A Semi-trailer Truck Right-Hook Turn Blind Spot Alert System for Detecting Cyclists with Transfer Learning

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ENGINEERING NEED

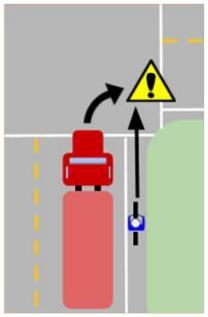
Semi-trailer truck drivers often have trouble identifying cyclists in their blind spots when making right-hand turns which can cause **truck-cyclist collisions**.

ENGINEERING GOAL

To engineer a device that can **detect cyclists** in a truck's right-rear blind spot and **provide alerts** for semi-trailer truck drivers.

BACKGROUND

- 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)



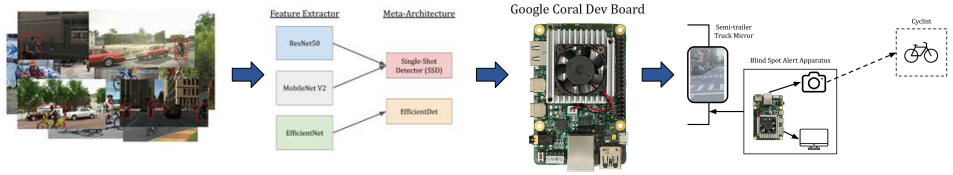
PROJECT OBJECTIVES

- Actively detects and locates cyclists with greater than 80% Mean Average Precision (mAP)
- Portable and installable onto most semi-trailer trucks
- Creates visual warnings on cyclists in the right-rear blind spot within 2 seconds
- Low cost – less than $300.00

BLIND SPOT SYSTEMS

Blind Spot System	Accuracy	Portability	Speed	Cost	Total Score
Proposed system	9	10	8	7	34 / 40
Ultrasonic	4	8	10	9	31 / 40
LiDAR	9	3	8	5	25 / 40
Mechanical	-	2	-	6	8 / 40
Truck cab redesign	-	1	-	2	3 / 40

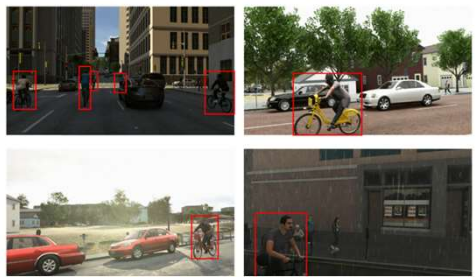
DESIGN PROCESS



CYCLIST DATASET

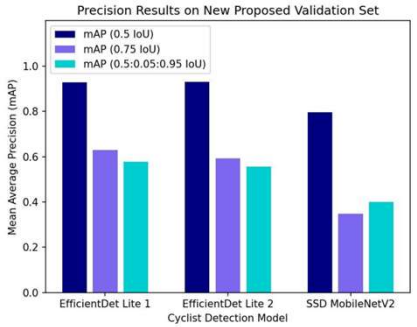
- 20,000 annotated cyclist images from web-scraped and synthetic cyclist images
- Contains *difficult* edge case scenarios: rain, dark, fog, glare, etc.
- Average of 2.2 cyclist instances per image
- Prevent AI bias and improve performance

Example Dataset Images



CYCLIST DETECTION MODELS

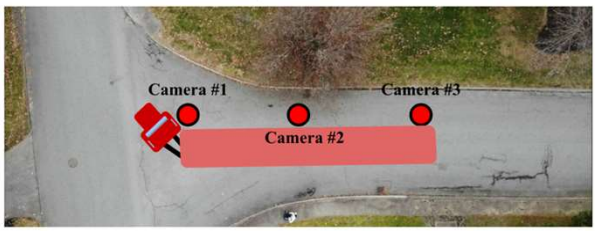
- 3 cyclist detection models trained on CIMAT and newly proposed dataset (Garcia-Venegas et al., 2021)
- Trained using Tensorflow Object Detection API and Model Maker API
- Highest accuracy: **95.6% mAP** (IoU: 0.5)



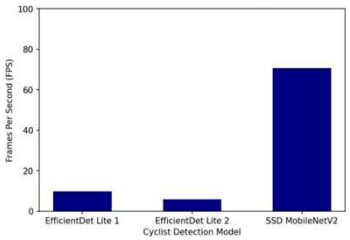
EXPERIMENTAL ON-ROAD TESTING

- Device deployed onto Coral Dev Board and tested in real-time scenario with three stationary cameras
- Cameras mounted at heights of 5, 13, and 5 feet, respectively, to model truck turning maneuver

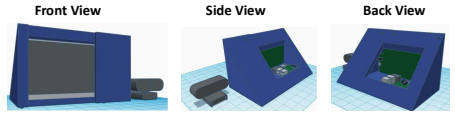
Aerial View of Model Testing Scenario



Frames Per Second (FPS) Results



DEVICE DESIGN



EXAMPLE DETECTIONS

VALIDATION DATASET

EXPERIMENTAL TESTING

DISCUSSION

- Able to make **fast and accurate** cyclist predictions in real-time – saving cyclist lives
- Robust performance in adverse lighting conditions and partial cyclist detection
- Camera placement #1 provides greater accuracy and ease of installation
- Matches LiDAR accuracy with **lower costs**
- **$175 per device** suggests feasibility for use in trucking industry

FUTURE WORK

- Testing and feedback in trucking industry
- Deploy larger system: cameras, sensors, etc.
- Pedestrian and motorcyclist detection

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