Final Project Proposal

# Vehicle Counting in Static Images

## Introduction

Vehicle counting in static images is a key task in traffic monitoring, urban planning and parking management. The objective of this project is to develop a system capable of detecting and counting visible vehicles in a single input image using only traditional computer vision techniques, without the use of deep learning.

## Scenario and Focus

We specifically focus on vehicle counting in aerial or surveillance images taken from fixed viewpoints (e.g., from traffic cameras, drones, or parking lot monitors). The system is not designed for pedestrians or moving video analysis, to limit complexity and better address the domain challenges.

## Goals

The system will:

1. Detect all visible vehicles in a static image.

2. Draw bounding boxes around detected vehicles.

3. Count the total number of vehicles.

4. Overlay the bounding boxes and the count on the output image.

## Challenges Addressed

- Viewpoint variation: top-down vs oblique angles.

- Illumination changes: shadows, reflections on windshields.

- Occlusions: partially visible vehicles.

- Scale variability: vehicles appearing at different distances from the camera.

## Techniques

We will rely on traditional computer vision methods, including:  
- Preprocessing: grayscale conversion, Gaussian blur.  
- Edge detection: Canny or Sobel filters.  
- Morphological operations: opening/closing to reduce noise.  
- Contour detection and filtering: size, aspect ratio, rectangularity.  
- Heuristics-based classification: distinguishing vehicles from noise or other shapes based on shape, area and context.

## Dataset

We will use a subset of the Urban Tracker dataset, focusing specifically on static frames where multiple vehicles are clearly visible. This dataset offers urban scenes with multiple types of vehicles and provides frame-wise annotations, from which we will extract labeled still images for evaluation.  
Here are some examples illustrating potential use cases shown:

Immagine che contiene strada, aria aperta, albero, Corsia

Il contenuto generato dall'IA potrebbe non essere corretto.

Immagine che contiene testo, parco giochi, aria aperta, terreno

Il contenuto generato dall'IA potrebbe non essere corretto.

## Evaluation Metrics

We will use the following quantitative metrics to assess system performance:  
1**. Counting Accuracy**:  
- Absolute Error:   
- Relative Error:   
Where N\_pred is the number of vehicles predicted and N\_true is the ground truth count.  
  
2. **Detection Accuracy:**  
- Precision, Recall and F1-score based on bounding box overlaps.  
- A detection is correct if the IoU ≥ 0.5 with a ground truth box.

## Conclusion

This project provides a practical application of classical computer vision techniques to a well-defined and constrained problem: counting vehicles in static urban scenes. By avoiding deep learning and limiting the scope to a single domain and object class, we aim to design a system that is explainable, lightweight and domain aware.