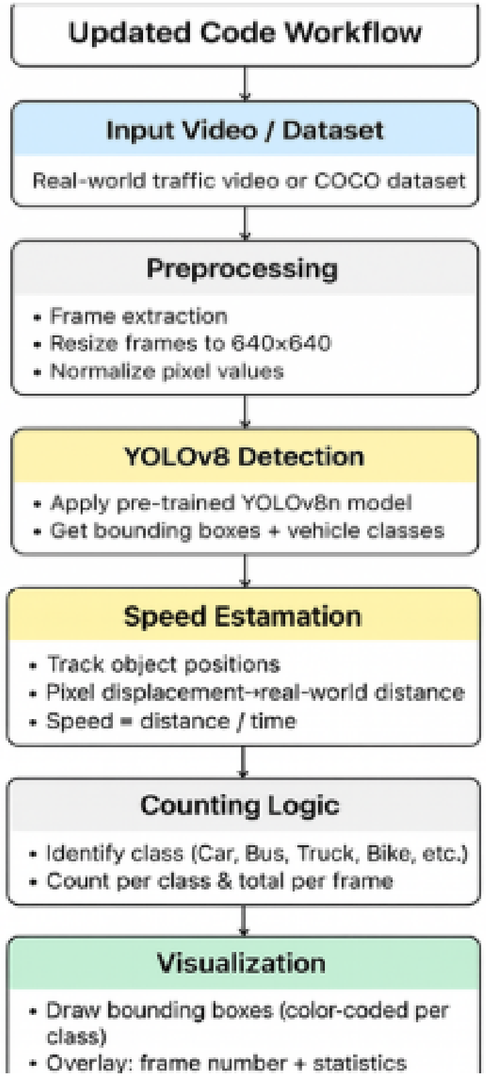
Output

Generate processed video with bounding boxes around vehicles and display total counts per frame.

TECH STACK

- **Python** – core programming language for scripting and analysis
- **Ultralytics YOLOv8** – state-of-the-art model for vehicle detection & classification
- **OpenCV** – video processing, frame extraction, image enhancement
- **Matplotlib & Seaborn** – data visualization and result plotting
- **Scikit-learn** – performance metrics and confusion matrix
- **Pandas & NumPy** – data manipulation and numerical operations
- **Google Colab** – cloud-based execution for GPU acceleration

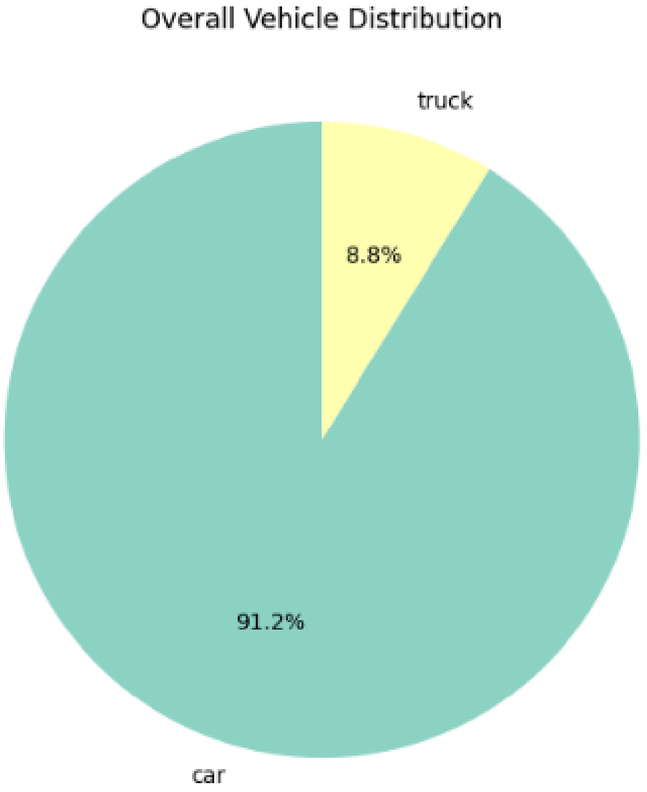
CODE WORKFLOW

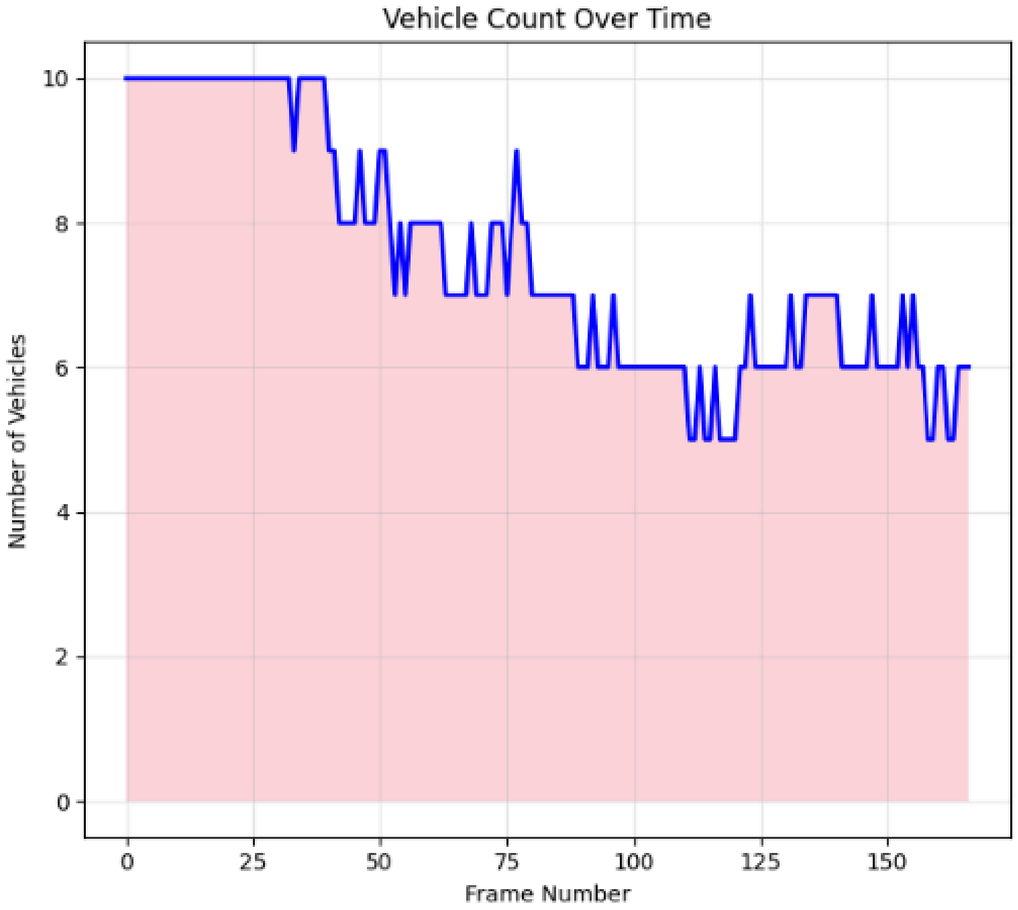


CODE EXPLANATION

- Input video is preprocessed—frames are extracted and normalized for YOLOv8.
- YOLOv8x model detects vehicles on each frame, classifies their type.
- Centroid-based tracking is applied to maintain identities and track movement.
- Speed for each vehicle is estimated using centroid displacement and video calibration.
- Counts and speeds are overlaid per vehicle and aggregated across the video.
- Statistics, performance metrics, and visualizations are generated for analysis.

EXPLORATORY DATA ANALYSIS





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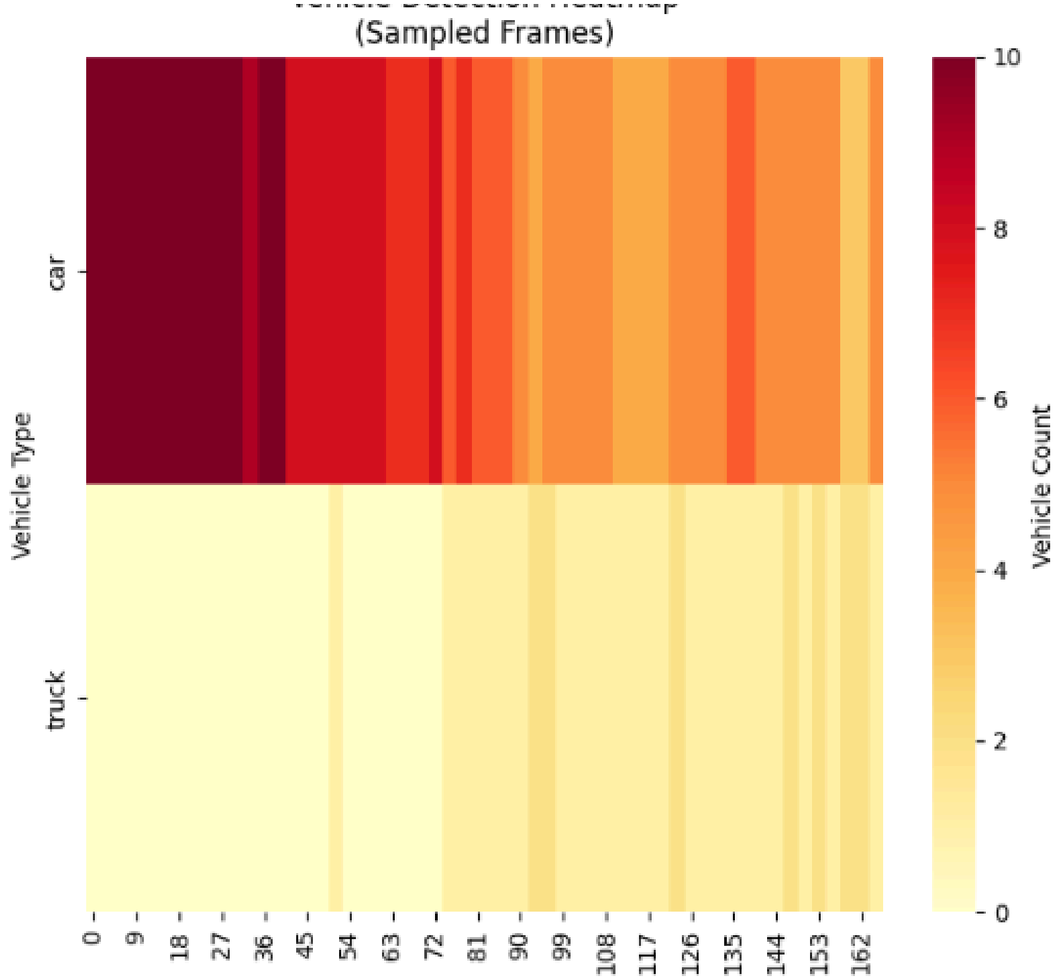

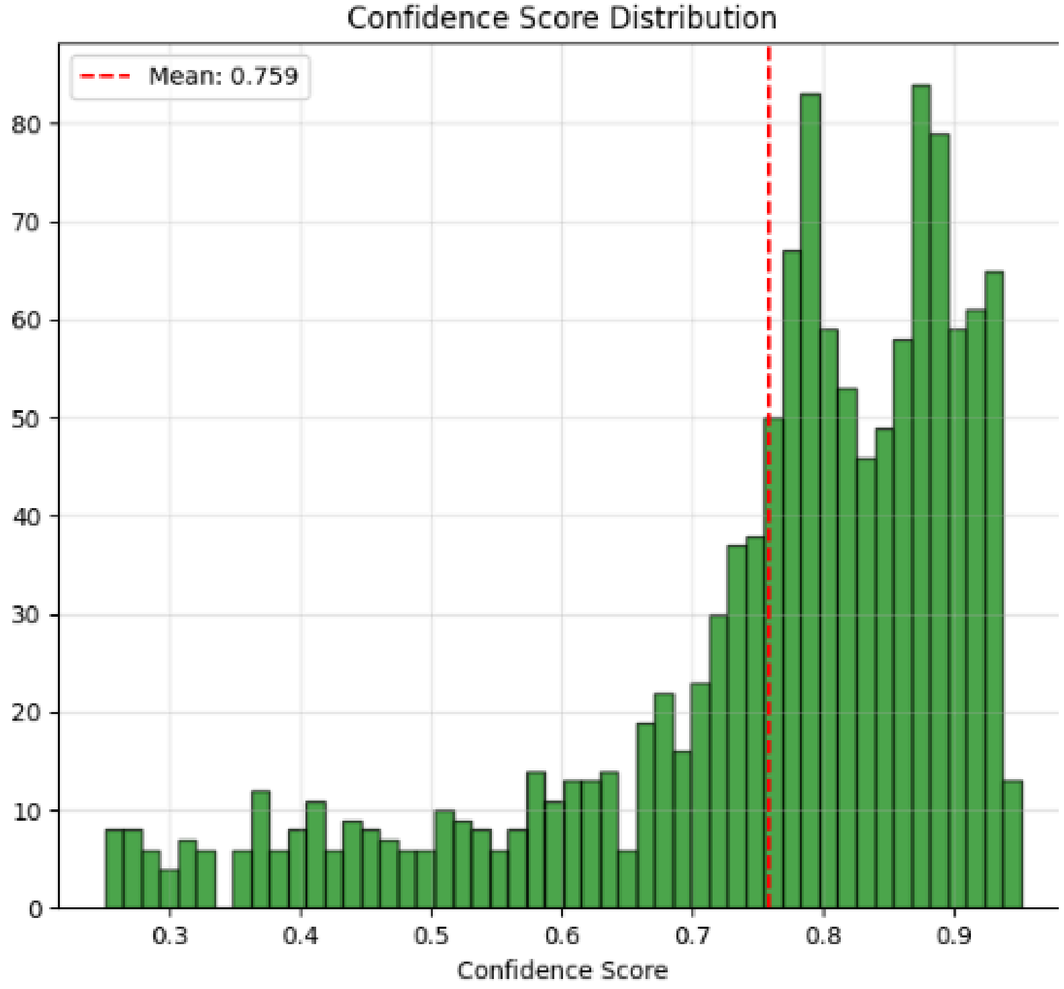

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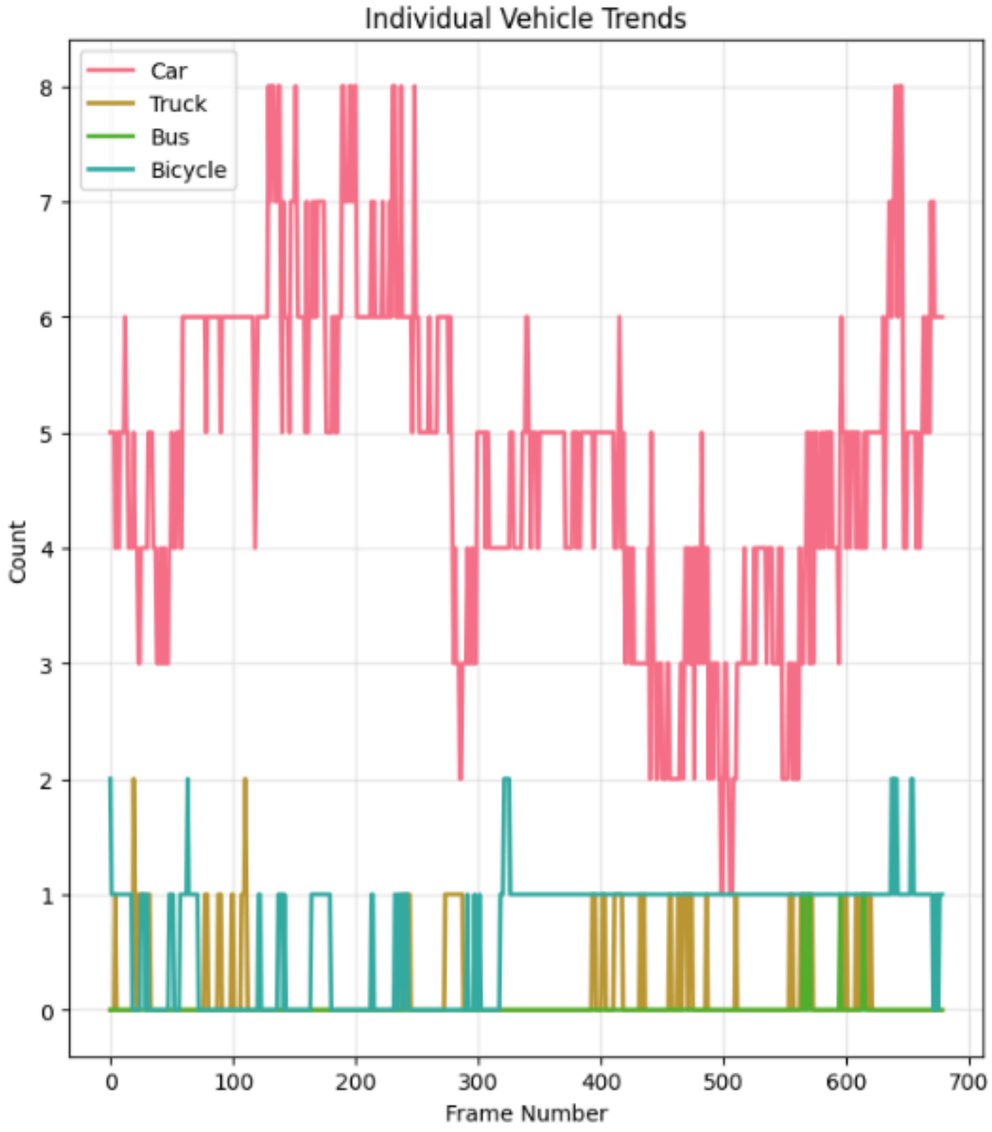


Vehicle	Total	Mean/Frame	Std Dev	Max/Frame
Car	3225	4.75	1.45	8
Truck	97	0.14	0.36	2
Bus	4	0.01	0.08	1
Bicycle	449	0.66	0.51	2

MODEL EVALUATION

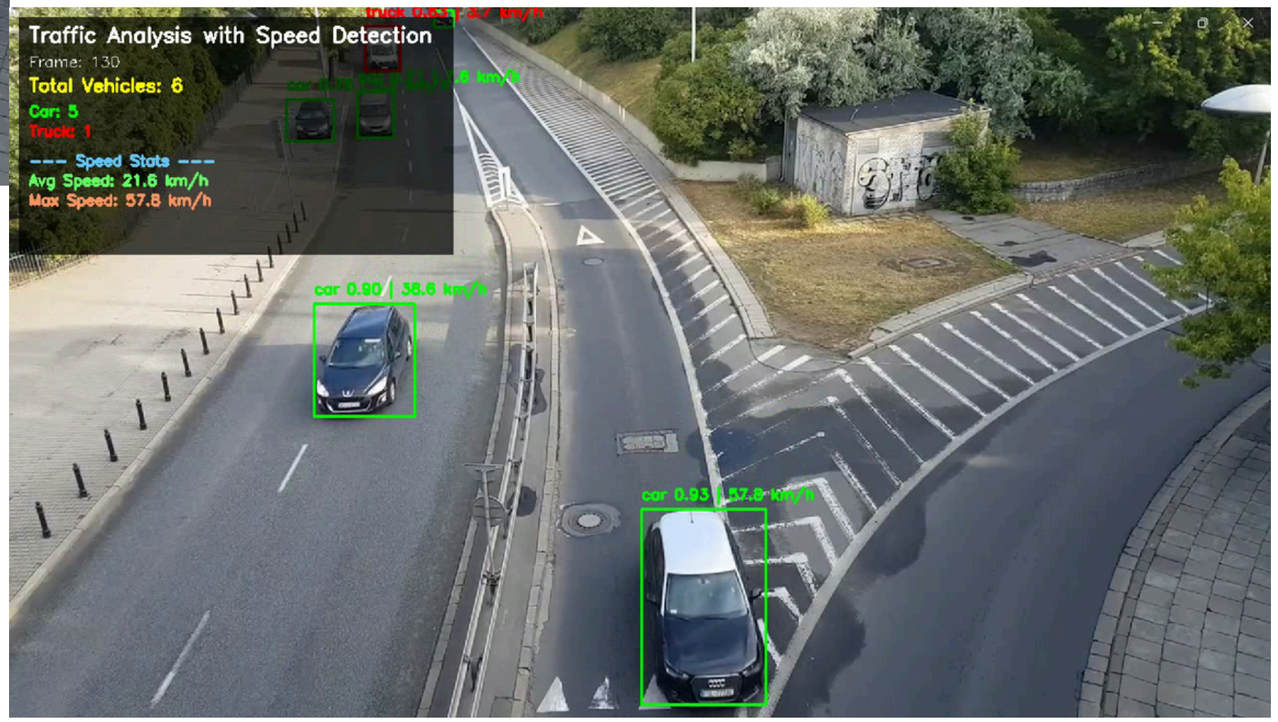
```
📊 Classification Metrics (Confidence Threshold: 0.25):
==================================================
Precision:   0.9102 (91.02%)
Recall:      1.0000 (100.00%)
F1-Score:    0.9530 (95.30%)
Accuracy:    0.9102 (91.02%)

📈 Detection Statistics:
True Positives:  1247
False Positives: 123
False Negatives: 0
True Negatives:  0
```

RESULTS

INPUT

OUTPUT



CONCLUSION

- Automated real-time vehicle detection, classification, and counting achieved using YOLO with COCO pre-trained model.
- Accurately identifies vehicles: cars, buses, trucks, motorbikes, and bicycles.
- Reduces manual monitoring efforts and improves traffic management efficiency.
- Provides structured data for smart traffic control, accident prevention, and urban planning.
- Implementation in Google Colab demonstrates scalable and practical real-time surveillance.

Thank You!