Report 3 - Nihal Afsal

Object Detection Using a Camera

Note: Homework must be uploaded as a **single pdf file**, not a zip file. If a problem solution requires a video, add it as a hyperlink in the pdf. The hyperlink should open the video file which is stored on your Google Drive. Any problem that requires Python code must show the entire code as well as a description of how the code works. Duplicate code submissions will result in a zero.

1. Describe the difference between computer vision, artificial intelligence, machine learning, deep learning, and object detection.

- Computer Vision processes the visual information captured by cameras and sensors mounted on the vehicle. This information is used to understand the environment around the car and make decisions about navigation, obstacle avoidance, and other tasks.

- Artificial Intelligence is the overarching field that encompasses the other technologies used in autonomous vehicles. It refers to the capability of machines to perform tasks that would typically require human intelligence, such as perception, decision-making, and control.

- Machine Learning is used to train algorithms and models that can learn from data and improve their performance over time. For example, machine learning algorithms might be used to identify and track other vehicles on the road, predict road conditions, and decide the safest and most efficient path to take.

- Deep Learning is a subfield of machine learning that is used to develop more advanced algorithms and models, such as those used in image and video analysis. For example, deep learning algorithms might be used to identify and classify objects in the road scene, such as pedestrians, cyclists, and other vehicles.

- Object Detection is a specific application of computer vision that involves identifying and localizing objects in the road scene. This technique is critical for autonomous vehicles, as it helps the car understand its surroundings and make informed navigation and obstacle avoidance decisions.

2. Solve for the output of the following artificial neural networks using Python. (*15 pts)*

a. A single-input neuron with a hard limit transfer function that has an input of 2.0, a weight of 2.3, and a bias of -3.0.

```
def hard_limit_function(x):
     if x >= 0:
          return 1
     else:
          return 0

     valInput = 2.0
     valweight = 2.3
     valBias = -3.0

     output = hard_limit_function(valweight * valInput +
valBias)
print(output)
```

```
> python main.py
 = 1
```

A single-input neuron with a log-sigmoid transfer function that has an input of 2.0, a weight of 2.3, and a bias of -3.0.

```
import math

def log_sigmoid_function(x):
     return 1 / (1 + math.exp(-x))

valInput = 2.0
valweight = 2.3
valBias = -3.0

output = log_sigmoid_function(valweight * valInput +
valBias)

print(output)
```

```
> python main.py
0.8320183851339245
```

b. A two-input neuron with a hard limit transfer function that has an input vector of [-5 6], a weight of [3 2], and a bias of 1.2.

```
import numpy as np

ValInputs = np.array([-5, 6])
ValWeights = np.array([3, 2])
ValBias = 1.2

sum = np.dot(ValInputs, ValWeights) + ValBias
output = np.where(sum >= 0, 1, 0)
print(output)
```

```
> python main.py
1
```

c. A two-input neuron with a log-sigmoid transfer function that has an input vector of [-5 6], a weight of [3 2], and a bias of 1.2.

```
import numpy as np

def log_sigmoid_function_two(x):
  return 1 / (1 + np.exp(-x))

ValInput = np.array([-5, 6])
ValWeights = np.array([3, 2])
ValBias = 1.2

val = np.dot(ValInput, ValWeights) + ValBias
output = log_sigmoid_function_two(val)
print(output)
```

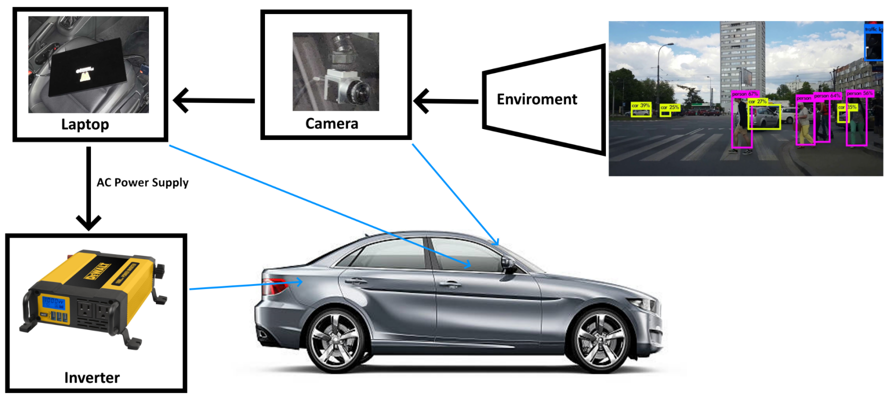
```
> python main.py
0.14185106490048777
```

3. Show a low confidence object detection from the YOLO network on a picture taken from your phone. Describe why the confidence level is low and how it could be improved. *(15 pts)*

- I believe it is low confidence because of the lack of data diversity. The network may only generalize well to new data if the training data is diverse enough. To improve it, we may need to gather more varied training data to increase the program's generalizability.

4. During class we recorded a video using the camera mounted on our autonomous vehicle development platform. Document the set-up of the camera on the vehicle by splitting the following tasks with your group. You can all turn in the same thing or have each student turn in their contribution. (*15 pts)*

    a. Create a wiring diagram



    b. Document with photos how and where the camera is connected

- The laptop in the passenger seat is connected to the camera, which is situated behind the rearview mirror. In addition, an AC inverter is linked to the laptop's charger. The inverter, located in the trunk, converts the DC voltage from the vehicle to AC voltage.

c. Document and describe how the video data was collected

- The footage was captured with the windshield-mounted camera and sent to Rvis on the laptop using a USB cord. The user can view the video after Rvis has processed it.

5. Apply the YOLO algorithm to the video we recorded during class. Turn in a video file of the resulting detections. Discuss the results. (*30 pts)*

   https://drive.google.com/file/d/1THSHYPJfNSfgncURWyvYlQKE4vg4TBGD/view?usp=sharing

- I discovered that the code is effective at recognizing things after modifying it to locate and display the video. It could see models of vehicles like cars, buses, etc. One problem, though, is how slowly the video plays; it appears to be moving at a super slow rate, frame-by-frame pace.