Pedestrians, Road Signs, Crosswalks Detection System

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Introduction

Nowadays car driving safety is a hot topic.

The goal of this project is to detect **pedestrians**, **signs**, and **crosswalks** to help autonomous cars to secure the pedestrians outside and inside the vehicle.

Modular Approach:

- DL approach with CNN to detect **pedestrians**.
- Retrieval and classification system using a custom CNN to classify **crosswalk road signs**.
- Geometry-based approach for **crosswalks**.

Pedestrians

Dataset:

- COCO (training and testing)
- PennFudan (testing on different datasets)

Model: Faster RCNN with different backbones. The best performing was with pre-trained ResNet50 provided by PyTorch

Performance (over COCO dataset):

'AP and AR are averaged over multiple Intersection over Union (IoU) values. Specifically we use 10 IoU thresholds of 0.50:0.95' [https://cocodataset.org/#detection-eval]

AP	AR
~0.25-0.45	~0.35-0.55

Road Signs

3 Different Datasets

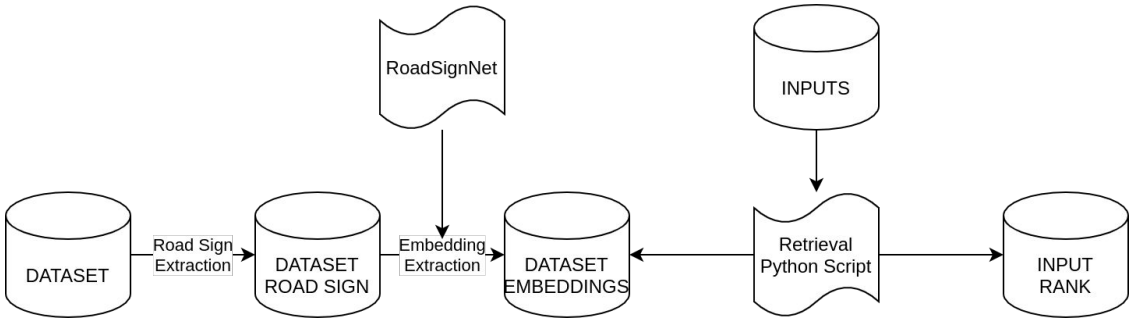
Custom CNN

2 approaches

- Classification
- Retrieval Pipeline
  - Contrastive Loss
  - Triplet Loss

Best performance:

- Accuracy 99.68% on GTSR
- MAP 0.72 on Mapillary with Triplet Loss



Crosswalks

TP

FP

FN

“Manual” geometric-based.

Localization and classification more than detection.

Annotated by hand sub-datasets (unbalanced) from the **DR(eye)VE** dataset.

Sub-dataset	Precision	Recall|TPR	TNR	G-Mean	Accuracy	F-Measure
05	1.00	0.67	1.00	0.82	1.00	0.80
06	0.40	0.53	0.77	0.64	0.71	0.46
26	0.57	0.50	0.97	0.70	0.94	0.53
35	0.88	0.41	0.99	0.64	0.90	0.56
Average	0.71	0.53	0.93	0.70	0.89	0.59

1. **Images pre-processing**: white balancing, grayscale conversion, bilateral filtering, Canny edge detection, bird’s eye view computation, erosion, and thinning.
2. **Hough Transform** for finding horizontal and vertical lines.
3. Search for **intersection** points.
4. Search rectangles that can be proper stripes belonging to a crosswalk (**appearance** and **geometric** constraints).
5. Compute bounding box and the **distance** between car and crosswalk.

Area of Improvement

Switch to YOLO model for faster detections.

Improve crosswalk road sign detection by exploring pattern matching solutions.

Crosswalks detection with more modern approaches (e.g. CNNs).