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CARLA HARDWARE-IN-THE-LOOP

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OBJECTIVE

- To develop and design a platform for autonomous vehicle research
- To develop and design a testing bench to perform integration testing on existing vehicle components (Instrument Cluster, Infotainment System, etc)
- Designed to be modular and cost effective

WHAT IS CARLA?

- An open-sourced simulator for autonomous driving research

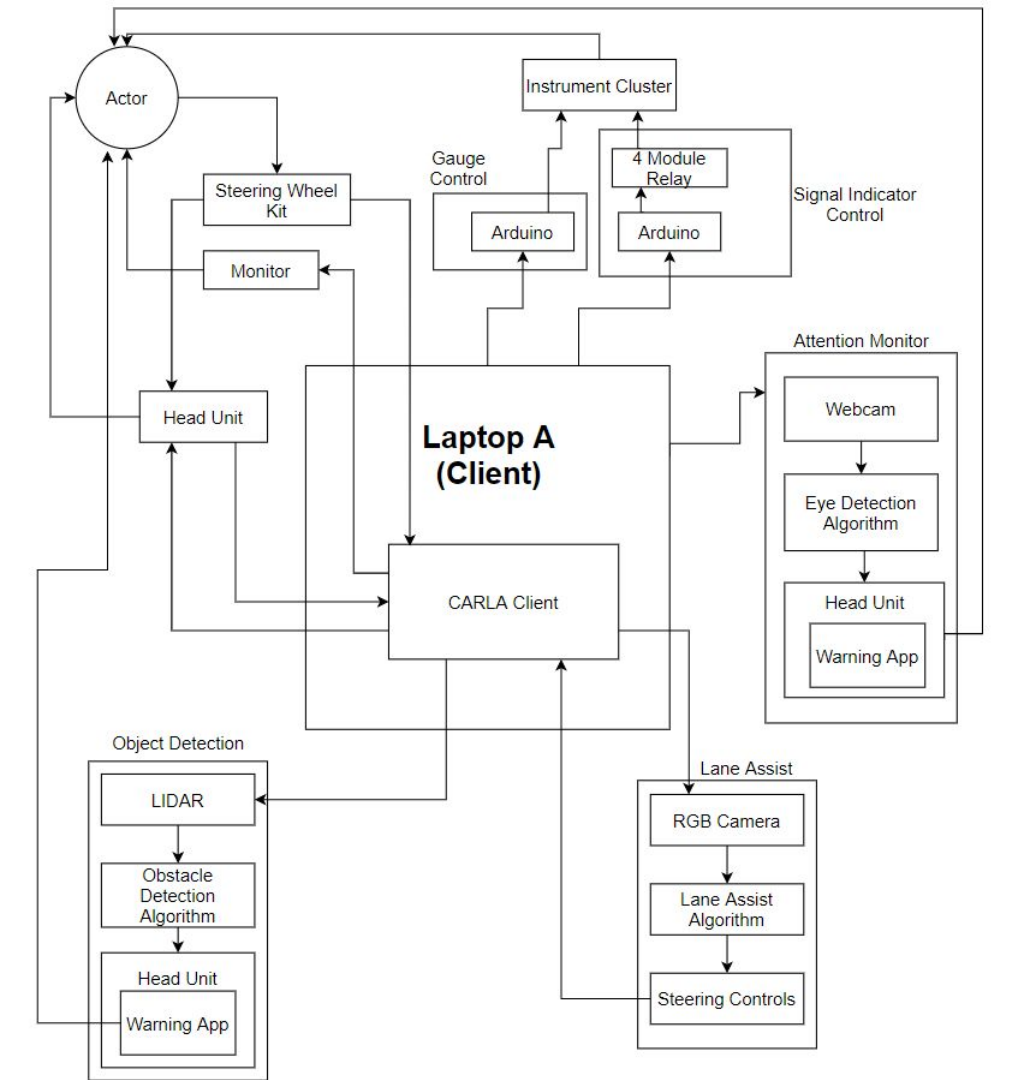
OVERVIEW OF FEATURES

- Lane Assist
- Instrument Cluster Integration
- Steering Wheel Kit Integration
- Obstacle Detection
- Infotainment Unit Integration
- Driver Monitoring System
- Custom Map (In Progress)

Existing Solutions

- Costly
- Non-Modular
- Closed Loop
- Proprietary
- Vehicle-Specific
- Immobile Platforms

Solution Architecture Diagram



LANE ASSIST

- Uses OpenCV to find the lines before-hand to make sure the car is in the middle of the two lines

- **PROCESSING**
  - Grayscale
  - Gaussian Blur - Used to blur the result to get more defined lines
  - Canny Edge Detection - Detects all the edges of an item
  - Region of Interest - Cut out a window for where to detect lines
  - Hough Lines - Detects lines

OBSTACLE DETECTION using LiDAR

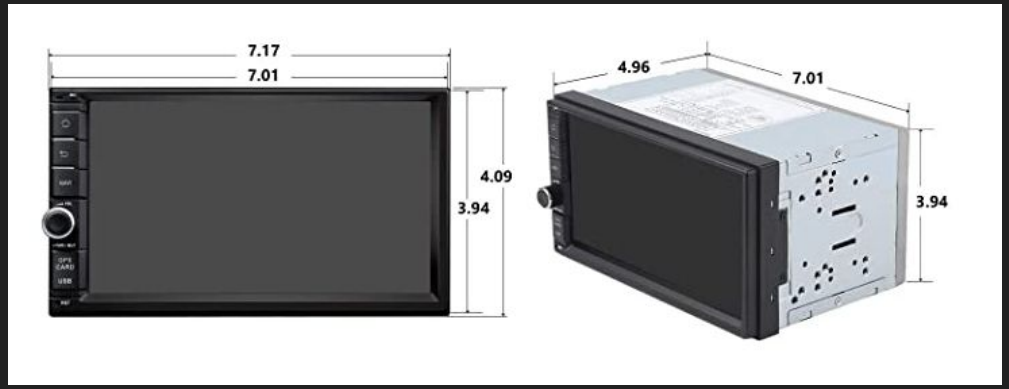
- LiDAR in CARLA is simulated using ray tracing and simulated rotational effects.
- We can visualise LiDAR in real time using PyGame, this is done in 2D by dropping the Z-axis.
- We can export captured data and view it in depth(Eg: using Blender) for detailed analysis.

Obstacle detection

- Detect object using a bounding box based collision system, simple and effective algorithm.
- Monitor and area anywhere near the car, if any unusual points appear above the ground that could be a possible obstacle, warn the user or apply breaks.

INFOTAINMENT UNIT

- Eonon GA2176 (Android 9.0)
- Interface over ADB
- Mimic backup camera using HDMI converter



INFOTAINMENT INTEGRATION

- Launch applications via ADB
  - Maps, AVIN (Backup Camera), Custom Alert Indicator App

- Geo-spoof our location via ADB
  - Preset list of coordinates which are iterated and spoofed on head unit to simulate movement of vehicle

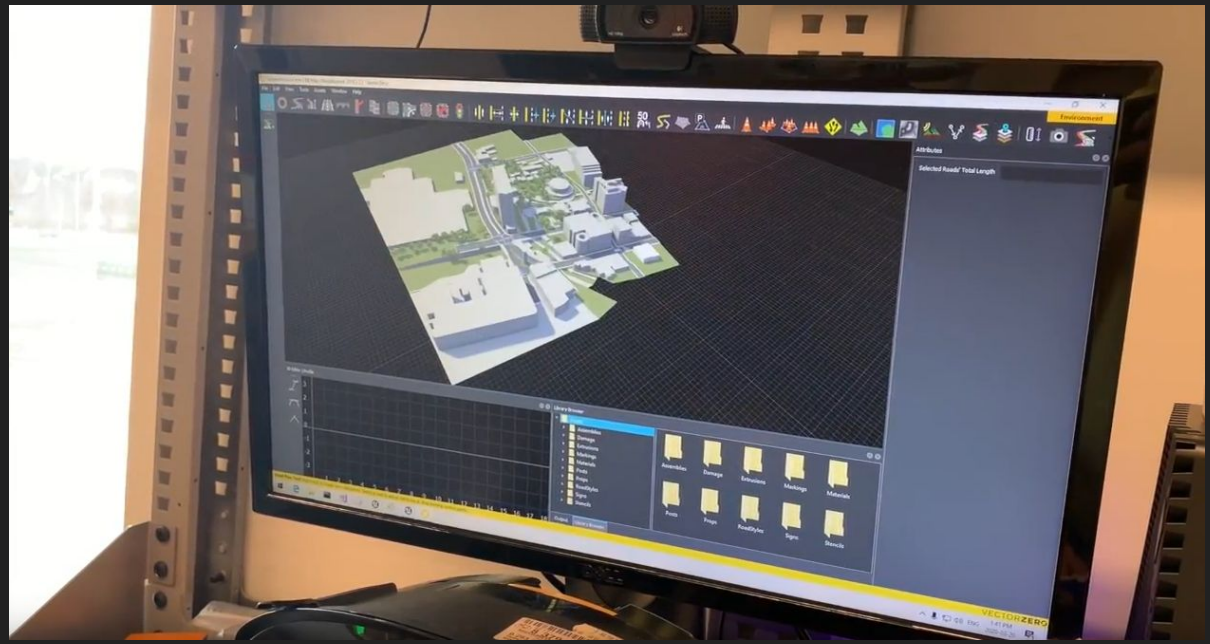
- Simulate a backup camera
  - Treats infotainment unit as a 2nd display and displays CARLA backup camera in an OpenCV window in 2nd screen

DRIVER MONITORING SYSTEM

- Searches for facial features that it can detect (eyes, nose, chin, etc.) to identify a face
- Uses eye tracking algorithm to check if user is facing the road
- If the user is not facing the road, it will launch a warning to the user after 3 seconds of not detecting the eyes and face
- Uses a standard webcam - Logitech C920, can use any webcam that has a RGB sensor

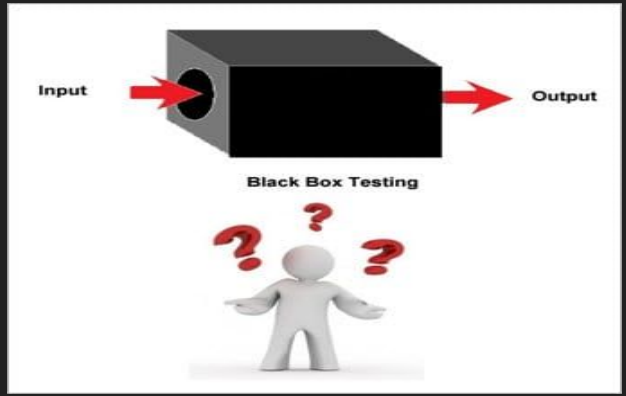
CUSTOM MAP

- Design using RoadRunner application
- Export map file and compile it with CARLA server source code



Custom Map Issues

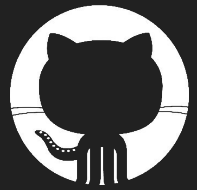
- CARLA not a finished product, builds are not stable.
- Windows based building of executable has issues, fails.
- Need to re-build executable with special plugins for importing custom maps.
- No open-source alternatives available for custom maps.
- Black-box nature of this feature leaves limited options.

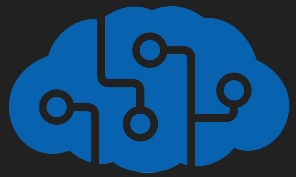


DEMO

VIDEO

Technologies





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ANY QUESTIONS?

Trailer Video Link

https://youtu.be/lZmZKLm0mFg