15.776 Automated Detection of Bike Lane Obstructions for Urban Road Safety

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1. Problem Statement

Bike lanes are designed to protect cyclists, yet in many urban areas they are frequently obstructed by parked vehicles, delivery vans, or construction equipment. These obstructions force cyclists into traffic, significantly increasing accident risk. Cities currently rely on manual reporting, citizen complaints, or costly inspections to identify unsafe areas.

This project aims to develop an end-to-end deep learning system that can: (1) detect bike lanes in street-level imagery, and (2) identify when they are blocked by vehicles or other objects. The output will include image-level obstruction labels and aggregated metrics (e.g., percentage of obstructed bike lanes per street or neighborhood) that can inform transportation planning and Vision Zero safety initiatives.

2. Dataset

We will use the *BikelaneDetector* dataset (GitHub: riya21parikh/BikelaneDetector), which includes crowd-sourced street-level footage from cities such as Chicago, Boston/Cambridge, New York, and Philadelphia. We extracted individual frames from video clips and will extend the dataset by annotating (a) bike lane regions and (b) obstructions, focusing primarily on parked or moving vehicles blocking the lane.

3. Technical Approach

We will train a semantic segmentation model (e.g., DeepLabV3+, U-Net, or SegFormer) to identify bike lane regions. In parallel, we will use an object detection or instance segmentation model such as YOLOv8 or DETR to detect vehicles. A post-processing step will determine whether a frame is classified as *blocked* by computing the overlap between vehicle masks/bounding boxes and the bike lane mask.

To align with course content, we will experiment with Vision Transformer-based architectures such as SegFormer or ViT+UPerNet. Models will be fine-tuned using transfer learning in Keras or PyTorch, with augmentations to improve robustness. Performance will be evaluated using IoU for lane segmentation and precision/recall for obstruction detection.

4. Impact and Deliverables

The final system will provide a full pipeline that detects bike lanes, identifies obstructions, and outputs visual overlays and safety metrics. While not a full city-scale deployment, the project will demonstrate the feasibility of automated, data-driven monitoring of cycling infrastructure. Deliverables include the trained models, sample inference results, reproducible code on GitHub, and a short report discussing methodology, limitations, and extensions.