LANE DETECTION

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CONTENTS

INTRODUCTION

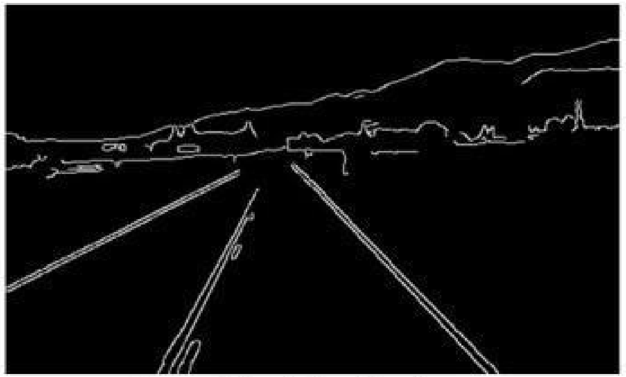
- Lane detection is a crucial technology within Advanced Driver Assistance Systems (ADAS) and the development of autonomous vehicles.
- Utilizing computer vision, lane detection systems identify road markings to help prevent accidents caused by unintentional lane departures, reduce driver fatigue, and provide a fundamental building block for self-driving capabilities.

SAMPLE INPUTS

Input Image

Grayscale Image

Gaussian Blur



Canny Edge Detection Image

Fig.1. Types of Input

OUTPUT

Fig.2. Output Sample

HARDWARE & SOFTWARE REQUIREMENTS

HARDWARE

- i5 Processor Based Computer
- 8GB Ram
- 320GB SSD
- Monitor
- Keyboard

SOFTWARE

- Windows 11
- Python
- Spyder
- OpenCV

Features

- **Color Masking:** Isolates red/white (typical lane colors) using HSV color space thresholding.
- **Canny Edge Detection:** Identifies intensity changes that correspond to lane edges.
- **Line Fitting:** Mathematical models fit lines to the detected edge points for lane estimation.
- **Hough Transform:** Specifically the Probabilistic Hough Transform, to efficiently detect lines.
- **Visualization:** Overlays detected lanes on the original image for visual understanding.
- **ROI Selection:** Defines a targeted image region (often trapezoidal) for focused analysis.

PROBLEMS ADDRESSED

Distracted Driving: Lane detection systems help alert drivers who might be distracted (texting, drowsy, etc.)

Long Distance Driving: On extended journeys, lane detection systems coupled with lane-keeping assist.

Real-Time Performance: For safety reasons, lane detection in ADAS or autonomous systems must operate in real-time.

FLOW DIAGRAM

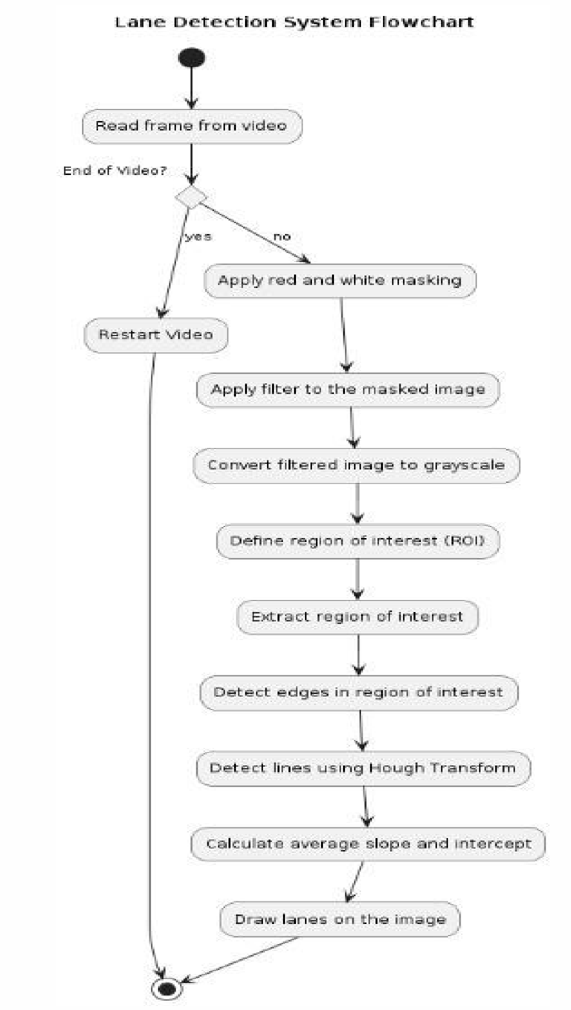


Fig.3. Flow Diagram of Model

Flow Diagram Steps

- **Frame Acquisition:** Capture individual frames from the video input.
- **Color Masking:** Isolate red and white colors, the typical hues of lane markings.
- **Image Filtering:** Apply filters to sharpen desired features (e.g., Gaussian blur to reduce noise).
- **Grayscale Conversion:** Simplify image data for edge detection.
- **Region of Interest (ROI):** Define a targeted area (often trapezoidal) where lanes are most likely.
- **Edge Detection:** Apply the Canny algorithm to pinpoint intensity changes that indicate lane boundaries.
- **Hough Line Transform:** Detect straight lines within the edge-filtered ROI.
- **Lane Calculation:** Average detected line slopes and intercepts to establish lane positions.
- **Visualization:** Overlay the detected lanes on the original video frame.
- **Video Loop:** Check for the video's end; restart if finished, else process the next frame.

Applications

Lane Departure Warning (LDW): Warns the driver if the vehicle begins to drift out of its detected lane unintentionally.

Lane Keeping Assist (LKA): Actively provides minor steering adjustments to keep the vehicle centered within its lane.

Adaptive Cruise Control (ACC): Can use lane detection to help maintain a safe distance from other vehicles and potentially adjust speed based on lane curvature.

Fundamental Building Block: Lane detection is a core component of self-driving systems.

LIMITATIONS

ENVIRONMENTAL CHALLENGES

Weather: Rain, snow, fog, or glare can obscure lane markings, making detection difficult.

Lighting: Shadows,nighttime conditions, or sudden changes in light levels can interfere with image processing.

Road Conditions: Worn, faded, or non-standard lane markings create challenges for algorithms.

COMPLEX ROAD SCENARIOS

Intersections, Merges, and Splits: Lane detection can become less reliable during complex road transitions.

Occlusions: Vehicles,pedestrians, or other objects blocking the view of lane markings cause issues.

Curved Roads: Maintaining accurate detection on highly curved roads brings specific challenges.

FUTURE SCOPE

ROBUST ALGORITHMS

Deep Learning: Advances in deep learning (e.g., convolutional neural networks) hold promise for more adaptable, resilient lane detection across varied conditions.

Semantic Segmentation: Understanding the overall scene (not just lines) can improve lane detection.

SENSOR FUSION

Combining with LIDAR and Radar: Supplementing cameras with other sensors can address visibility problems and improve reliability.

GPS and HD Maps: Incorporating high-precision map data can provide context and assist with lane tracking.

INFRASTRUCTURE SUPPORT

Smart Roads: Embedding markers or sensors in the road itself could make lane detection easier for vehicles.

V2X Communication: Vehicle-to-infrastructure communication could share real-time road condition updates and lane information.

CONCLUSIONS

We'll be able to observe how well your system performs in detecting lane lines in videos with:

- Clear, well-defined lane markings (yellow and white)
- Good lighting conditions
- Relatively straight roads

Sensitivity to HSV Thresholds: You'll notice how the HSV color thresholds in the red_white_masking function are critical to successful lane line isolation.

THANK YOU