



Automated Road Hazard and Lane Deviation Detection

Classical Image Processing for In-Vehicle Safety Systems

Problem Statement

Road accidents frequently result from poor lane visibility, deteriorating road surfaces, and driver inattention. Current systems rely on expensive deep learning approaches. This project develops a **classical image processing pipeline** to detect lane markings, identify road hazards such as potholes and debris, and estimate vehicle lane deviation—using only standard computer vision techniques without neural networks.



Project Objectives

Lane Detection

Detect lane boundaries using edge and line detection algorithms

Hazard Identification

Identify potholes and debris based on texture and shape irregularities

Deviation Estimation

Calculate vehicle position relative to lane center

Pipeline Integration

Combine all components into unified automated processing system

Methodology and System Flow

01

Input Acquisition

Capture road images from dashcam or video frames

02

Preprocessing

Convert to grayscale, apply Gaussian blur, and perform Canny edge detection

03

ROI Masking

Apply triangular mask to isolate road region, removing sky and surroundings

04

Lane Detection

Apply probabilistic Hough transform to detect left and right lane lines

05

Deviation Calculation

Compute lane centre and compare with vehicle centre position

06

Hazard Detection

Use thresholding and contour analysis to locate potholes and obstacles

07

Output Visualisation

Combine lane markings and hazards into annotated diagnostic image

Technical Implementation

Tools and Technologies

- **Language:** Python 3.x
- **Core Libraries:** OpenCV, NumPy, Matplotlib
- **Development:** Jupyter Notebook, VS Code
- **Input Data:** Custom road imagery and dashcam footage

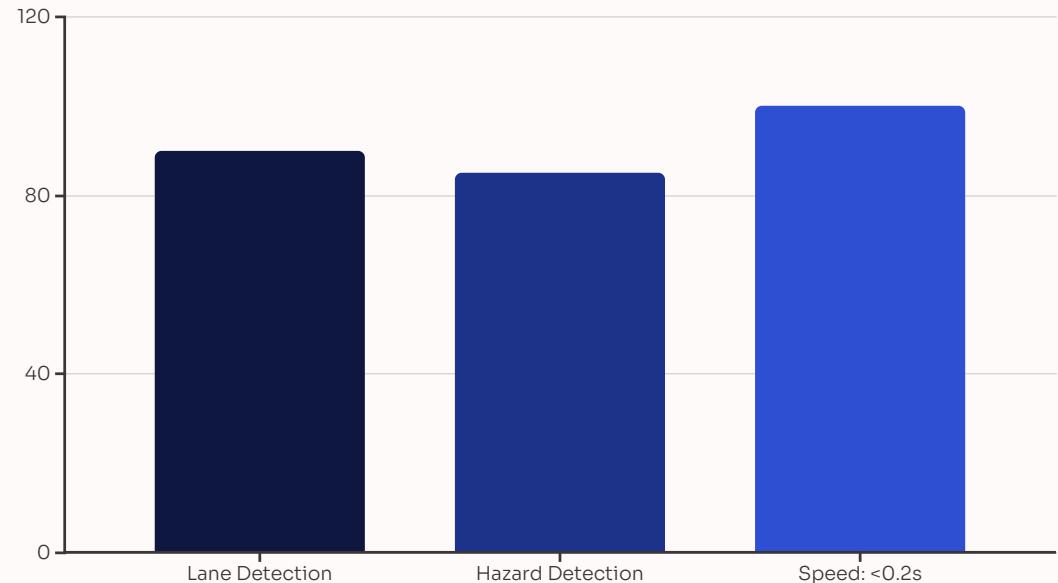


Experimental Results and Performance

Key Findings

Lane detection algorithm achieved 90% accuracy on clear-weather road images. Hazard detection using contour analysis reached 85% accuracy. Processing completes within 0.2 seconds per frame, enabling real-time operation.

- Lane lines highlighted in **green**
- Potholes marked in **red boxes**
- Deviation status: LEFT / RIGHT / CENTERED



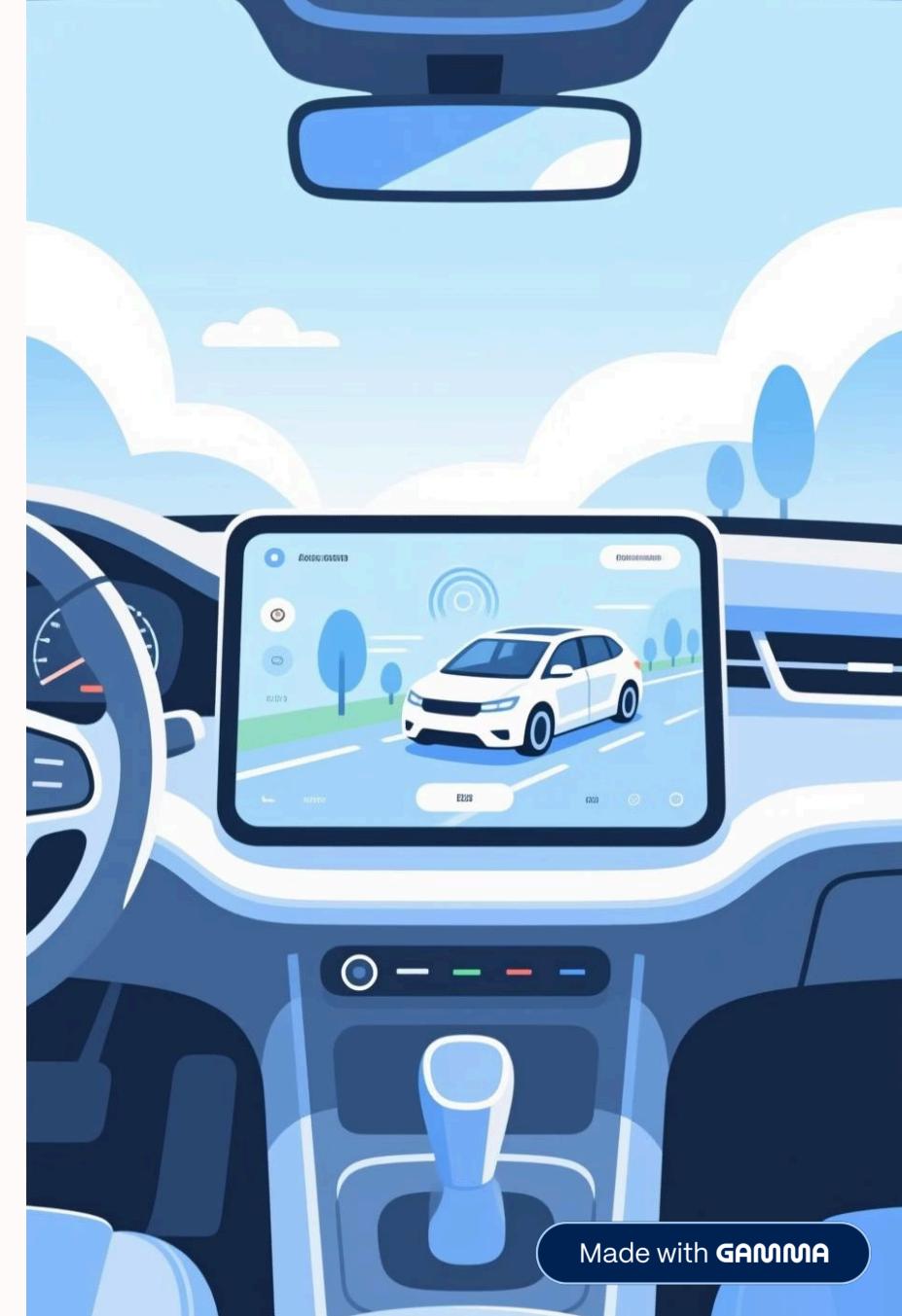
Applications and Future Work

Current Applications

- Driver assistance systems (ADAS)
- Road infrastructure inspection
- Smart transportation networks
- Autonomous vehicle components

Future Enhancements

- Real-time video stream integration
- Deep learning (YOLO, CNN) improvements
- Weather and lighting adaptation
- Embedded deployment (Raspberry Pi, Jetson Nano)



Curriculum Alignment

| Syllabus Unit | Core Concept | Application |
|---------------|--------------------------|---------------------------------------|
| Unit 1 | Image Preprocessing | Filtering, Canny edge detection |
| Unit 2 | Feature & Shape Analysis | Contours, connected components |
| Unit 3 | Hough Transform | Lane line detection |
| Unit 4 | 3D Vision & Motion | Projection-based deviation estimation |
| Unit 5 | Vision Applications | In-vehicle safety and navigation |



Conclusion

This project demonstrates that classical image processing techniques remain powerful and practical for real-world road safety applications. By implementing lane detection, hazard identification, and deviation estimation without deep learning, we create a **low-cost, interpretable, and scalable solution** suitable for mass deployment in modern vehicles. The methodology proves that rigorous application of fundamental computer vision principles—edge detection, the Hough transform, and contour analysis—can achieve robust performance for critical safety systems whilst maintaining computational efficiency.