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**Paper name**

Road Lane Detection System Using Advanced Computer Vision and Video Analytics

**Abstract**

Road lane and object detection is a crucial aspect of autonomous driving and advanced driver-assistance systems (ADAS). This system enhances situational awareness and driving safety by detecting lane markings and identifying vehicles, pedestrians, and other obstacles in real-time video footage. The project employs image processing techniques such as perspective transformation, edge detection, and Gaussian blur for lane detection, while a deep learning-based object detection model (YOLOv8) is used for identifying objects. The combined results are overlaid onto the original video frame to provide a comprehensive visualization of the road environment.

**Source link**

<https://www.ijert.org/research/road-lane-and-object-detection-in-the-video-footage-using-open-cv-and-python-IJERTV14IS020084.pdf>

**Introduction**

It can be quite difficult to keep track of student attendance, particularly in large classroom. Conventional manual techniques are laborious and prone to mistake. To effectively record student presence, we suggest an automated attendance system that make use of facial recognition.

**Proposed System**

There are five essential steps in the system:-

* Develop an automated system for road lane detection using image processing techniques.
* Implement real-time object detection using the YOLOv8 model.
* Integrate lane and object detection results into a unified video output.
* Improve road safety through enhanced situational awareness.
* Provide a scalable solution for real-time deployment in autonomous vehicles and ADAS.

**Tech to be used**

**Technologies and Tools**

1. **Programming Language**: Python
2. **Computer Vision Library**: OpenCV
3. **Machine Learning & Deep Learning Framework**:
   * **YOLOv8 (You Only Look Once)** – Object detection using the Ultralytics YOLO model
   * **PyTorch** – Deep learning framework for running YOLOv8
4. **Image Processing Techniques**:
   * Gaussian Blur
   * Canny Edge Detection
   * Perspective Transformation
   * HLS Color Space Conversion
5. **Video Processing**:
   * OpenCV for real-time video handling
   * Frame-by-frame processing
6. **Hardware Requirements**:
   * GPU (Optional but recommended for real-time processing)
   * High-performance CPU for frame processing
7. **Libraries for Data Handling & Visualization**:
   * NumPy
   * Matplotlib (for debugging and visualization)

**Methodology**

**1. Image Preprocessing**

* **Conversion to HLS Color Space:** The input image is converted to the HLS color space to enhance the visibility of lane markings under different lighting conditions.
* **Gaussian Blur:** A Gaussian blur is applied to reduce noise and minimize false edge detection.
* **Edge Detection:** The Canny edge detection algorithm is used to highlight lane boundaries for further processing.

**2. Region of Interest (ROI) Extraction**

* **Masking:** A mask is applied to isolate the road and ignore irrelevant areas.
* **Perspective Transformation:** The image is warped into a bird’s-eye view for better lane detection.
* **Points Definition:** Source and destination points for transformation are defined to align lane markings correctly.

**3. Lane Detection and Tracking**

* **Histogram-Based Localization:** A histogram of the lower half of the bird’s-eye view image is analyzed to locate lane lines.
* **Sliding Window Technique:** Windows are placed along the lane lines to identify non-zero pixels and track lane curves.
* **Polynomial Fitting:** A smooth curve is fitted to detected lane points for accurate representation.

**4. Object Detection System**

* **Installation and Setup:** The Ultralytics package is installed, and the YOLOv8 model is configured.
* **Model Loading:** The YOLOv8 model with pre-trained weights is loaded for object detection.
* **Frame Processing:** Each frame of the video is passed through YOLOv8, detecting objects and classifying them into categories such as vehicles and pedestrians.
* **Detection Details:** Bounding boxes, class labels, and confidence scores are assigned to detected objects.

**5. Integration with Lane Detection**

* **Overlaying Results:** Detected lanes and objects are superimposed onto the original video frame for a unified visualization.
* **Video Processing:** The processed video is displayed in real time with detected objects and lane markings.
* **Saving Processed Video:** The final output is stored for further analysis.

**6. System Integration**

* **Synchronization:** Lane and object detection processes operate on the same video frames to ensure temporal alignment.
* **Overlaying Results:** The final output is displayed, highlighting lane boundaries and detected objects in a single view for enhanced situational awareness.

**Step-wise Solution Approach**

1. **Data Acquisition and Pre-Processing**
   * Collect video footage of roads with annotated lane and object data.
   * Pre-process frames, including resizing and noise reduction.
2. **Feature Extraction**
   * Apply image processing techniques for lane detection.
   * Extract object features using the YOLOv8 model.
3. **Detection and Integration**
   * Detect lanes and track them across frames.
   * Detect and classify objects in each frame.
   * Overlay detected lanes and objects onto the video.
4. **Model Training and Evaluation**
   * Train object detection models on annotated datasets.
   * Evaluate using precision, recall, and mean Average Precision (mAP).

**Key Findings**

* The YOLOv8 model achieved high accuracy in real-time object detection.
* Image processing techniques effectively enhanced lane visibility under various lighting conditions.
* The combined system improved situational awareness by providing a detailed view of lane boundaries and detected objects.