**Simultaneous Localization and Mapping**

Simultaneous localization and mapping is a method used for autonomous vehicles of building or updating a map of an unknown environment or space while simultaneously being able to track the position or movement of your camera. This helps in accurately articulate the movement of a particular object. SLAM algorithms allow the vehicle to map out unknown environments. Engineers use the map information to carry out tasks such as path planning and obstacle avoidance.

**Importance of SLAM**

Without SLAM, any robot will move around randomly and may not able to function efficiently. It will use excessive battery and will not provide sufficient information.

But with SLAM the robot can also simultaneously use the camera and other sensors to create a map of the obstacles in its surroundings. SLAM also allows us to implement simultaneous localization and mapping along with other tasks such as sensor fusion, object tracking, path planning etc.

**Different methods of SLAM**

Visual SLAM or vSLAM uses images acquired from cameras and other image sensors. Visual SLAM can use simple cameras whereas light detection and ranging or lidar uses a laser sensor or distance sensor. Lasers are significantly more precise and are used for applications with high-speed moving vehicles such as self-driving cars and drones. A point cloud is a set of data points in space which may represent a 3D shape or object. These point cloud data serve as the output from the laser sensors.

But point clouds may cause some drawbacks as they not as finely detailed as images in terms of density and do not always provide sufficient features for matching. In places where there are few obstacles, it is difficult to align the point clouds and this may result in losing track of the vehicle location

More disadvantages can be that point cloud matching generally requires high processing power, so it is necessary to optimize the processes to improve speed. Due to these challenges, localization for autonomous vehicles may involve fusing other measurement related data.

**Errors and countermeasures**

As SLAM estimates sequential movement, the marginal errors accumulate over time, causing substantial deviation from actual values. Imagine an autonomous vehicle moving in a loop, as the error increases vehicle’s starting and ending point are not the same anymore. This is called a loop closure problem.

Marking and remembering landmarks of previously explored place is essential to resolve this error.

Computing cost is a problem when implementing SLAM on a vehicle hardware.