Identifying Cyclist Safety In Urban Traffic Using Computer Vision

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Computing • IT • Business

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Introduction

Incentivising cycling as a means of transport is key to reducing traffic congestion in urban centres, promoting active life and reducing carbon emissions. However, attracting people to cycling requires infrastructure investment and road users' education regarding cyclists' rights to mitigate the risks of cycling.

Research Question

Q1. Can Computer Vision (CV) automatically collect structured data bring together evidence to support infrastructure investment and legislation regarding the use of protective equipment to mitigate the risks of cycling?

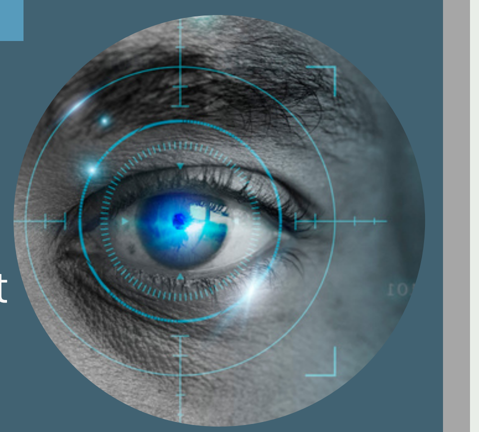
Figure 1. Computer Vision Illustration

Methodology

The methodology applied was the 6 phases of the Cross Industry Standard Process for Data Mining (CRISP-DM).

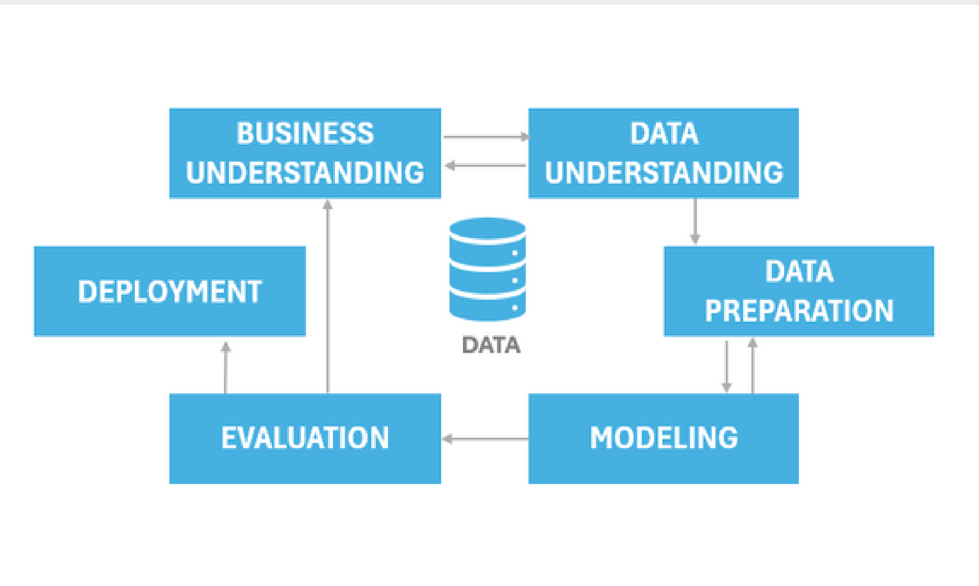

Figure 2. CRISP-DM Phases

1. Business Understanding

Objective: Build a CV model that can detect bikes, scooters, helmet and high visibility vest with **mAP@50 ≥ 75%**.

2. Data Understanding

The data was collected from Open Images Dataset V7 and from Roboflow Universe. A total of 62,107 images.

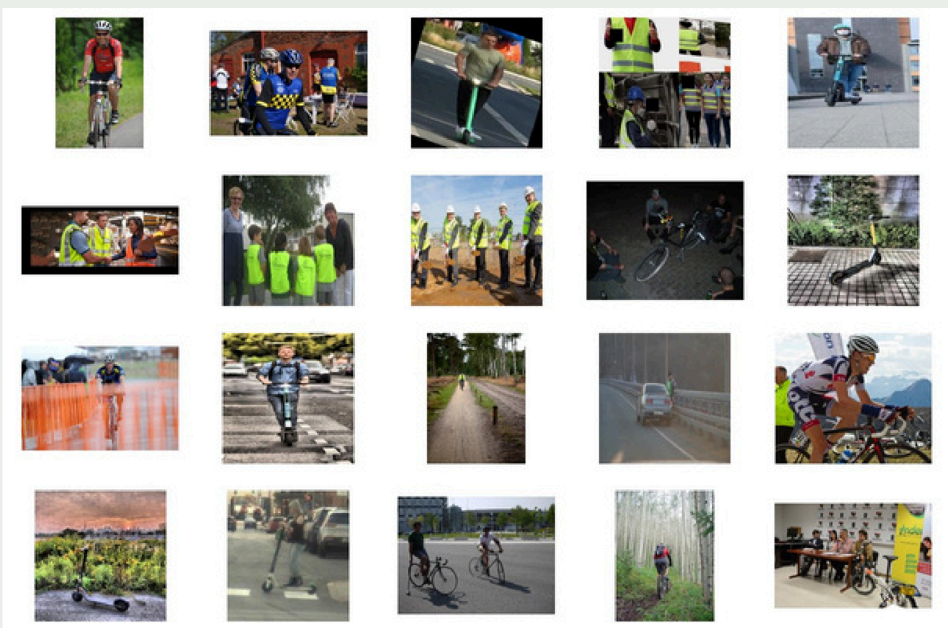
Figure 3. Dataset Sample

The labels are in YOLO-format:

- index (x, y) (width, height)

The dataset contains four classes:

- Bicycle, helmet, scooter, and vest.

3. Data Preparation

After the cleaning process, the final dataset contains6 of 40,157 images.

Data Split:

- Train (80%): 32121 images.
- Validation (10%): 4015 images.
- Test (10%): 4021 images.

Classes Distribution

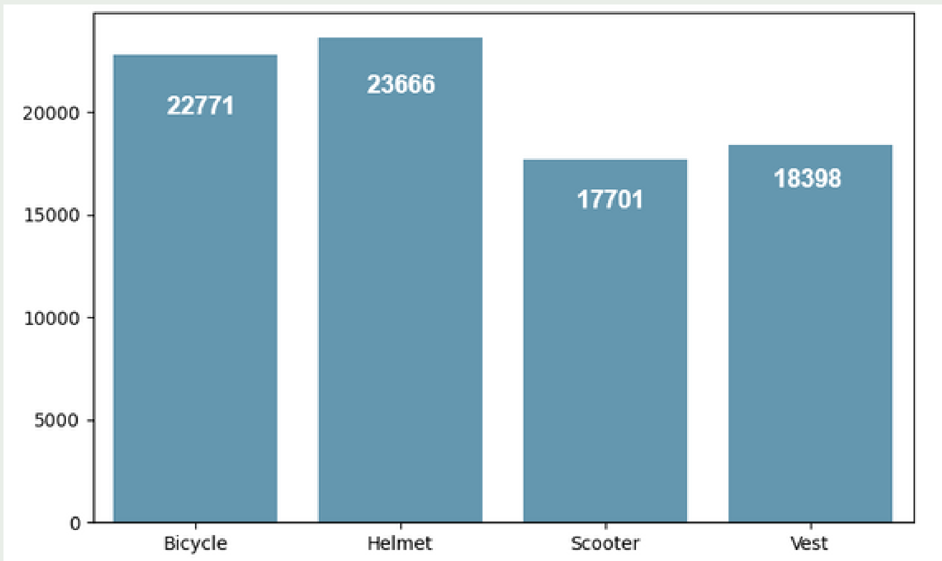

Figure 4. Classes Distribution Graph

4. Modeling

The model was trained using the YOLOv8 pre-trained weights (Ultralytics, 2024).

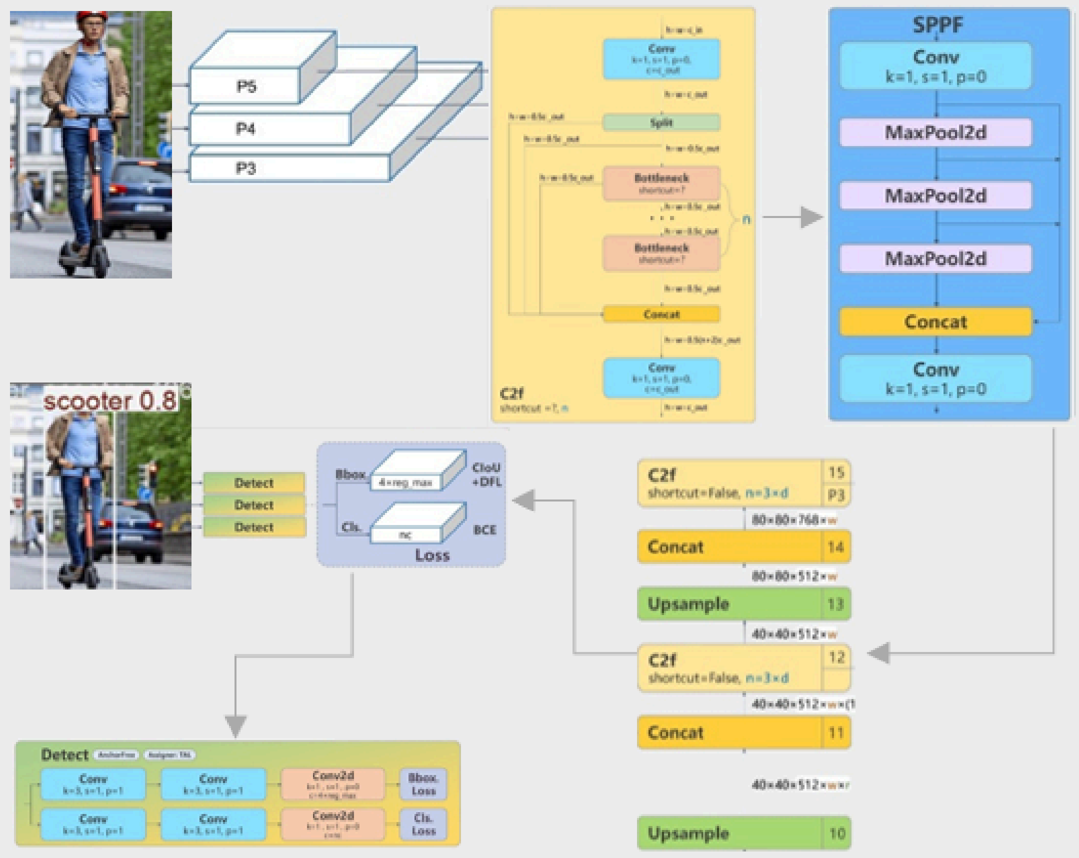

Figure 5. YOLOv8 Architecture

5. Evaluation

For the evaluation phase, the inference was done using a test subset to assess if the model meets the business criteria (mAP@50 ≥ 60%).

Class	Images	Instances	Box(P	R	mAP50	mAP50-95)
all	4021	8174	0.787	0.804	0.827	0.603
bicycle	909	2467	0.621	0.654	0.649	0.411
helmet	941	2388	0.66	0.688	0.719	0.404
scooter	1431	1579	0.942	0.95	0.972	0.782
vest	740	1740	0.925	0.922	0.969	0.816

Figure 6. Metrics

- mAP@50: 0.827 (criteria ≥ 0.60)
- Precision: 0.787 | Recall: 0.804
- Strong: Scooter, Vest
- Weak: Helmet, Bicycle

The overall performance of the final model is satisfactory. However, some areas can improve; for example, the helmet and bicycle classes performed below the other two classes of the dataset.

6. Deployment

The deployment phase is a video recorded simulation in two different scenarios, on a bicycle and a scooter and during day and night, to simulate a cycle lane monitoring system.

The simulation reflected the model's performance evaluated previously. The easier object to detect was the scooter, followed by the vest when closer to the camera. The bicycles were detected with low precision, and the helmet was detected only in one specific scenario with the lowest confidence

Conclusion

- The implementation phases of this model proved that computer vision can be used in cycle lane monitoring systems to extract relevant data.
- The overall precision and recall are acceptable. And the model achieved a mAP@50 of 0.827, which surpassed the business criteria.
- For future work, an idea is to collect data from the cycle lanes where the models would be used.

References

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