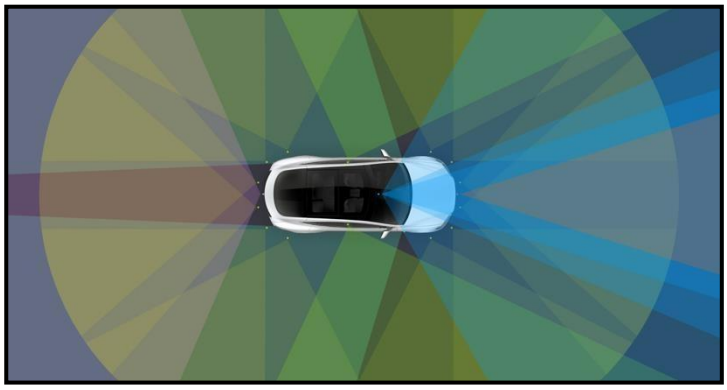
FSIPLeiria Recruitment Assignment

Autonomous Driving

DEADLINE: 23/10/2022. Submit your assignment to your project manager via email (see the contact info below).

Project Introduction



For a vehicle to drive itself, it needs to assess its environment. As roads and tracks were made for humans, which mainly use their vision to drive, an autonomous vehicle needs to adapt to the infrastructure already in place.

This assignment is quite big and at some questions challenging, not to scare you but instead to give you the freedom to work on what you feel more akin of and explore.

Deliver the source code and any other files as a reasonably well structured compressed folder: good organization is always valued and saves time.

Perception

Project Description

- The main objective of this assignment is reading the feed from your own computer webcam and transform the camera image feed. If your computer doesn't have a working webcam, the assignment can also be done by reading a video stored locally. After getting the feed of the camera, you will need to pick 4 pixels on the image feed, and, using those pixels, make a "warped" transformation on the image, where the area delimited by the pixels points will be shown on a new feed, to appear as a 2D image.

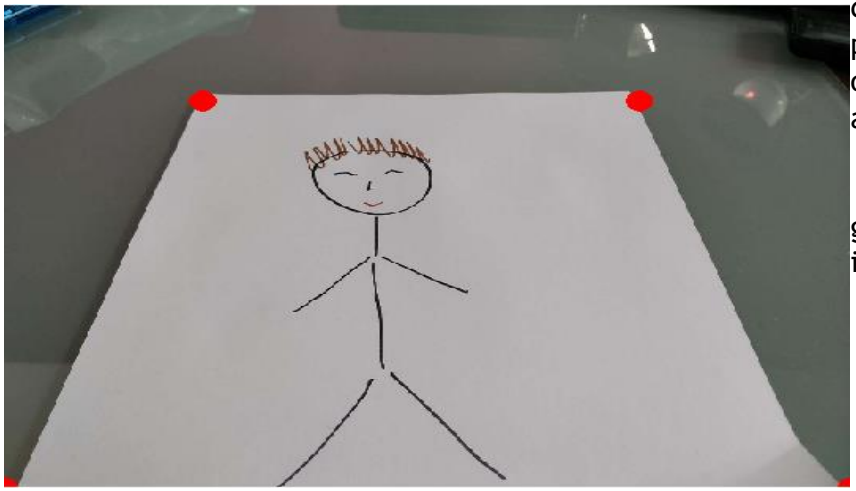


Figure 1: One-point perspective

- An example is given in the following image:

Figure 2: Warped perspective

- For this, you will need to program through an IDE (Integrated Development Environment). For a simpler and more efficient solution, we recommend using an already built-in library.

Requirements

- Design a script that reads the data of the webcam and makes a "warped perspective" transformation on the camera feed.
- Commenting the most important functions or code with what it does.
- Digital image transformation is normally based on linear transformations. Consider that a given grayscale image is represented by a matrix M of integers with 600 rows and 800 columns, with each element a value between 0 and 25, where 0 is black and 255 is white. Define a function $inv(M)$ (mathematically only) that receives the matrix M and returns its inverse version relative to the yy-axis.
- The programming language, IDE and libraries are not mandatory. You have the freedom to use the most comfortable tools that fulfill the objective of this assignment. But we recommend using the following tools:
  - Programming language: Python – most used language for computer vision.
  - IDE: PyCharm – easy to use IDE for Python.
  - Library: OpenCV – user friendly library.
- For the submission of the assignment, send a recording of your screen with the script running.

Planning

Project Description

- Path planning consists in, considering the data obtained from the perception stage, plan the optimal path for the car.
- The key points in the world and reachability between them can be described by a graph. Graphs are usually the theory behind most of the path planning algorithms, such as RRT* and A*. Consider the following graph:

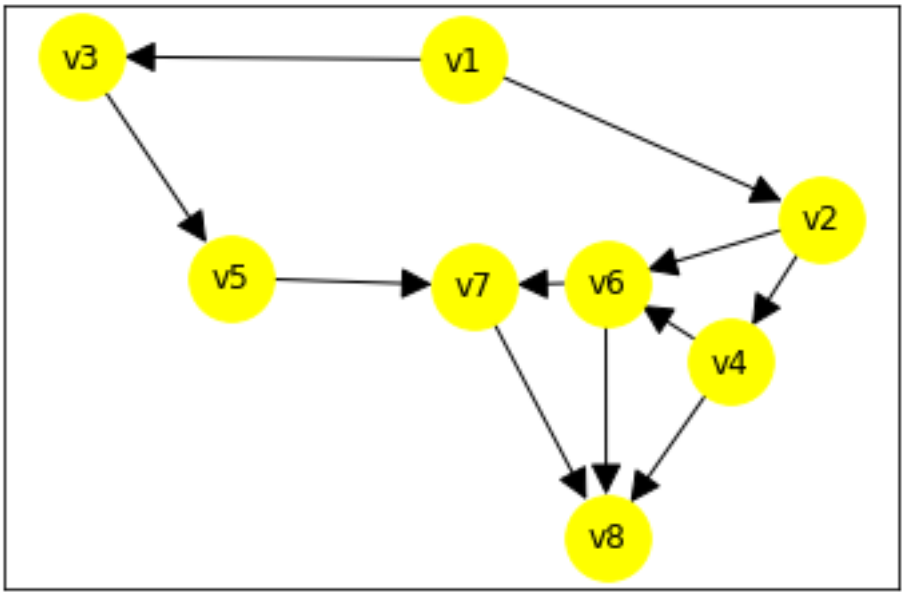


Figure 3 - Relations Graph

Requirements

- By using the graph relation matrix and some basic graph theory, find the answer to the following questions. You can write the responses in the code as comments:
  - How many paths are possible between node “v1” and node “v8”?
  - What is the minimum path length between node “v1” and node “v8”? Which path is this?

Control

Project Description

- Given a planned path (set of waypoints), the control is responsible by leading the car towards those goals.
- This involves applying car specifications relevant to the dynamics studies and doing the necessary prediction on how to actuate.

Requirements

- Write a small report on which you study possible models and approaches to take when controlling the car having in account the following specifications.
  - Wheelbase: 1550mm
  - Mass: ~270 kg
  - Weight distributions front/back: ~50/50
  - Steering angle limits: ±40°
  - Steering ratio: 2.25
- For example: describe the kinematic model that could be used from the data above (just a tip: no need to use all the data); propose, describe and justify the usage of some path tracking algorithm; propose, describe and justify the usage of some control model for the actuators.

2. Resources

If you use the recommended tools, the 3.7 version of Python is the safest option since this version works well with OpenCV:

- Python – Official pagelink.
- PyCharm – Official pagelink.
- SciPy – Official pagelink.
- OpenCV – Computer vision library.

Note: If you need any help feel free to email us!

Project Manager:

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