Self-Driving Car

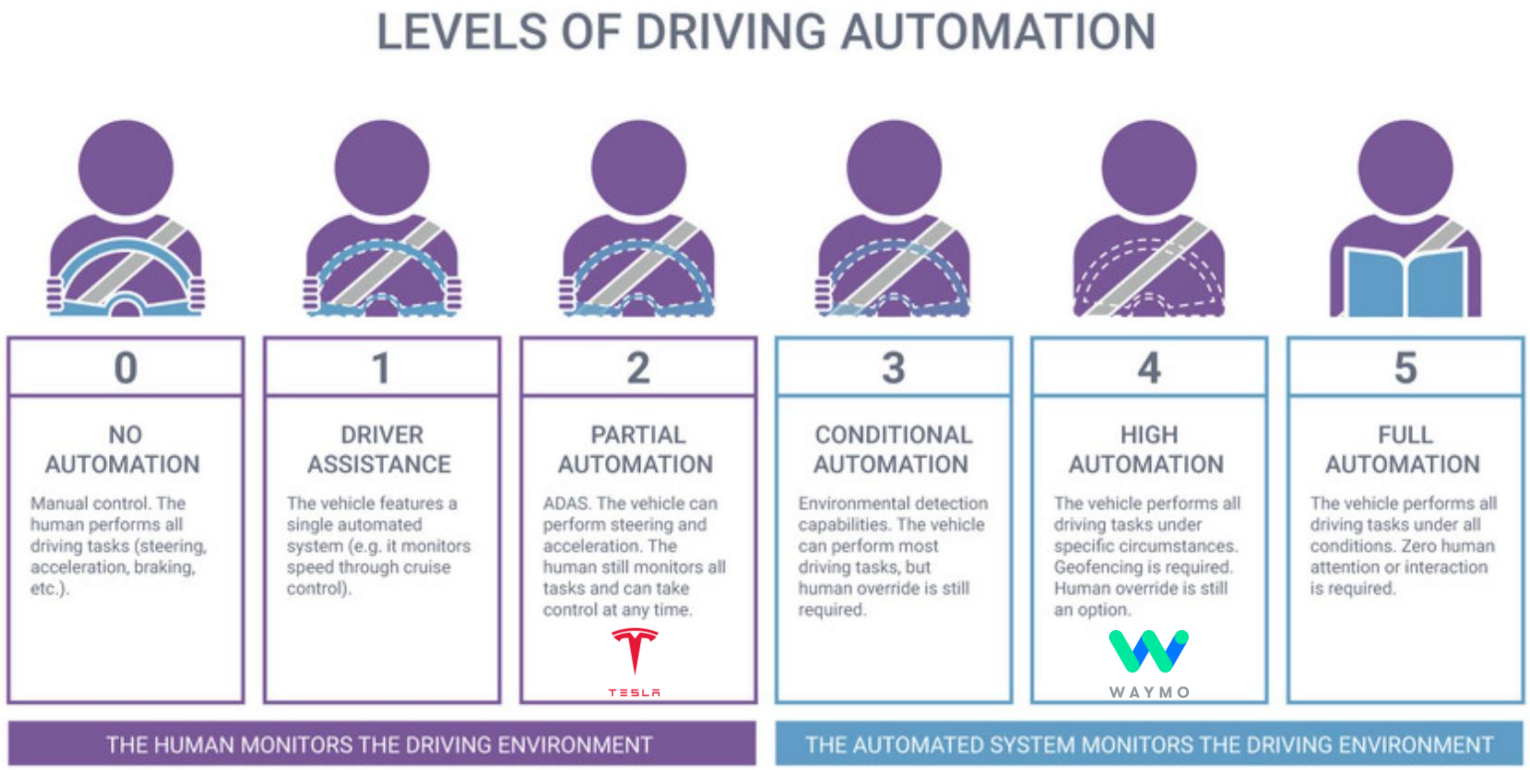
Presented by Wing Chan

Agenda

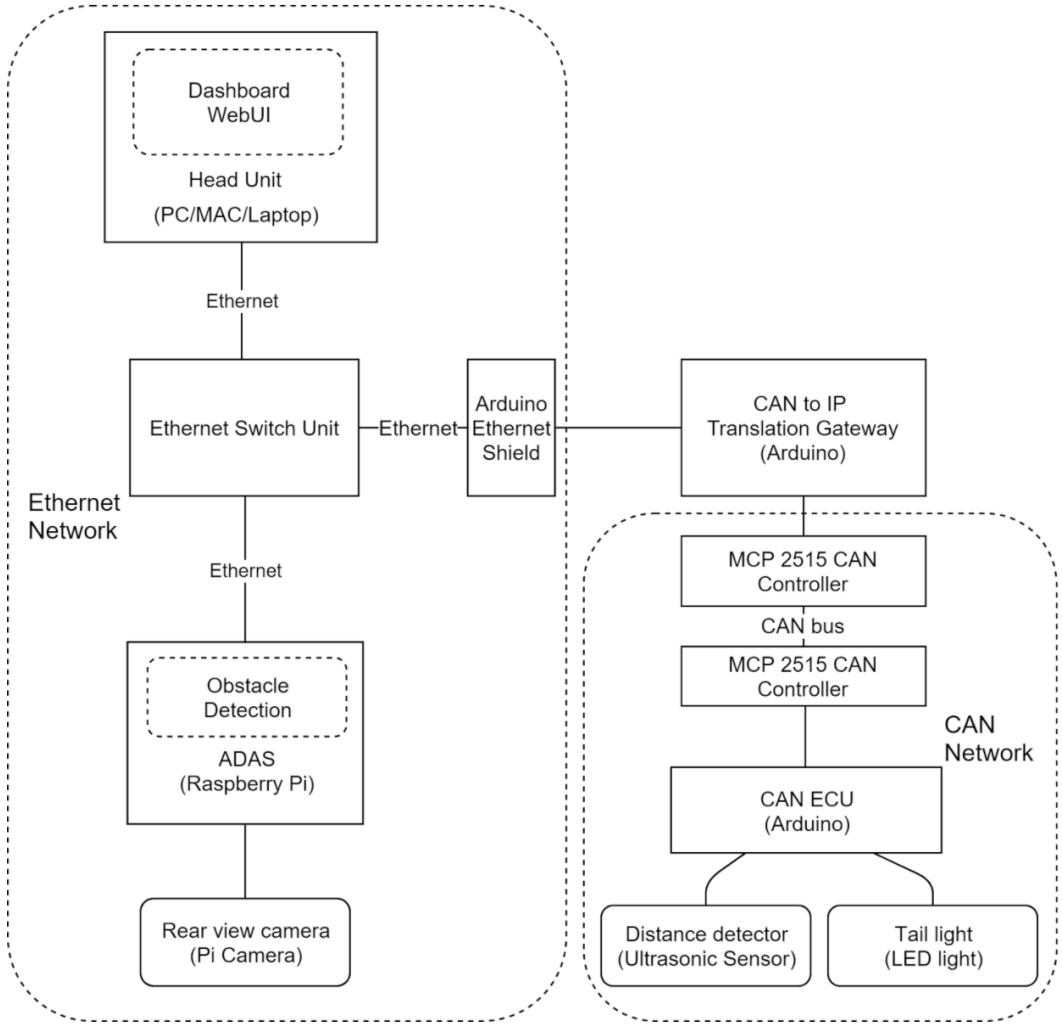
- What is a Self-Driving Car?
- Self-Driving Car Technology
- How to build a self-driving car
- Topology
- Technical Design
- Demo

What is a Self-Driving Car

Definition: A **self-driving car**, also known as an *autonomous vehicle*, *driverless car*, or *robo-car* is a vehicle that is capable of sensing its environment and moving safely with little or no human input.

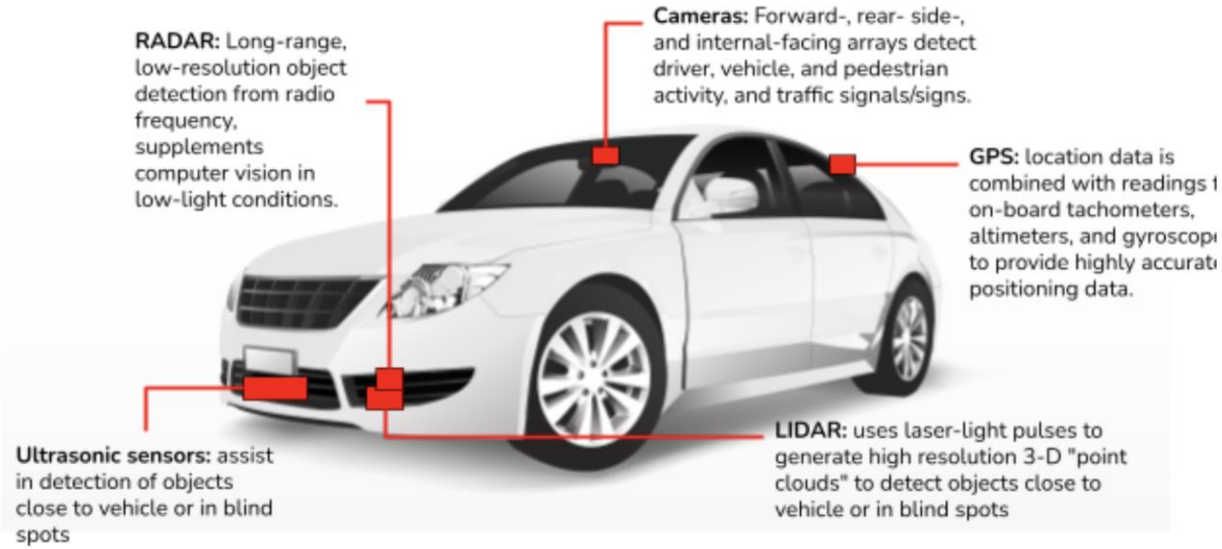


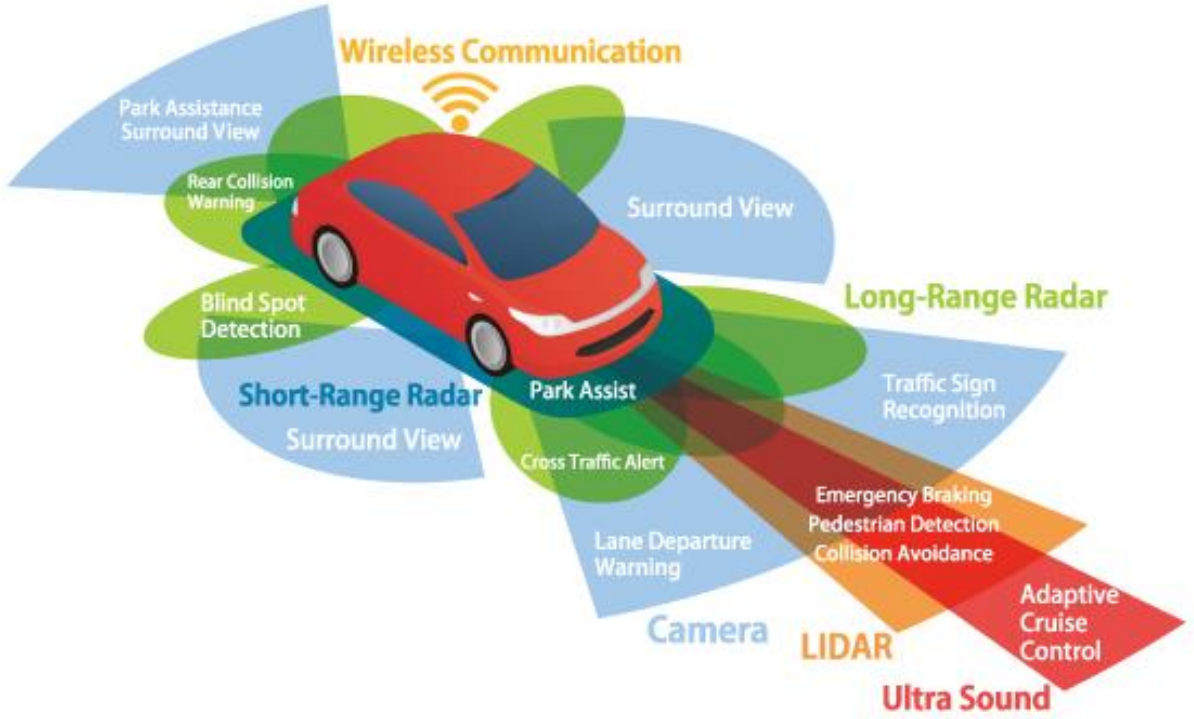
Self-Driving Technology – Internal (Intra-Vehicular network)



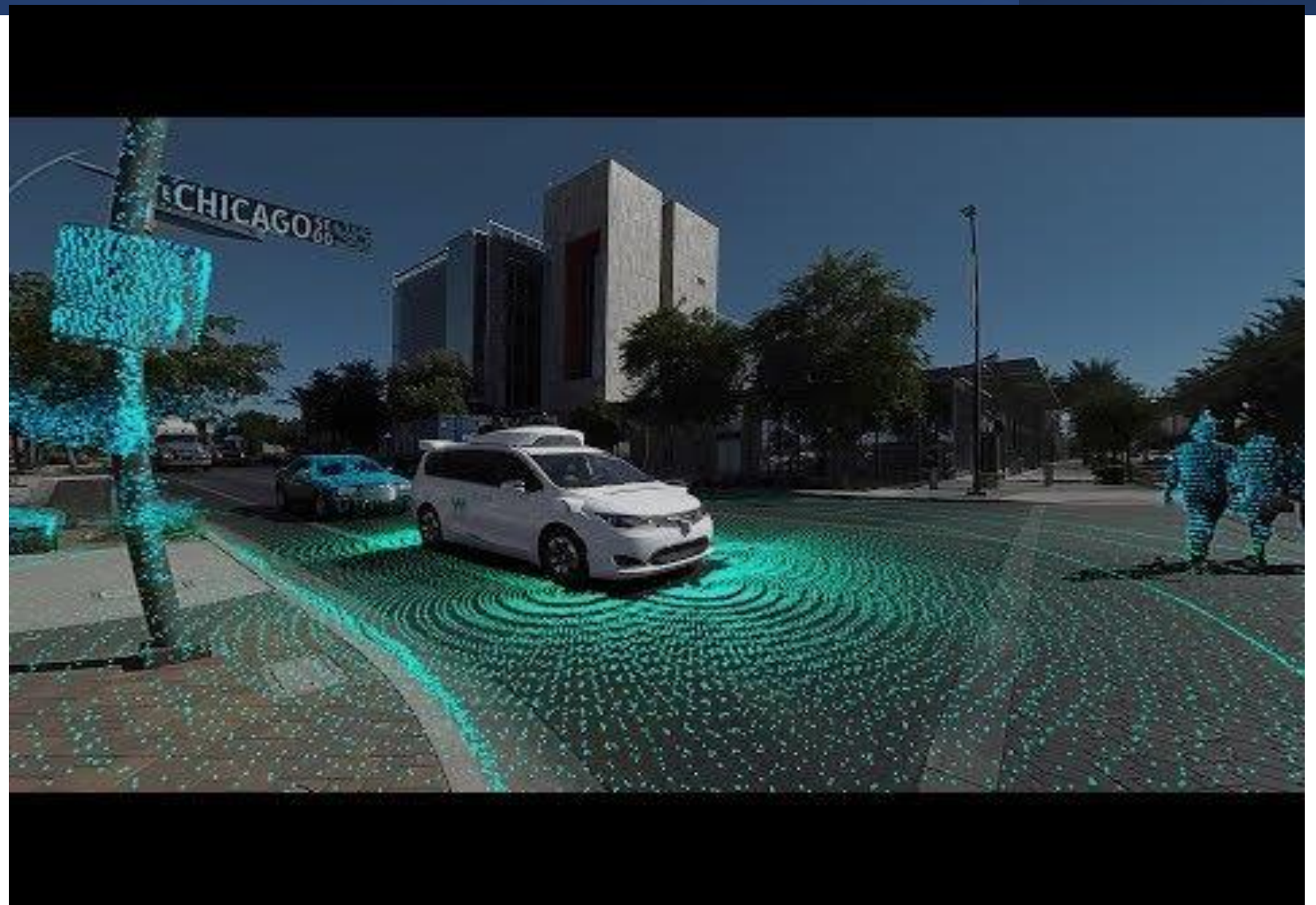
- A vehicular network consists of a Head Unit, an Ethernet Switch Unit (ESU), an Advanced Driver-Assistance System (ADAS), Engine Control Units (ECU), Sensors (Like Ultrasonic sensors and Lidars), an Ethernet Network and a CAN (Controller Area Network)
- CAN is a network within the car, providing a means of communication between the various sensors and microcontrollers in a distributed fashion without the need for a dedicated head computer.
- Head Unit allows the vehicle to communicate with the Internet via 5G or Wi-Fi, while displaying media and driving assistance information to the driver.
- ADAS is responsible for taking input from all the sensors to perform driver assistance like lane departure mitigation and obstacle avoidance.

Self-Driving Technology – External (Sensors)





Self-Driving Technology – Waymo



Self-Driving Technology – Tesla

How to build a Self-Driving Car

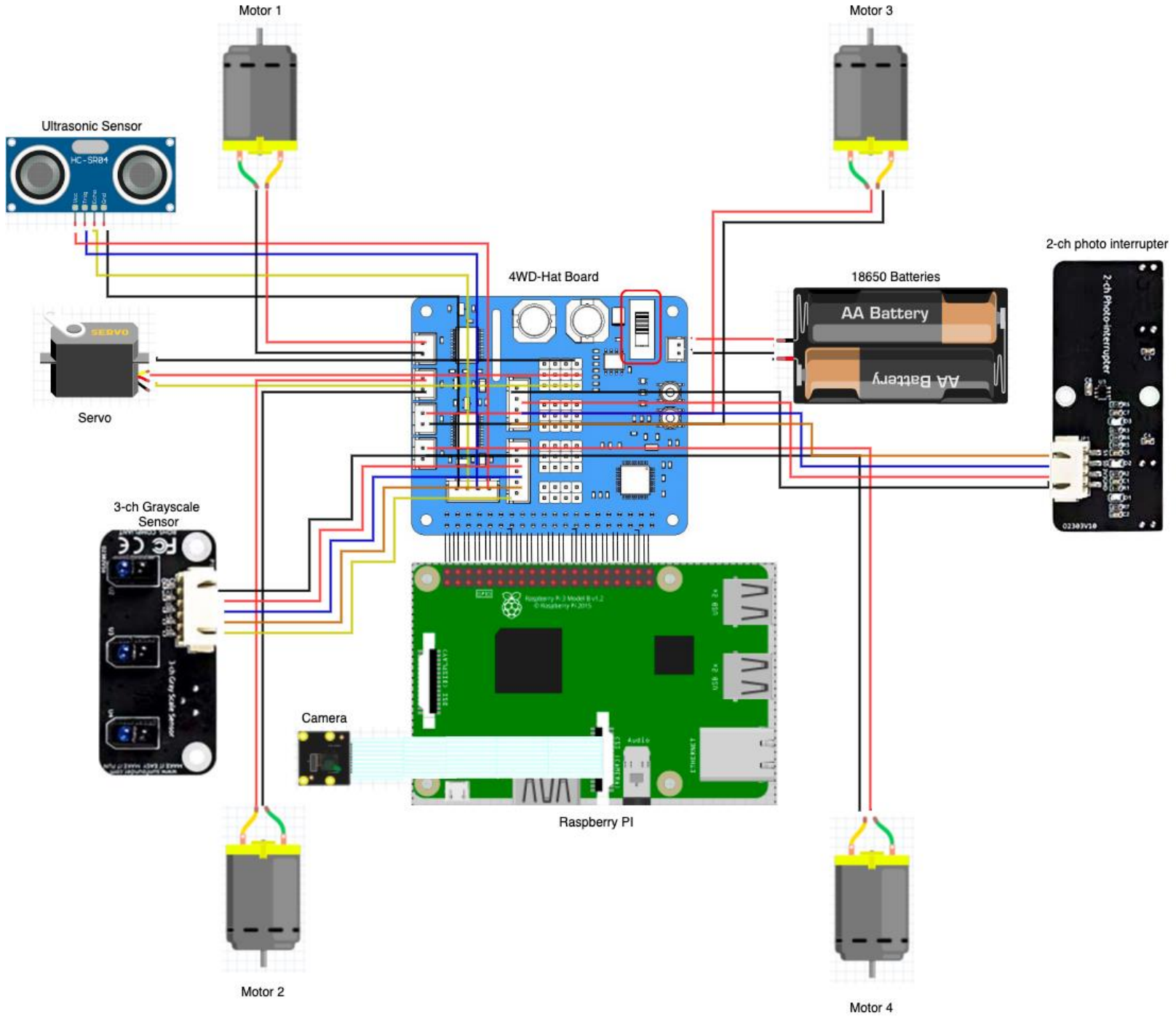
Hardware

- SunFounder PiCar-4WD Car Kit
- Raspberry Pi

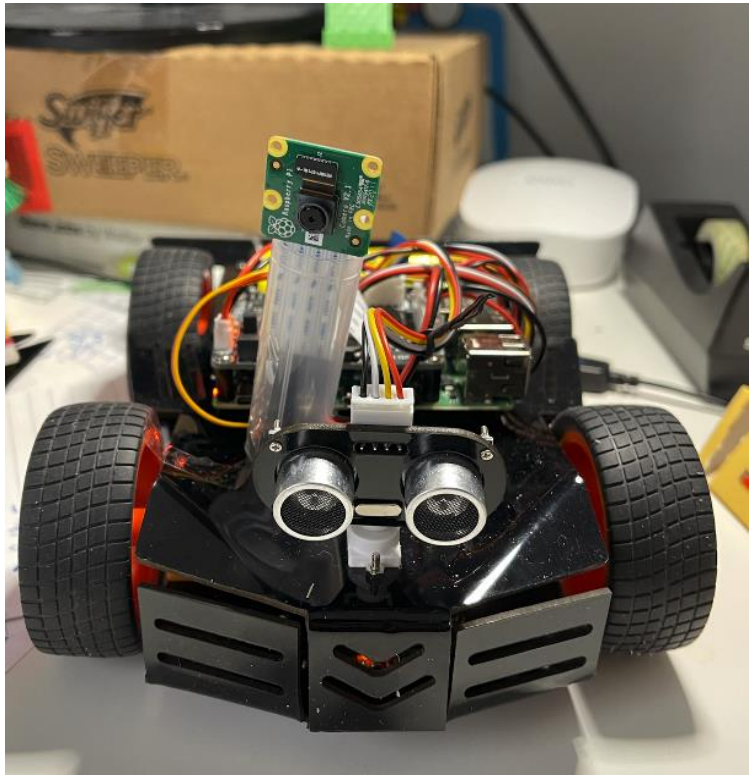
Software

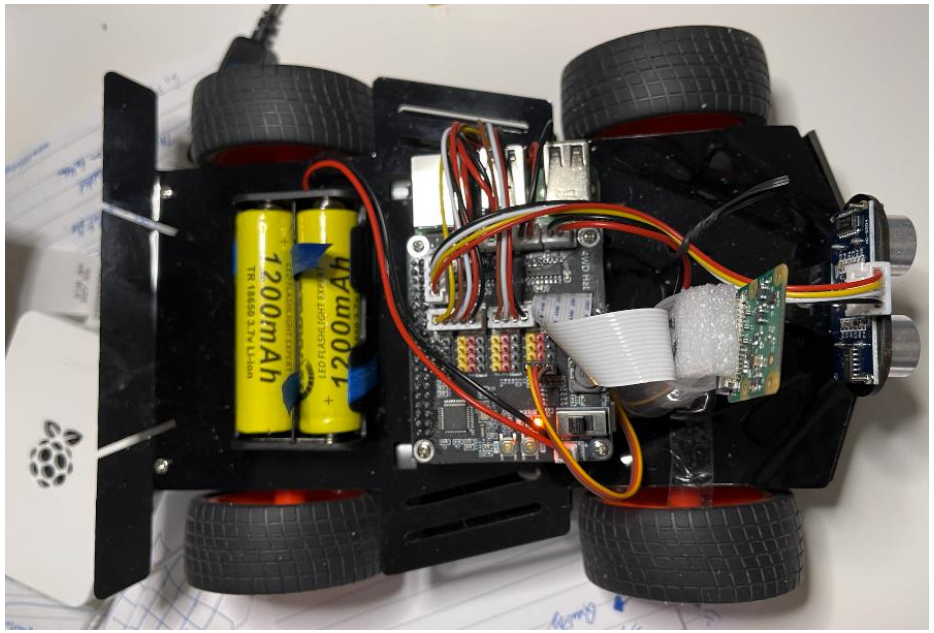
- Python 3
- Tensorflow Lite
- OpenCV
- Pathfinding

Topology

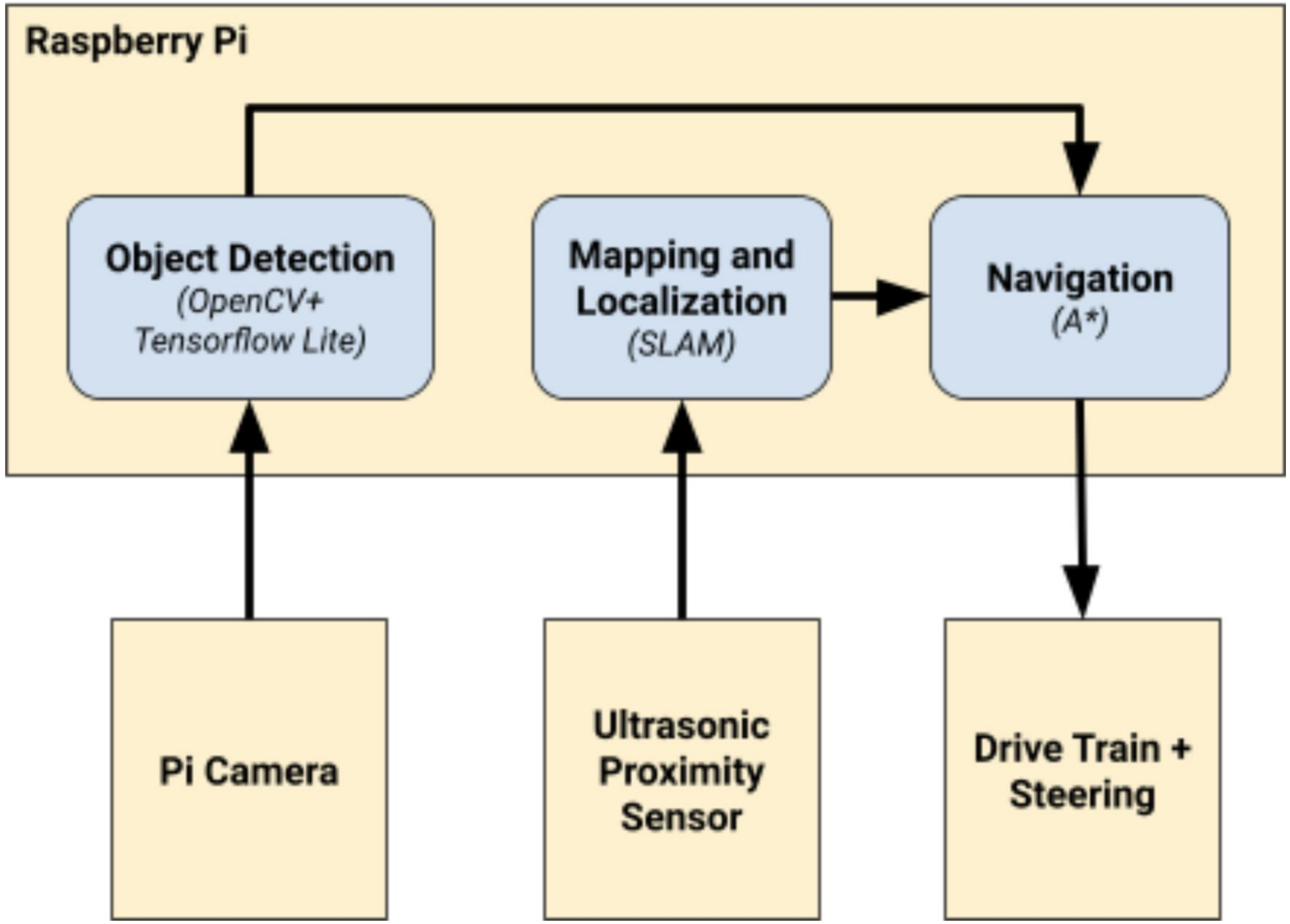

Motor 1
Motor 3
Ultrasonic Sensor
HC-SR04
2-ch photo interrupter
4WD-Hat Board
18650 Batteries
AA Battery
AA Battery
2-ch Photo-interrupter
SERVO
Servo
3-ch Grayscale Sensor
Camera
Raspberry PI
Motor 2
Motor 4

My Car Pictures





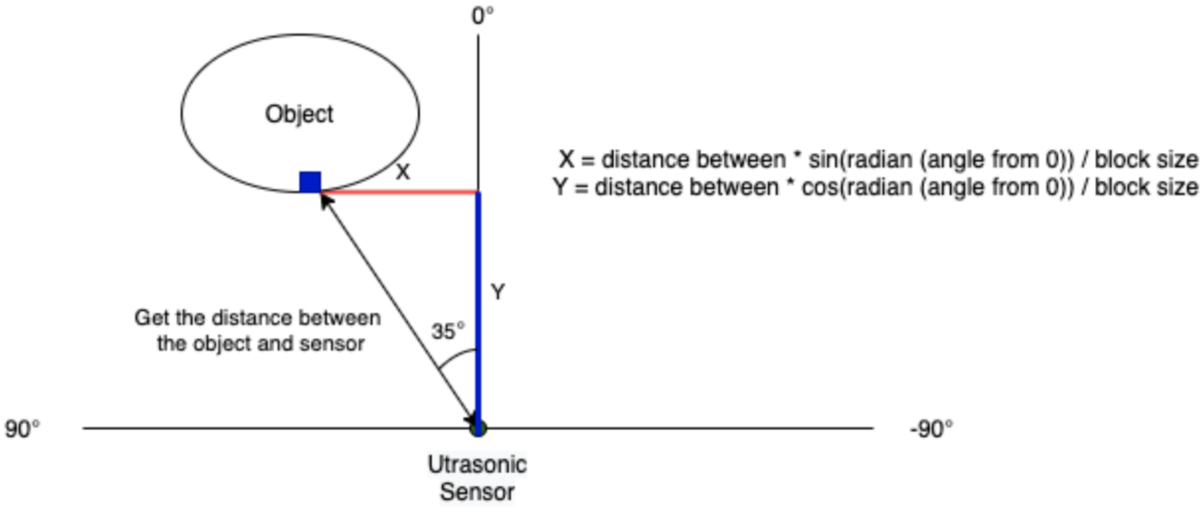
Obstacle Avoidance System

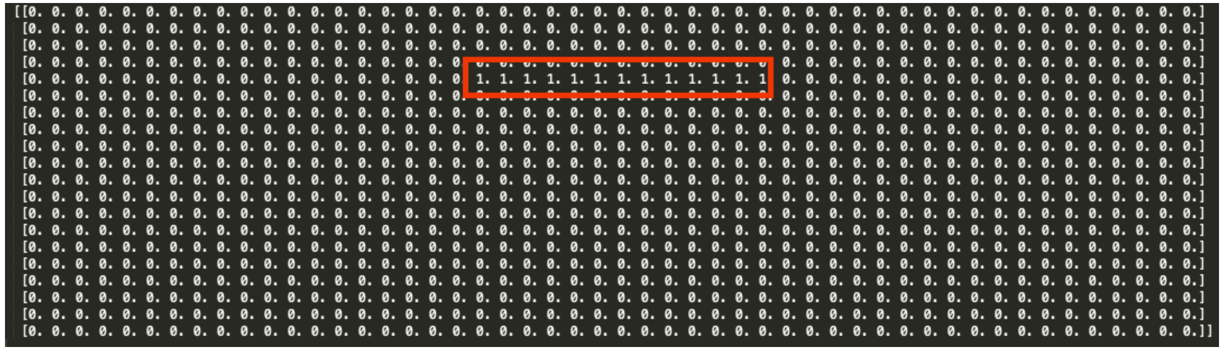


Object Detection

Mapping and Localization

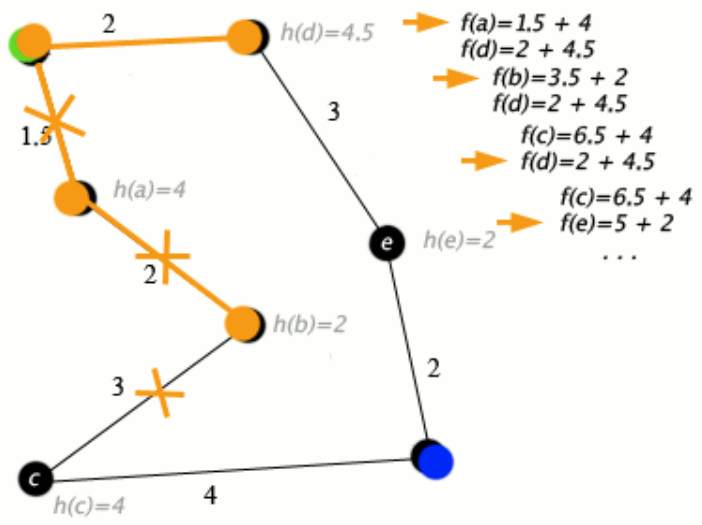
Simultaneous localization and mapping (SLAM) is the computational problem of constructing or updating a map of an unknown environment while simultaneously keeping track of the car location within it.





Navigation

A* Search algorithm is one of the best and popular technique used in path-finding and graph traversals.



$$f(n) = g(n) + h(n)$$

g(n) = is the cost of the path from the start node to *n*

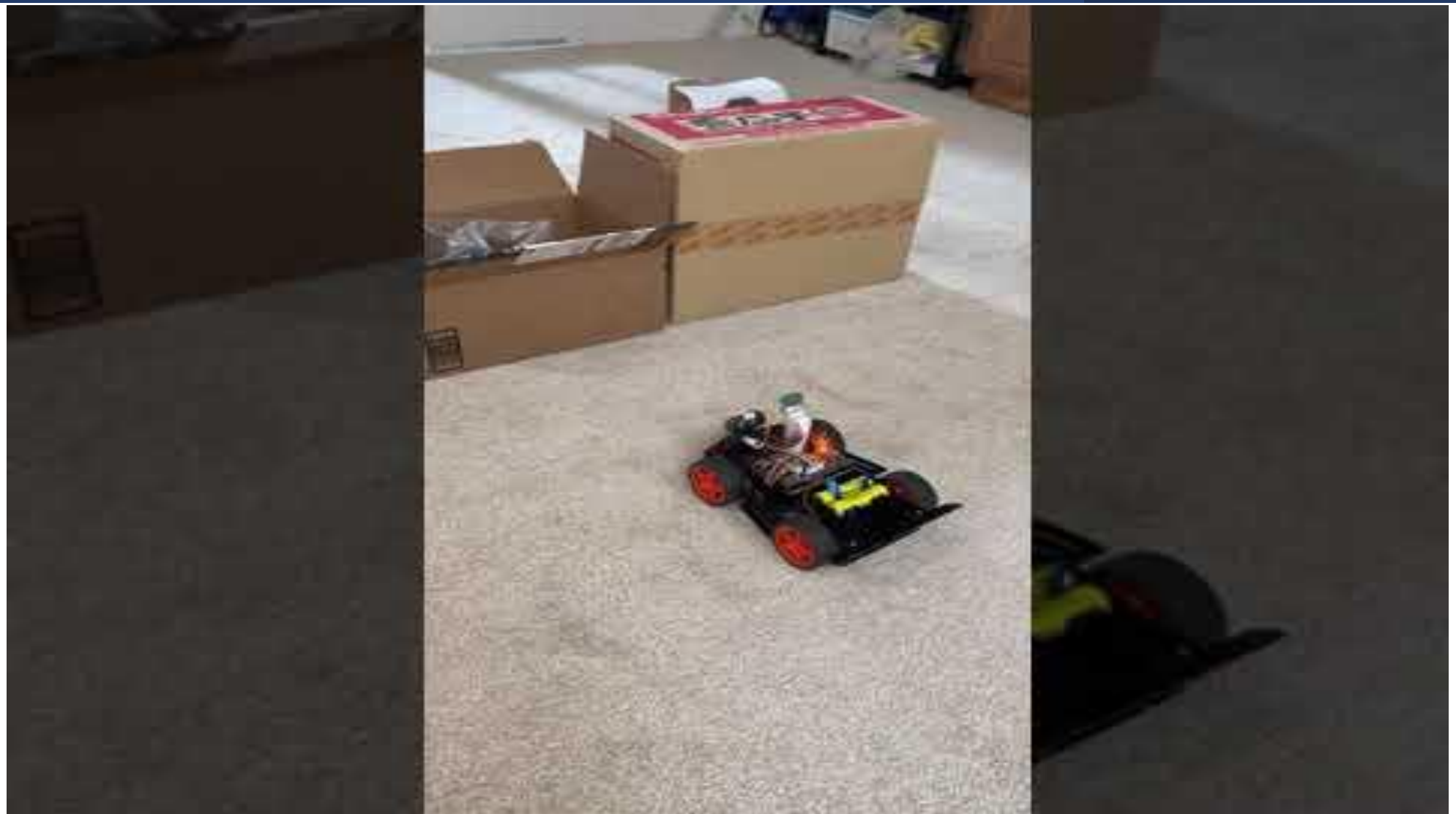
h(*n*) is a heuristic function that estimates the cost of the cheapest path from *n* to the goal

Using pathfinding library to handle A* algorithm implementation.

Code example

```
matrix = [
  [1, 1, 1],
  [1, 0, 1],
  [1, 1, 1]
]
grid = Grid(matrix=matrix)
start = grid.node(0, 0)
end = grid.node(2, 2)
finder = AStarFinder(diagonal_movement=DiagonalMovement.always)
path, runs = finder.find_path(start, end, grid)
```

Demo Video



References

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- A* Algorithm
  http://theory.stanford.edu/~amitp/GameProgramming/AStarComparison.html
- Tensorflow Lite
  https://www.tensorflow.org/lite/guide/python
- OpenCV
  https://opencv.org/
- Simultaneous Localization and Mapping (SLAM)
  https://pythonrobotics.readthedocs.io/en/latest/modules/slam.html
- Pathfinding
  https://github.com/brean/python-pathfinding