# Vehicle Speed and Lane Usage Analysis Using Computer Vision

**Course:** TTENG564 | **Group:** B

# Problem Statement

### Critical Safety Challenge

Traffic safety remains a pressing issue worldwide, with vehicle speed and lane violations contributing significantly to accidents.

### Traditional Monitoring Limitations

Current methods are costly, require manual intervention, and provide limited scalability for comprehensive traffic analysis.

### Automation Need

Scalable, automated solutions are essential for simultaneous analysis of vehicle speeds and lane usage patterns.

# Objectives - Group B Focus

## Speed Estimation

Accurately estimate vehicle speeds using computer vision techniques with high precision and reliability.

## Lane Usage Analysis

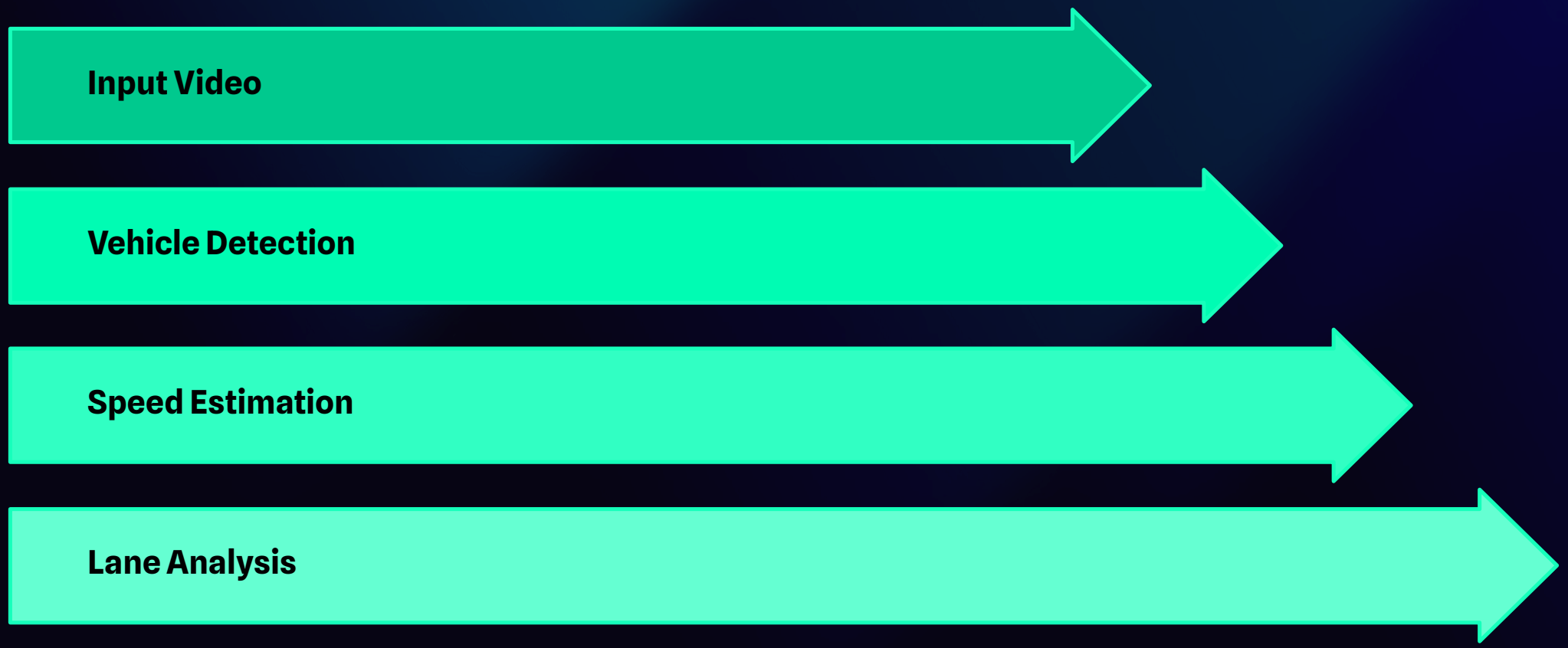
Analyze vehicle lane usage patterns to identify traffic flow characteristics and potential safety concerns.

## Safety Insights

Provide actionable insights for traffic safety improvement and intelligent transportation management systems.

# Proposed Solution

Computer vision-based system integrating real-time detection, tracking, and analysis capabilities.




### Real-Time Detection

Detect and track vehicles in live video feeds using advanced computer vision algorithms.

### Speed Calculation

Estimate vehicle speed using calibrated distances and temporal analysis between frames.

### Pattern Monitoring

Monitor and analyze lane usage patterns for comprehensive traffic behavior assessment.

# Methodology

### Vehicle Detection

**YOLO (v5/v8)** implementation for robust real-time vehicle identification and classification in various traffic conditions.

### Camera Calibration

**Perspective correction** using reference objects to establish accurate spatial measurements and distance calculations.

### Speed Estimation

**Frame-to-frame analysis** calculating displacement over time intervals for precise velocity measurements.

### Lane Analysis

**Position mapping** comparing vehicle coordinates against defined lane boundaries for usage pattern identification.

# Technical Implementation

## Core Technologies

**OpenCV + Python** for comprehensive vehicle detection and image processing capabilities with robust performance.

## Advanced Tracking

**Kalman filtering** ensures smooth vehicle tracking across frames, handling occlusions and maintaining trajectory consistency.

## Spatial Correction

**Perspective transformation** converts camera view to real-world coordinates for accurate distance and speed measurements.

## Analysis Tools

**Pandas & Matplotlib** for comprehensive data analysis, statistical processing, and professional visualization output.

# Challenges & Limitations

### Environmental Factors

Variable lighting conditions between day and night operations significantly impact detection accuracy and system reliability.

### Camera Positioning

Variations in camera angles and mounting positions require adaptive calibration methods for consistent performance.

### Traffic Complexity

Vehicle occlusion in dense traffic scenarios poses challenges for continuous tracking and accurate speed estimation.

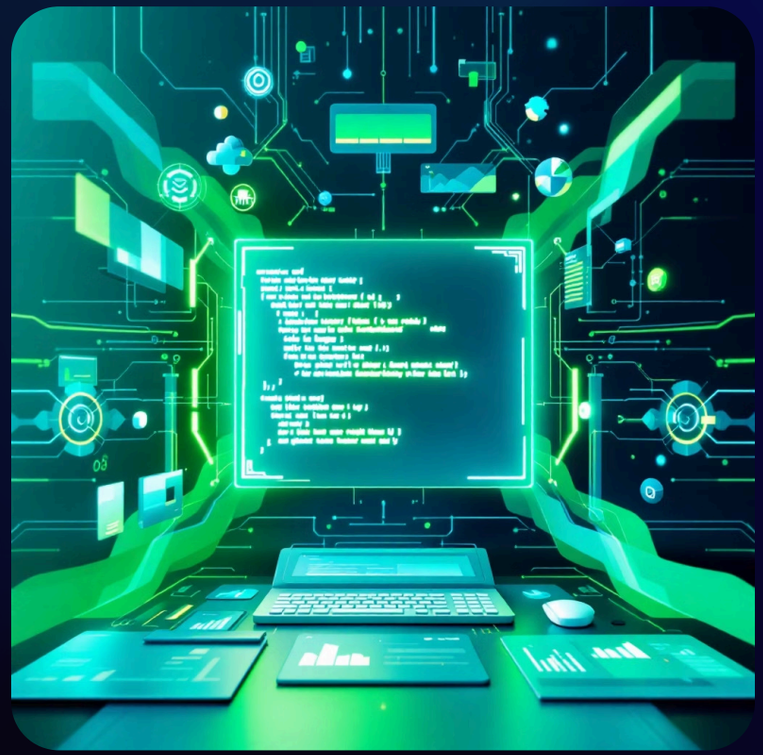
### Performance Balance

Optimizing the trade-off between real-time processing requirements and detection accuracy for practical deployment.

# Deliverables & Evaluation

## Project Deliverables

- Complete Python codebase with documentation
- CSV datasets with processed traffic data
- Statistical charts and visualization outputs
- Comprehensive technical report
- Professional presentation materials



**⩽5%**

### Speed Accuracy

Maximum acceptable error rate in speed estimation measurements

**30**

### FPS Target

Real-time processing performance requirement for live video analysis

**95%**

### Overall Accuracy

Target system accuracy for vehicle detection and tracking operations

# Resources & Timeline

## Technology Stack

- **Python 3.8+** - Core programming language
- **OpenCV** - Computer vision processing
- **YOLO v5/v8** - Object detection framework
- **TensorFlow/PyTorch** - Machine learning
- **Pandas & Matplotlib** - Data analysis
- **Git** - Version control system

## Data Requirements

Traffic camera feeds from multiple highway locations and calibration videos with known reference measurements.

1
**Weeks 6-7**
Setup & Research

2
**Weeks 8-9**
Detection & Speed Estimation

3
**Weeks 10-11**
Lane Analysis & Testing

4
**Weeks 12-13**
Validation & Documentation

5
**Week 14**
Final Presentation

# Expected Impact & Closing

### Real-World Application

Demonstrate practical computer vision implementation in transportation engineering for scalable traffic monitoring solutions.

### Foundation Technology

Establish robust groundwork for automated traffic monitoring systems that can be deployed across highway networks.

### Performance Targets

95% accuracy | 30 fps real-time | 4 lanes coverage

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# Thank You

## Questions & Discussion