Project Overview

Title: Road Defect Detection using YOLOv8
Goal: Automatically detect road anomalies (e.g., potholes, cracks, zebra crossings, speed bumps) from GPS-tagged road video footage using deep learning.

This system extracts frames from road videos at fixed GPS-based intervals, labels them with road defect categories, and trains a YOLOv8 model to detect and localize these defects. It outputs bounding boxes along with GPS coordinates and timestamps, aiding municipal bodies in maintenance planning.

Data Collection & Preparation

- **Source:** Road videos captured using a GPS-enabled camera.
- **Frame Extraction:** Every 3 to 5 meters based on GPS distance.
- **Total Frames:** 1000 images
- **Annotations:**
  - Manual using Label Studio
  - Classes:
    ```
    Lane mark, Plain road, Manhole, Divider, Speed bumps, Cracks,
    Pothole, Zebra crossing, Footpath, Rumble strips, Sign board,
    Leading lines
    ```
- **Format:** YOLOv8 format (image and corresponding `.txt` label files)
- **Data Split:**
  - Train: ~80%
  - Validation: ~20%

Model & Training Details

- **Model Used:** YOLOv8 (Ultralytics)
- **Model Type:** `YOLOv8n` / `YOLOv8s` (specify)
- **Training Parameters:**
  - Epochs: 50
  - Image size: 640x640
  - Batch size: 16
  - Optimizer: SGD
- **Augmentations:** Flip, scale, HSV shift (handled by YOLO)

Inference & Output

- Script: `detect_defects.py`
- Inputs: Video or image folder

- Outputs:
  - Detected image with bounding boxes
  - CSV file with:
    - Frame_name
    - Location
    - Latitude, Longitude
    - Detected class
    - Defected_count

Project Folder Structure

road-defect-detection/

├── runs/   → YOLO outputs

├── dataset/   → Images and labels

├── scripts/   → Python scripts for detection and preprocessing

├── reports/   → This report + detection results

├── repo/   → Notebooks, helper files

├── README.md

├── requirements.txt

Limitations & Challenges

- **Class Confusion:** Similar-looking objects lead to misclassification.

- **Lighting Issues:** Glare, shadows, and night scenes reduce detection accuracy.

- **Small/Occluded Objects:** Small or partially hidden defects are often missed.

- **Class Imbalance:** Rare classes are underrepresented, affecting model learning.

Conclusion

This project successfully implements a YOLOv8-based pipeline for detecting road anomalies from GPS-tagged videos. The output includes both detection visuals and structured data, making it suitable for road safety analysis and maintenance scheduling. A feedback loop has been proposed for continuous model improvement.