Machine Learning for Object Detection in Self-driving Vehicles

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INTRODUCTION

- Machine learning is a sub-branch of artificial intelligence that is used to analyze and automate big data
- Object detection utilizes machine learning to recognize numerous targets in images and videos
- Research focuses on developing self-delivery wagons and self-parking bikes
- Adopting a dynamic algorithm to allow automobiles to maneuver themselves with different purposes in different locations
- YOLOv5 (You Only Look Once) – a new but efficient deep learning model, is implemented in order to bring the most optimal performance for budget microcontrollers

METHODS

Setting Up

- Installing YOLOv5 and SDCar environment with necessary libraries, packages, and dependencies on our microcontrollers
- Benchmarking inference time of all devices

Raspberry Pi 3B

($34.99)

Raspberry Pi 4B

($69.99)

Google Coral Edge TPU

($85.00)

Nvidia Jetson Nano

($99.00)

Nvidia Jetson AGX Xavier

($999.00)

METHODS

Object Detection Training

- Identifying classes that are often appear on driving paths
- Gathering dataset of those objects
- Labeling classes in images with bounding boxes in PyTorch format
- Training dataset in YOLOv5 on a server desktop
- Adjusting the epoch, image size, and batch size to produce the most optimized result

Image of cars is labelled by bouding boxes

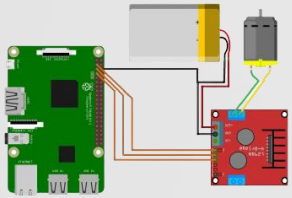
```
0 0.296675 0.478802 0.495173 0.443318
0 0.762801 0.558065 0.410800 0.310599
```

Coordinates of bounding boxes is saved in a text file

METHODS

Transfer Learning

- Connecting and controlling the vehicle's motors using the header pinout
- Substituting OpenCV with YOLOv5 object detection in SDCar
- Coding instructions when the camera detects objects within a closed by distance.
- Installing VNC for remote control
- Deploying the microcontroller on any desired vehicles.

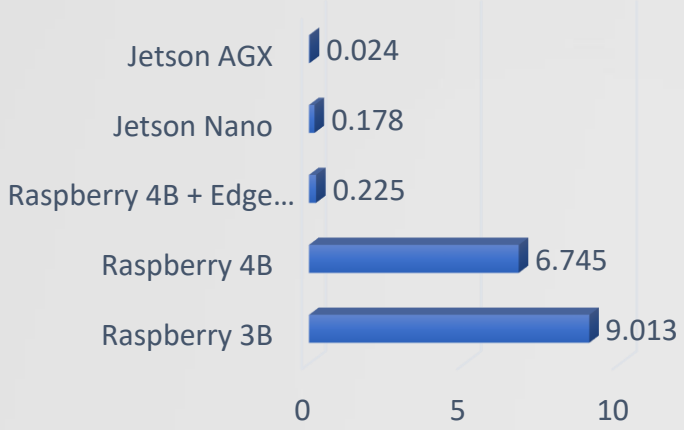


A model of microcontroller connected to the system

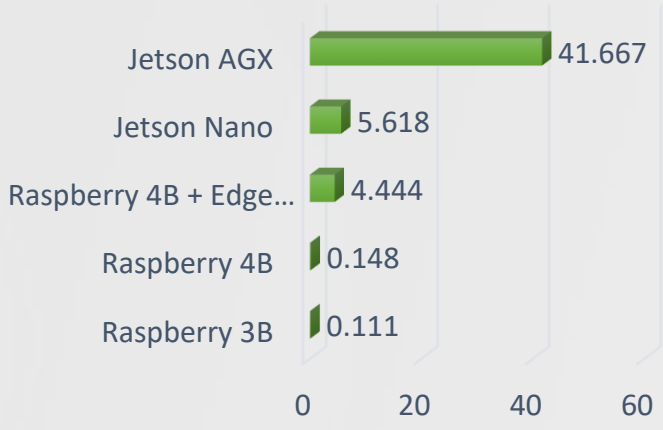
YOLOv5 detects with confidence scores

RESULTS

Inference Time (seconds)



FPS (Frame Per Second)



	Jetson AGX Xavier	Jetson Nano	Raspberry 4B + Edge TPU	Raspberry 4B	Raspberry 3B
FPS per dollar	0.042	0.057	0.029	0.002	0.003

RESULTS

Inference time of YOLOv5 on Nvidia Jetson Nano with all instruction codes is about 0.35s (~3FPS) on average.

Object Detection Performace

Our microcontroller is being implemented and tested. It is working on the wagon in lab environment.

Overall Product

FUTURE WORK

- Revising SDCar code to improve inference time
- Adding potential datasets and removing unnecessary datasets to help better object detection
- Lidar sensor might be needed to detect object's distance accurately

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- YOLOv5. https://github.com/ultralytics/yolov5
- Towards Data Science, “Deep Pi Car”. https://towardsdatascience.com/tagged/deep-pi-car
- Primary Investigator: Dr. Yu Bai
- Graduate Research Student: Yucheng Yang
- Research Mentor: Ryan Luong

QUESTIONS?

THANKS