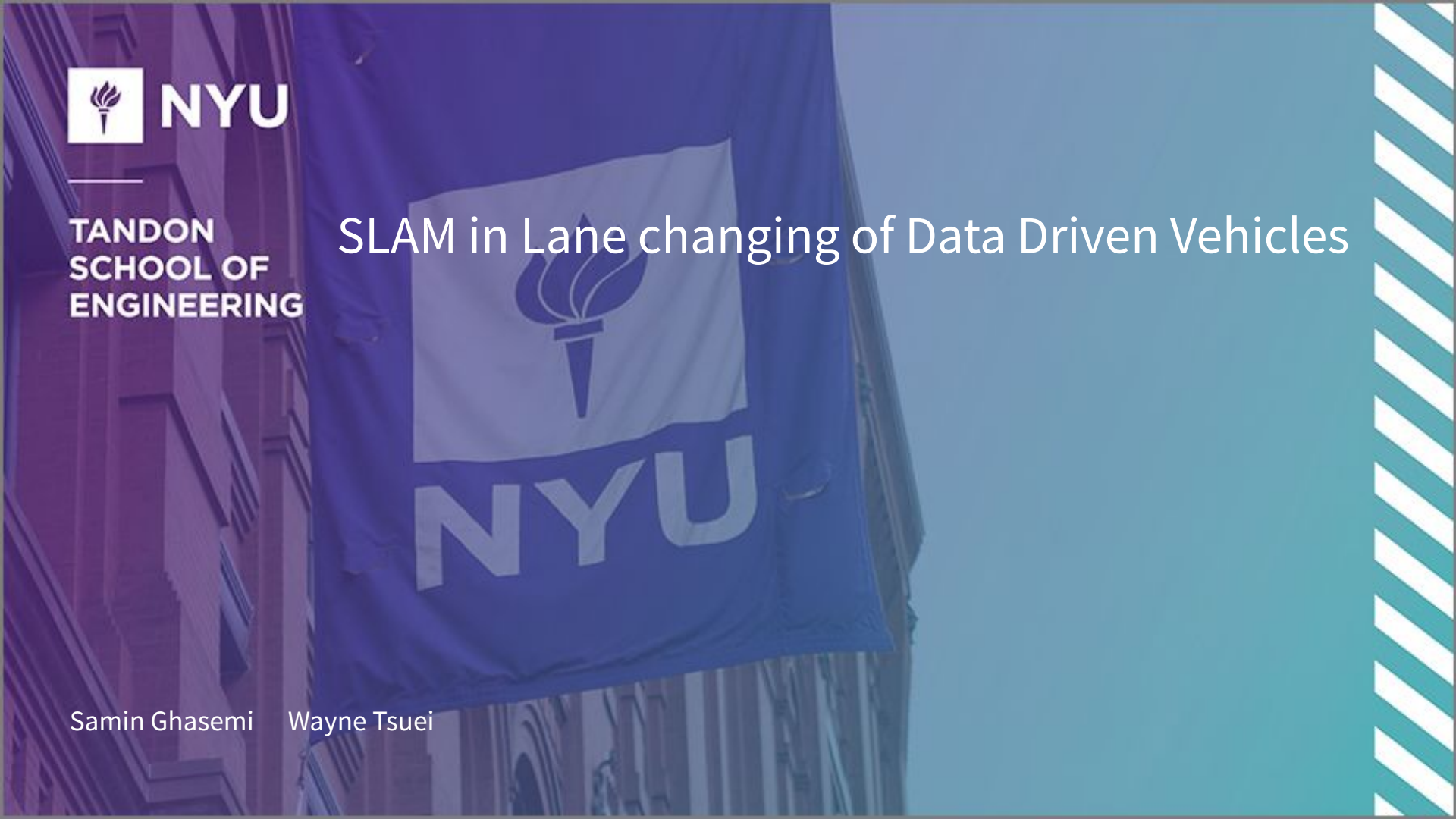


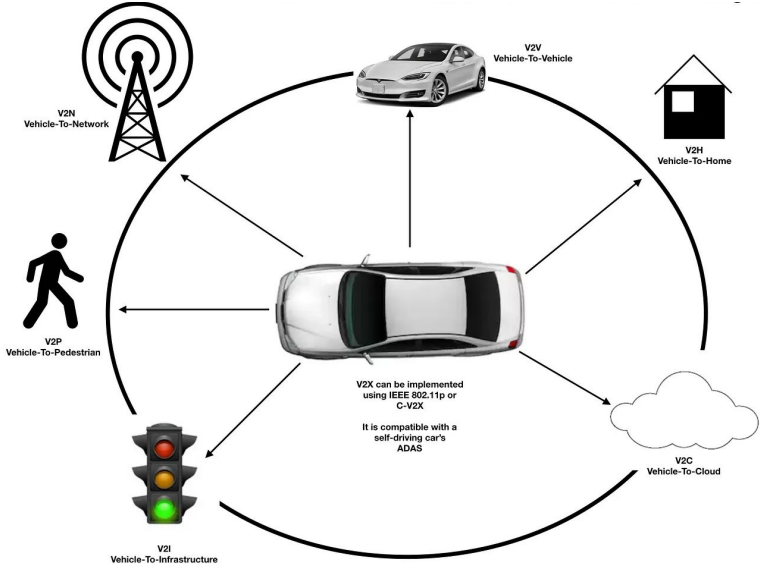
SLAM in Lane changing of Data Driven Vehicles

Samin Ghasemi Wayne Tsuei

Lane Changing of Data Driven Vehicles

Self driving vehicles become significantly popular in today's automation industry.

One of the most important challenges of autonomous driving is how these vehicles will optimally interact with each other as well as their surrounding.



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Lane Changing of Data Driven Vehicles

SLAM (Simultaneous Localization & Mapping).

It is a method to generates the map of a vehicle’s surroundings and locates the vehicle in that map at the same time. The SLAM system uses the depth sensors such as 3D Cameras to gather a series of views , with approximate position and distance. Then, it stores these 3D views in memory.

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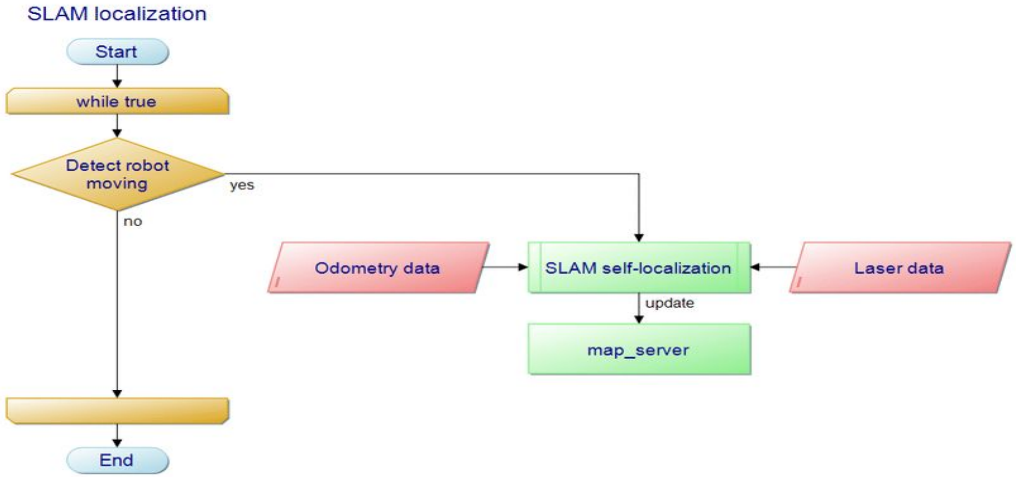
How does SLAM Navigate?

The idea of SLAM is inspired by a person trying to figure out their way in an unknown/unfamiliar place. Initial step is the person looking around to recognize familiar markers, landmarks or signs. Once the person recognizes a familiar landmark, they figure out where they are in relation to it. However, the more that person observes the environment, the more landmarks the person will recognize and begin to build an image, or map, of that place. The person may have to navigate this certain environment several times before becoming familiar with a previously unknown place.



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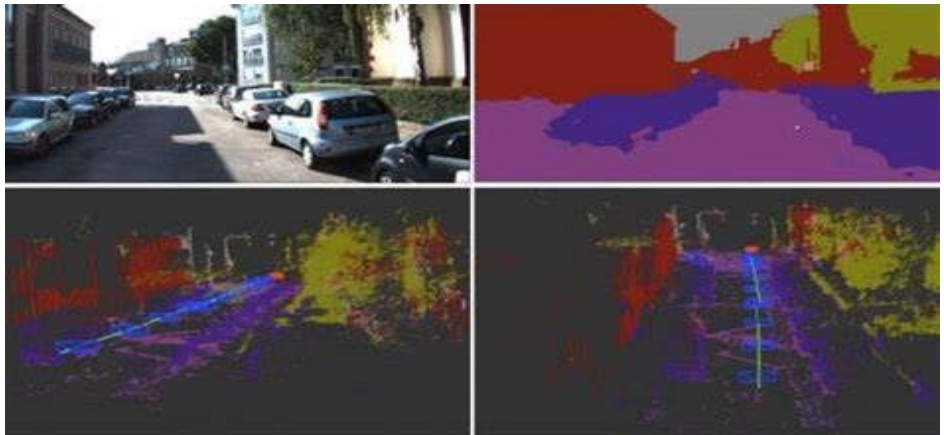
Requirement of SLAM

In order for SLAM to collect information from the environment, it requires ,measurement devices, the most commonly used tools of measurement is a laser scanner such as LiDAR.

-The laser scans can capture pinpoint accurate data throughout the interior, offering a higher level of accuracy in measurement.

-Calibration is an important factor for accuracy and reliability, however it can be time-consuming and costly, requiring special equipment and skills.

-Generally, the measurement device used depends on several variables, including preferences, costs, and availability.



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Mathematical Definition

Given a series of controls and sensor observations over discrete time steps , the SLAM problem is to compute an estimate of the agent's location and a map of the environment . All quantities are usually probabilistic, so the objective is to compute:

$$P(m_{t+1}, x_{t+1} | o_{1:t+1}, u_{1:t})$$

Applying Bayes' rule gives a framework for sequentially updating the location posteriors:

$$P(x_t | o_{1:t}, u_{1:t}, m_t) = \sum_{m_{t-1}} P(o_t | x_t, m_t, u_{1:t}) \sum_{x_{t-1}} P(x_t | x_{t-1}) P(x_{t-1} | m_t, o_{1:t-1}, u_{1:t}) / Z$$

Similarly the map can be updated sequentially by:

$$P(m_t | x_t, o_{1:t}, u_{1:t}) = \sum_{x_t} \sum_{m_t} P(m_t | x_t, m_{t-1}, o_t, u_{1:t}) P(m_{t-1}, x_t | o_{1:t-1}, m_{t-1}, u_{1:t})$$

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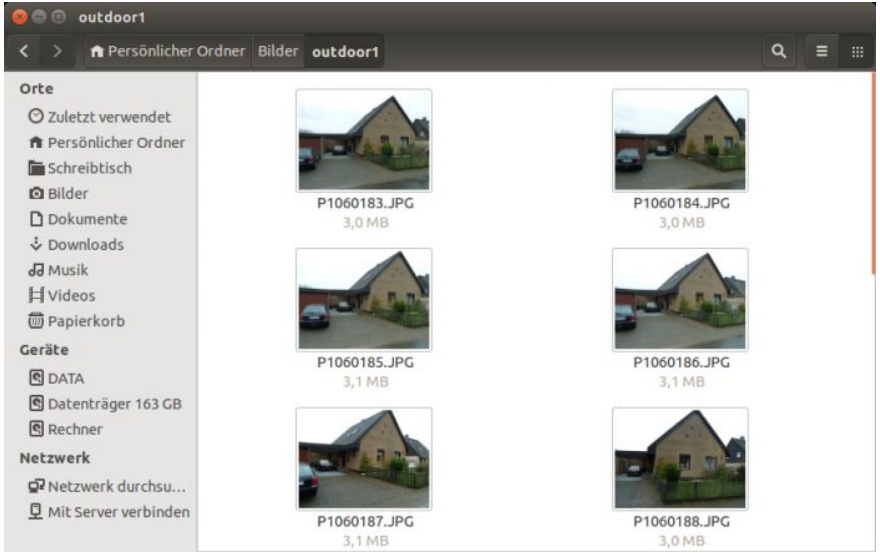
An Example

Imagine that you have a robot which has been placed in an unknown location. This robot requires map this environment in 3D and localize its position within this.

A) Using a photo camera

-Capturing different photos of the scene at different position and angels some commonly used cameras :Panasonic DMC-TZ8 digicam.

Input Images Captured by Camera



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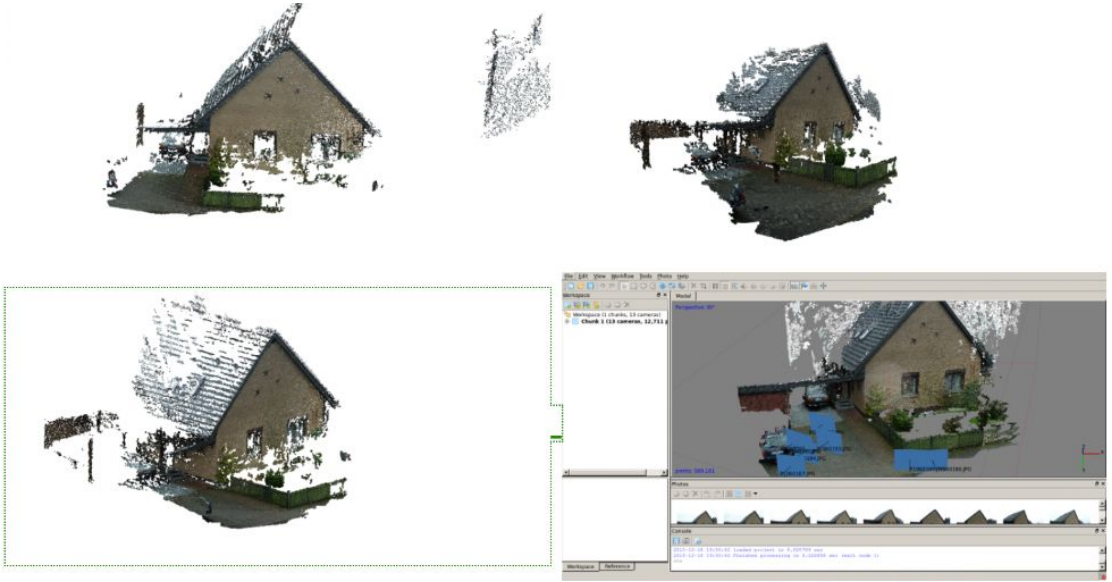
An Example

B)Using the Capture Images to calculator sparse point cloud, these are the points will be used for matching.



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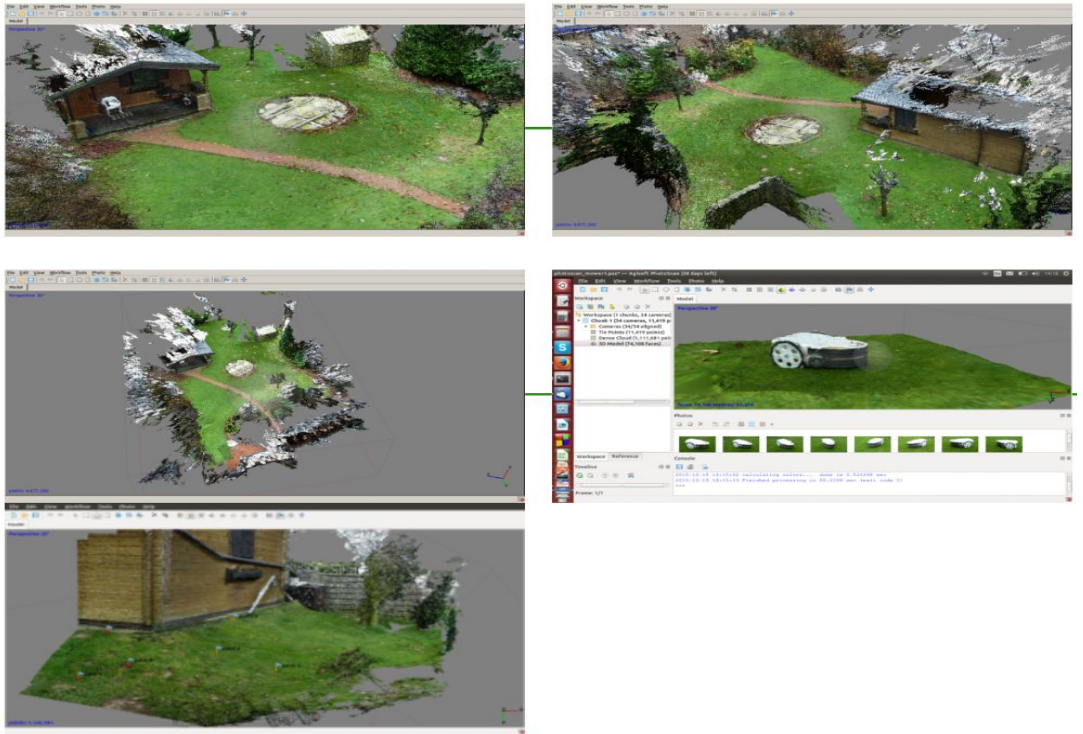
An Example

C)Reconstructive dense point clouds

D)Optional: make new photo at arbitrary position and use same principles to estimate actual camera position.



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SLAM Implementation

-SLAM technology is now widely used in different section such as autonomous vehicles, road observation and mapping, lane changing and robots navigation.

-SLAM becomes more important in emergency situations where affected places are not accessible by human or can risk lives if accessed by them. They are able to map the damaged area after a disaster such an earthquake.

- SLAM could be used for drone delivery instead of GPS for more accurate result.

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Why SLAM is better for drone application?

The reason is that the accuracy of GPS is about 6 meters, so drone working on GPS can deliver goods close to the house, but it can’t autonomously land the parcel on the rug in front of the door. A drone will either slams into the door or does not reach it at all – the accuracy of the GPS system does not allow it to do so.

SLAM if works properly and accurately specially in more complex environment can open a new door to the world of delivery companies such as Amazon.

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Thank You