

Autonomous Driving World Map Auto-Generation for CARLA Simulator Using OpenStreetMap

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Research Question

Using OpenStreetMap, RoadRunner and Unreal Game Engine, can real world map be imported as an auto-generated simulation scenario into CARLA simulator?

Research Method

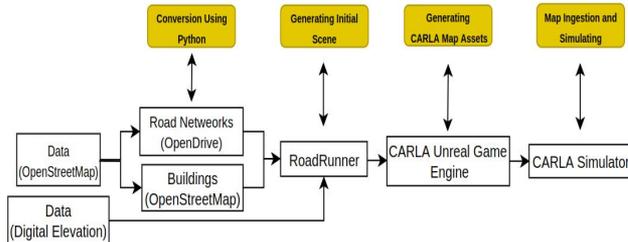


Fig. 1 Method Used to Solve the Problem

Input: OpenStreetMap and Digital Elevation data
Output: Auto-generated map for CARLA simulator

In the developed method, Python language is used in format conversion for map data and map ingestion by CARLA simulator. RoadRunner is used to provide an initial scene involving road networks and elevation data. However, the buildings are auto-generated in Unreal Game Engine. CARLA simulator is built from source using Unreal Game Engine. The programming language used for Unreal Game Engine is C++.

Obstacles

In this research, some obstacles were faced which are explained as follows:

- GPU drivers incompatibility between RoadRunner, CARLA and Unreal Game Engine
- CARLA simulator version and Ubuntu version incompatibilities

These obstacles were overcome by switching between GPU drivers and finding compatible versions between CARLA simulator and Ubuntu.

Discussion

```
1 import carla
2 # Read the osm data
3 f = open("~/home/local/ASUAD/FURI/Map/Map.osm", "r")
4 osm_data = f.read()
5 f.close()
6
7
8 # Define the desired settings. In this case, default values
9 settings = carla.Osm2odrSettings()
10
11 # Set OSM road types to export to OpenDRIVE
12 settings.set_osm_way_types([
13     "motorway",
14     "motorway_link",
15     "trunk",
16     "trunk_link",
17     "primary",
18     "primary_link",
19     "secondary",
20     "secondary_link",
21     "tertiary",
22     "tertiary_link",
23     "unclassified",
24     "residential"])
25
26 # Convert to .xodr
27 xodr_data = carla.Osm2odr.convert(osm_data, settings)
28
29 # save.opendrive file
30 f = open("~/home/local/ASUAD/FURI/Map/Map.xodr", "w")
31 f.write(xodr_data)
32 f.close()
```

CARLA library can be developed in order to get more categorized data as OpenDrive format out of input data from OpenStreetMap file. This can happen by defining more way types in the script.

Fig. 2 Format Conversion Using Python Language

Results

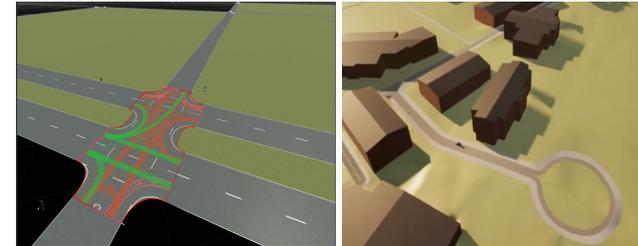


Fig. 3 Auto-Generated Road Network from World Map

Fig. 4 Final Auto-Generated CARLA Map

In addition to auto-generated map for CARLA simulator, the following were obtained:

- Multiple formats for the generated map which provides the support for other autonomous vehicle simulators
- Auto-generated road networks for the final map
- Auto-generated way points which provides a high quality simulation of self-driving cars
- Custom signaling cross-sections

Future Work

World map auto-generation can be expanded to provide:

- Diverse simulation scenarios for self-driving cars
- Enhancing the security of self-driving cars

Using the same concept, robot simulation environments can be auto-generated from the real world for robot simulators.