A Blind Spot Alert Apparatus for Cyclists in Right-Turning Semi-trailer Trucks

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1. Introduction

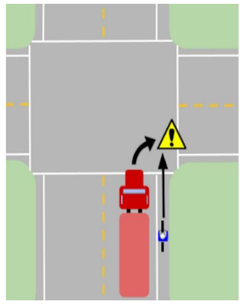
Bicycling is a hobby and sport many enjoy for its fitness and mental health benefits. Unfortunately, cyclists face numerous risks when traveling along a road or path with other vehicles; in the U.S, over 1,000 cyclists die, and 130,000 more are injured each year (CDC, 2022).

2. Engineering Need

Semi-trailer truck drivers often have trouble identifying cyclists in their blind spots when making right-hand turns which can cause bicyclist-truck collisions. The overall aim of this project is to engineer a device that can detect cyclists in a truck's right-rear blind spot and provide alerts for semi-trailer truck drivers.

Figure 1. Right Hook Collision

- When a truck makes a right-turn and collides with a cyclist
- Semi-trailer truck blind spots hinder visibility of approaching cyclists
- Are often fatal or cause severe injuries (Wang et al., 2022)



3. Project Objectives

Design a blind spot detection apparatus which can:

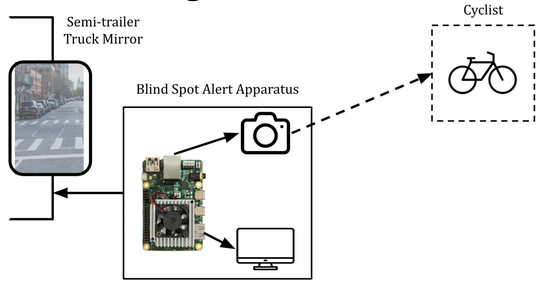
- Actively detect and locate cyclists with 80% or higher accuracy.
- Be portable and installable onto most semi-trailer trucks.
- Create visual warnings on cyclists in the right-rear blind spot within 2 seconds.
- Be low-cost – less than $300.00.

4. Design Process

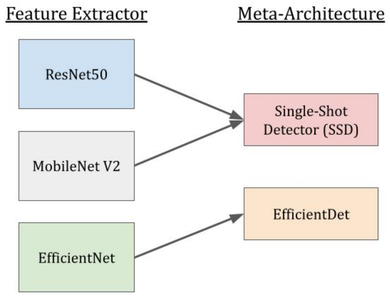
Annotated Cyclist Dataset

(Garcia-Venegas et al., 2021)

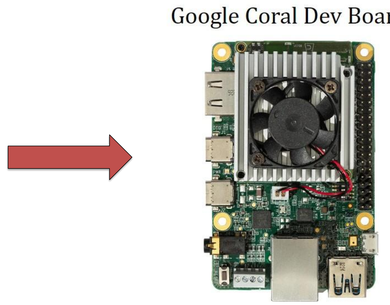
Testing in Real-Time



Object Detection Model

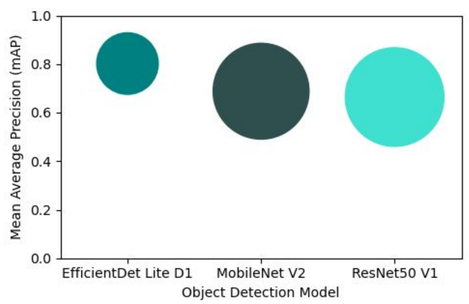


Mini-Computer Deployment



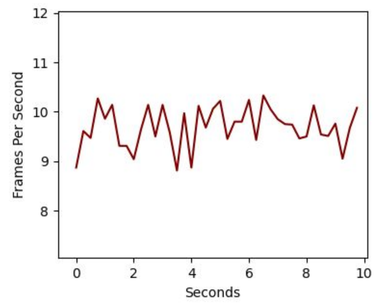
5. Preliminary Results

Figure 2. *Accuracy and size of prototype cyclist detection models.*



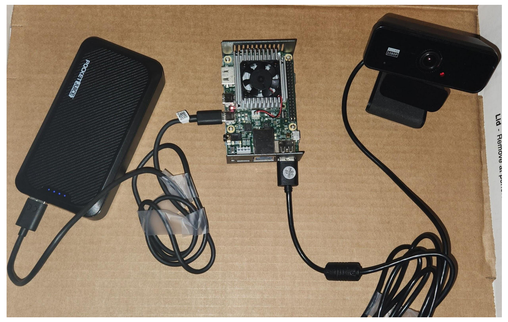
Note. The bubble size represents the relative size of the models. The MobileNetV2 and ResNet50 models were trained with 8 classes, and the EfficientDet model was trained on 1 class. Larger models run slower than smaller models

Figure 3. *Frames per second of EfficientDet Lite cyclist detection model.*



Note. The average frames per second for the EfficientDet Lite model was 9.7 FPS. The average inference time per frame was 103.3 milleseconds.

6. Prototype Design



7. Continued Work

Planned Work

- Real-time testing scenarios
- Designing LCD screen attachment
- Designing an attachment handle to truck mirrors
- Conducting latency tests on the Coral Dev Board

Future Considerations

- Evaluating of other mini-computers
- Evaluating temporal object detection architectures
- Collecting feedback from industry users
- Multiple blind spot cameras to create a connected detection system

8. Acknowledgements

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9. References

Bicycle Safety | Motor Vehicle Safety | CDC Injury Center. (2022, May 4). Centers for Disease Control and Prevention. https://www.cdc.gov/transportationsafety/bicycle/index.ht ml

Garcia-Venegas, M., Mercado-Ravell, D. A., & Carballo-Monsivais, C. A. (2021). On the safety of vulnerable road users by cyclist orientation detection using Deep Learning. *Machine Vision and Applications*, *32*(5), 109. https://doi.org/10.1007/s00138-021-01231-4

Wang, Q., Sun, J., Wang, N., Wang, Y., Song, Y., & Li, X. (2022). Exploring the Influencing Factors and Formation of the Blind Zone of a Semitrailer Truck in a Right-Turn Collision. *Sustainability*, *14*(16), Article 16. https://doi.org/10.3390/su14169805