Module 2 - Lesson 4

Course 1 - Introduction to Self-Driving Cars

Module 2
Self-Driving Hardware and Software Architectures

Lesson 2
Environment Representation

There are three types of map used in self-driving cars.

1. Localization Map
2. Occupancy Grid Map
3. Detailed Map

Localization Map:
This map is created using a **continuous set of LIDAR points** or **camera image features** as the car moves through the environment. This map is then used in combination with **GPS, IMU** and **wheel odometry** by the **localization module To accurately estimate the precise location of the vehicle at all times.**

The **localization map uses recorded LIDAR points** or **images,** which are combined to make a **point cloud representation of the environment.** As **new LIDAR camera data is received it is compared to the localization map** and a measurement of the **eagle vehicles position is created by aligning the new data with the existing map.** This measurement is then combined with other sensors to estimate eagle motion and ultimately used to control the vehicle.

As the car drives out of a driveway and onto the street ahead. **This detailed evolving representation of the motion of a car through its environment Is extremely valuable for the localization module.** The **localization map can be quite large**, and **many methods exist to compress** it's contents and keep only those features that are needed for localization.

Occupancy Grid Map:
The occupancy grid also uses a **continuous set of LIDAR points** to build a map of the environment which **indicates**
the location of all static, or stationary, obstacles. This map is used to **plan safe**, c**ollision-free paths for the autonomous vehicle.**

The **occupancy grid is a 2D or 3D discretized map of the static objects** in the environments surrounding the eagle vehicle. This map is created to **identify all static objects around the autonomous car, once again**, using point clouds as our input.

The objects **which are classified as static include trees, buildings, curbs, and all other nondriveable surfaces.** For example, In this grid map, if all occupied grids were coloured in, this is what the occupancy
grid may look like. **As the occupancy grid only represents the static objects from the environment, all dynamic objects must first be removed. This is done by removing all LIDAR points that are found within the bounding boxes of detected dynamic objects identified by the perception stack.**

Next, static objects which will not interfere with the vehicle are also removed. Such as dryable service or any over hanging tree branches. As result of these steps only the relevant writer points from static objects from the environment remain. The filtering process is not perfect and so it is not possible to blindly trust the remaining points are in fact obstacles The occupancy grid, therefore, represents
the environment probabilistic ally, by tracking the likelihood thatta a grid cells occupy over time. This map is then relied on to create paths for the vehicle which are collusion-free.

Detailed Map:
It contains **detailed positions for all regulatory element**s, **regulatory attributes** and **lane markings**. This map is used to **plan a path from the current position to the final destination.**

The detailed road map can be created in one of **three ways. Fully online**, **fully offline**, or **created offline** and **updated online.**

A map which is created **fully online** relies heavily on the **static object proportion of the perception stack to accurately labe**l and correctly localize all relevant static objects to create the map. This includes all lane boundaries in the current driving environment, any regulation elements, such as traffic lights or traffic signs, any regulation attributes of the lanes, such as right turn markings or crosswalks. **This method of map creation is rarely used due to the complexity of creating such a map in real time.**

A map which is created entirely **offline** is usually done **by collecting data of a given road several times.** Specialized vehicles with high accuracy sensors are driven along roadways regularly to **construct offline maps.** Once the collection is complete, the information is then labelled with the use of a mixture of automatic labelling from static object perception and human annotation and correction. This method of map creation, while producing **very detailed and accurate maps,** is