A Pipeline for Indoor Navigation

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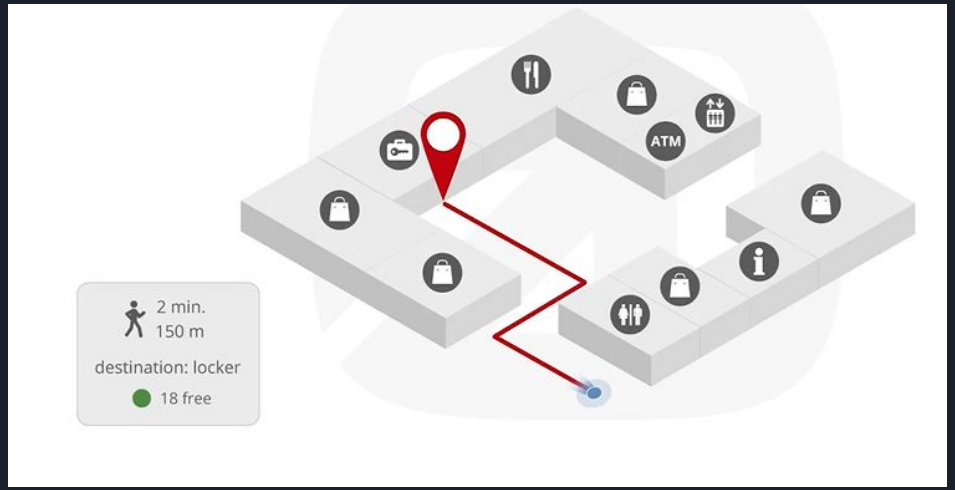
Why indoor navigation?

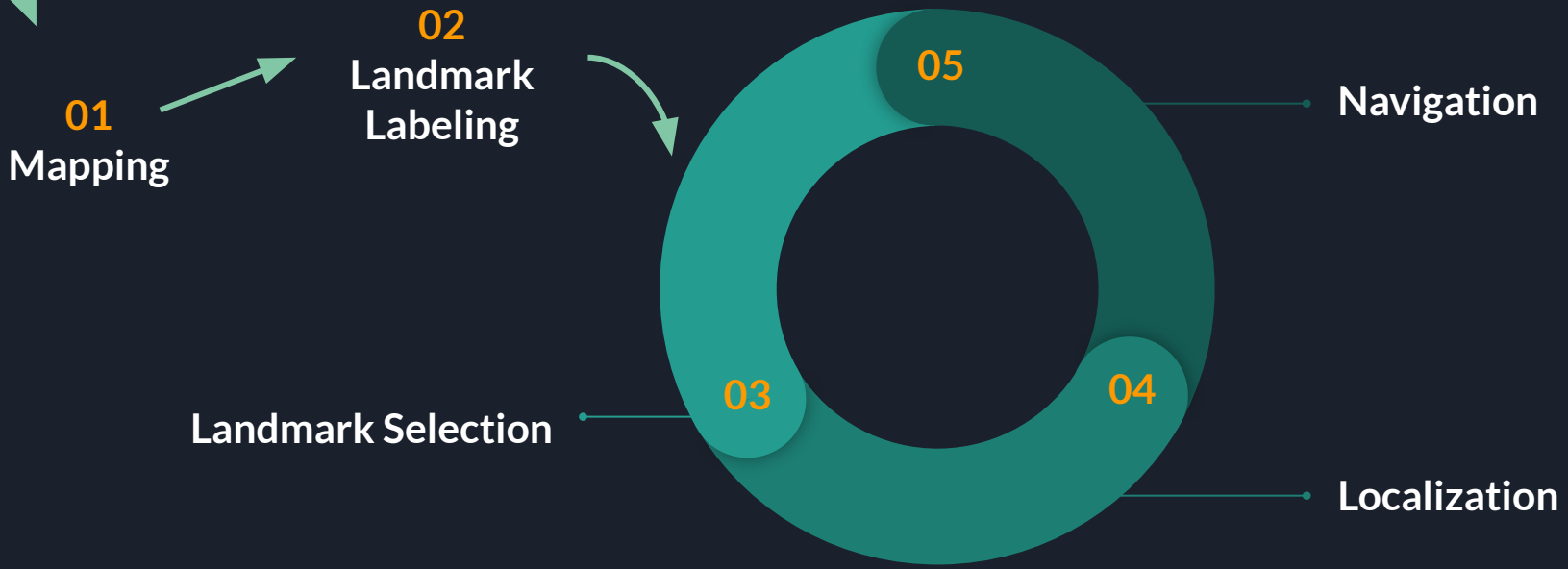
Indoor navigation always deals with navigation within buildings. However, GPS signal normally can't penetrate the buildings' walls, finding an alternative way to navigate is needed.

IMU based navigation

- Spread widely
- Cost advantage



Overview of Pipeline

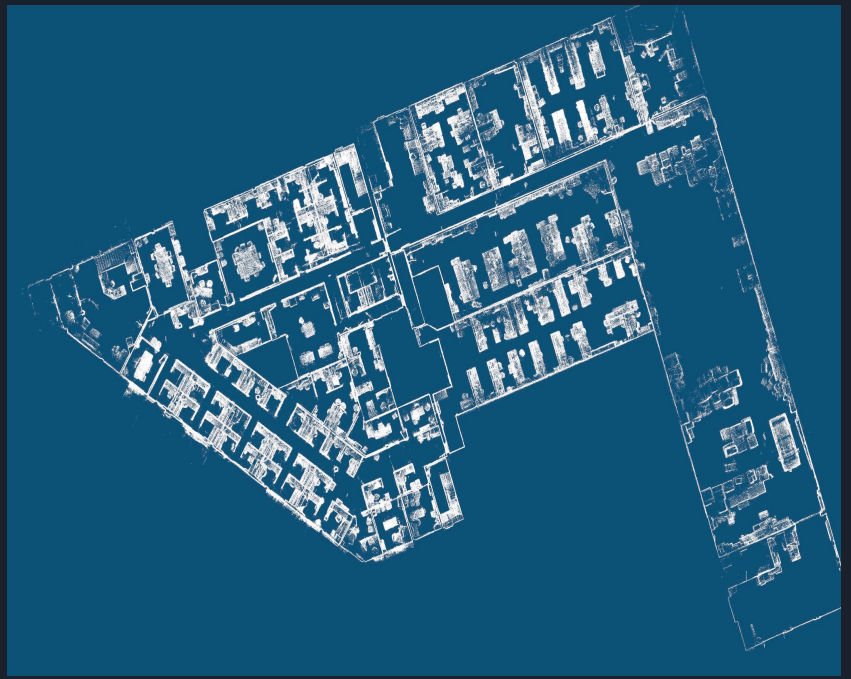


SLAM Navigation/Mapping Methods

- Mapping in Turtlebot can be done with different methods:
- Laser Based SLAM:

➔ The laser rangefinder emits short pulses of infrared laser light and measures how long it takes for the reflection pulse to return.

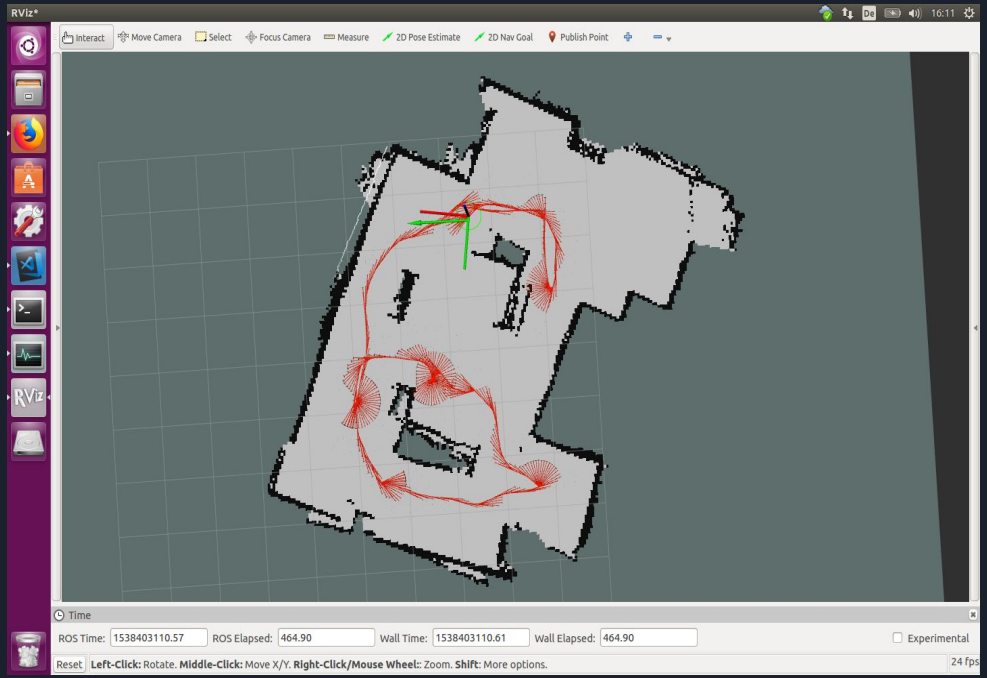
- Vision Based SLAM: It uses a camera to build a map.



SLAM Navigation/Mapping Methods: GMapping

There are particularly three methods, involved in laser based SLAM for simultaneous mapping and localization, which are::

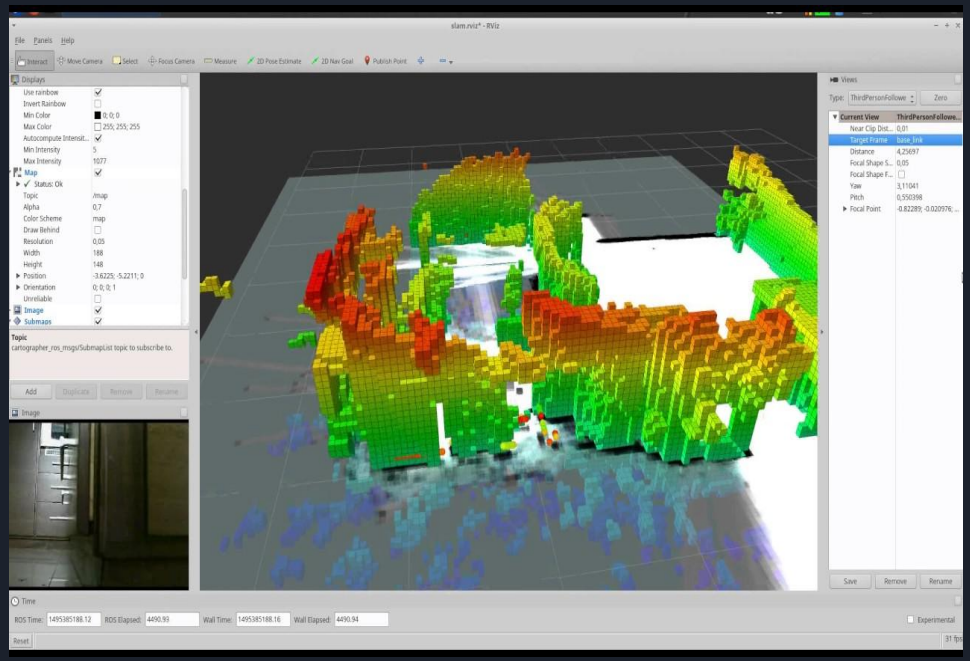
1). GMapping: SLAM package that supports 2D indoor mapping.



SLAM Navigation/Mapping Methods: Cartographer

2). Cartographer: package that provides 2D and 3D mapping support for turtlebot.

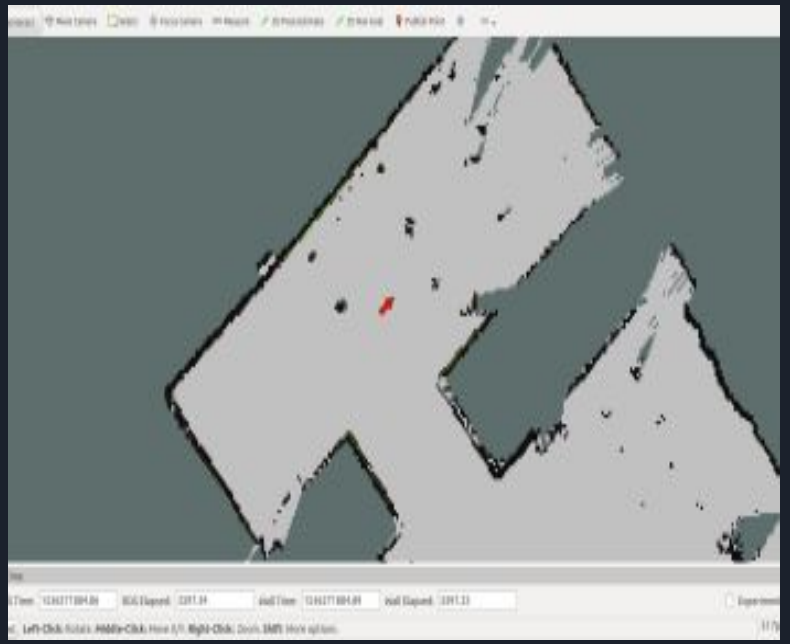
We will have to use a camera for 3D mapping.



SLAM Navigation/Mapping Methods: Hector

3). Hector: can be used without the use of odometry mechanisms, and with platforms which have motion sensors. Provides 2D estimates.

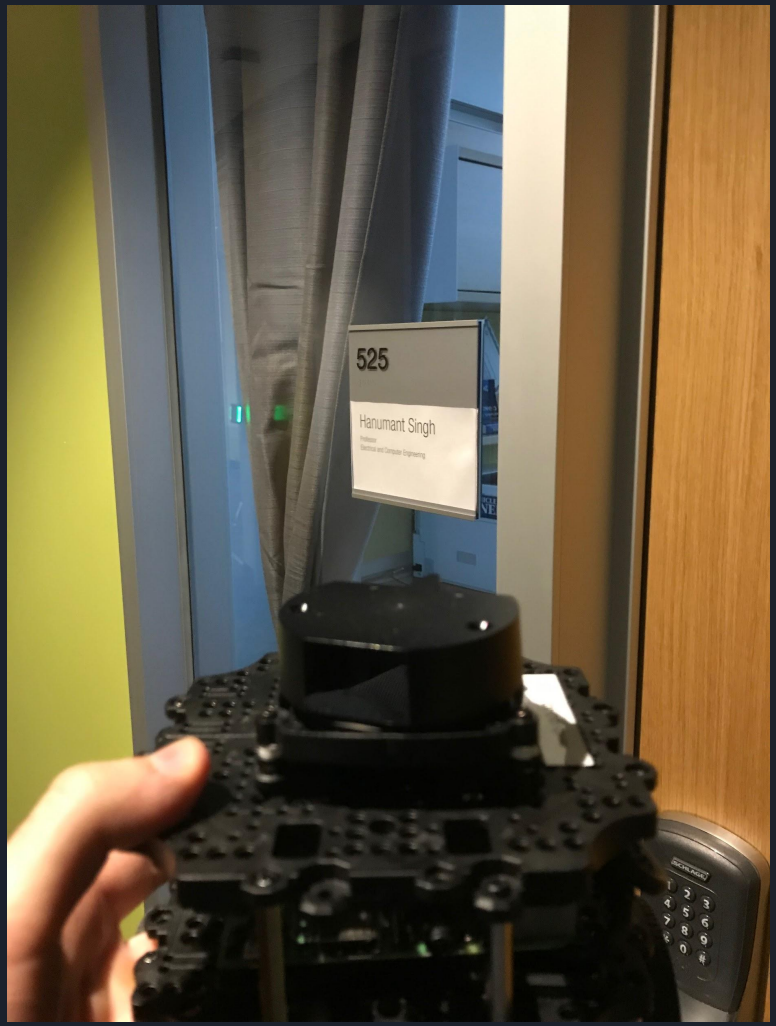
Some of the methods for Vision Based SLAM include RTAB-Map (Real Time Appearance Based Mapping).



Mapping Environment...


EXIT


ELKAY
0004715
DISPOSABLE PLASTIC BOTTLES
EZH2O
WATER BOTTLE FILLING STATION
If this water station needs to be repaired or needs a new filter, please contact Facilities at 617-373-2754 and provide machine code.
CODE: ISEC-005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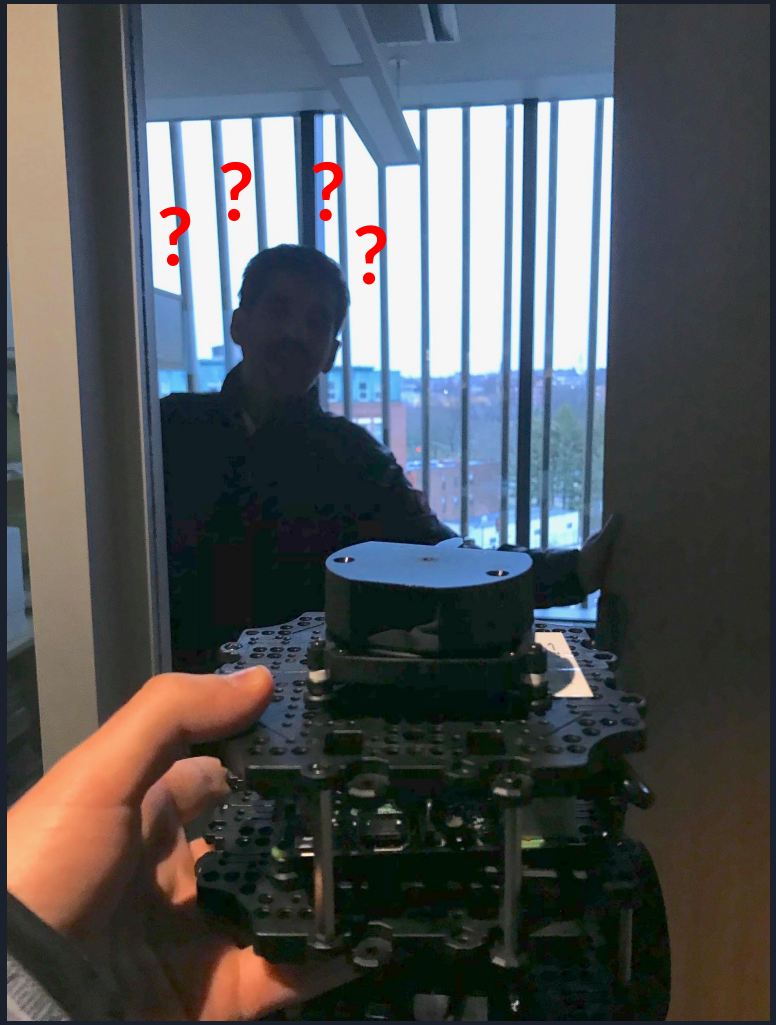
Hanumant Singh



Localization Methods

LiDar

IMU

Localization Methods - LiDar
I. Bayes filter

x: the location of the robot

z: LiDar data

u: joystick command

t: at time t

$$p(x_t \mid z^t, u^t) = \text{const.} \cdot p(z_t|x_t) \int p(x_t|u_t, x_{t-1}) \, p(x_{t-1}|z^{t-1}, u^{t-1}) \, dx_{t-1} \quad (1)$$

Localization Methods - LiDar
II. Particle filter

Initialization (t=0):

Draw M particles ~ p(x_0) => X_0

Recursion (t>0):

Generate x_t for each x_t-1 ~ p(x_t | u_t, x_t-1)

Draw M particles for each x_t ~ p(z_t | x_t) => X_t

$$p(x_t \mid z^t, u^t) = \text{const.} \cdot p(z_t|x_t) \int p(x_t|u_t, x_{t-1}) \; p(x_{t-1}|z^{t-1}, u^{t-1}) \; dx_{t-1} \quad (1)$$

Sebastian Thrun, Particle Filtersin Robotics

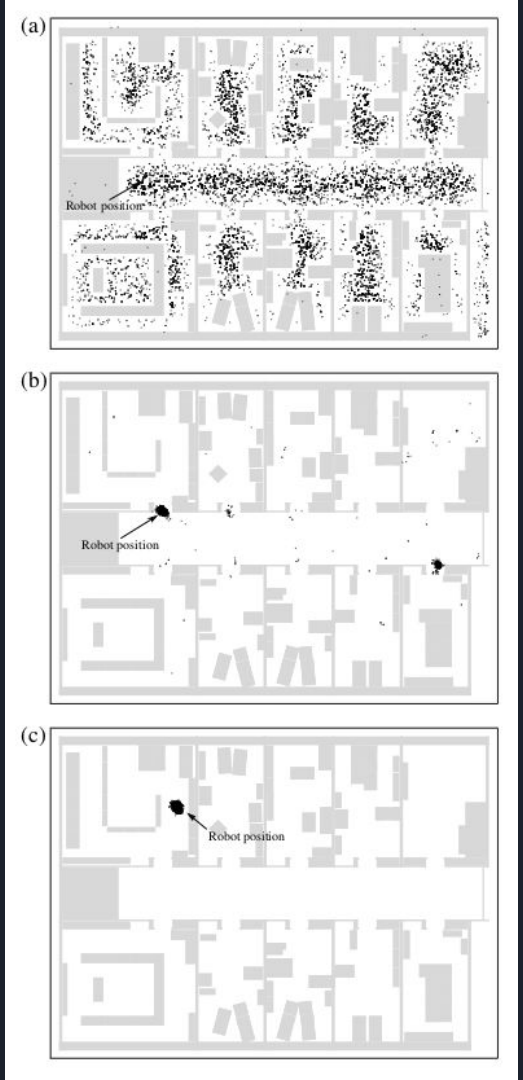
Localization Methods - LiDar
II. Particle filter

As t→infinity:

X_t→converge

Why?

More accurate informations

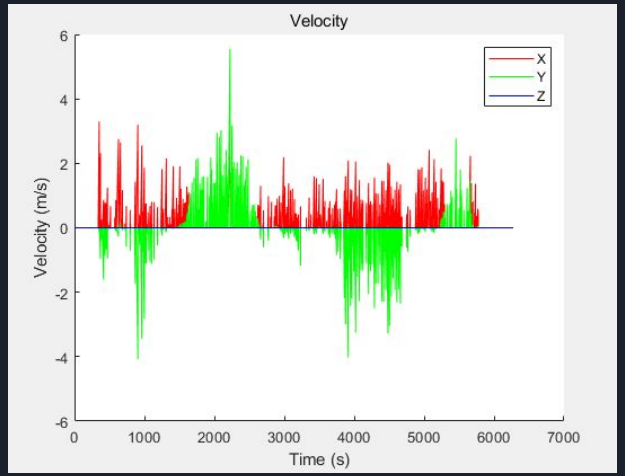


Sebastian Thrun, Particle Filtersin Robotics

IMU Methods

Why IMU could work for indoor navigation ?

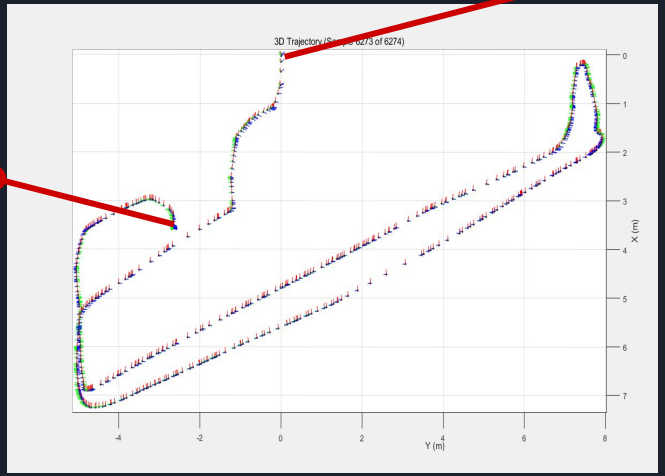
By estimating the forward velocity, we can obtain the displacement. Then it's possible to locate a person in a room by mapping the estimated trajectory on the room map.



Estimated Velocity from IMU

Start point

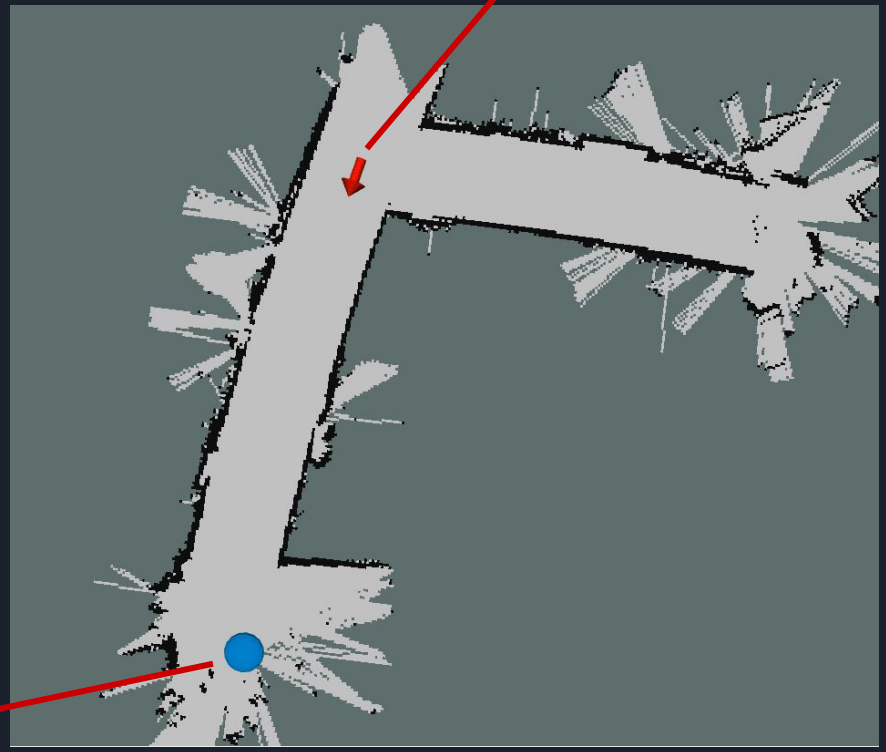
End point



Indoor Trajectory

Visualization

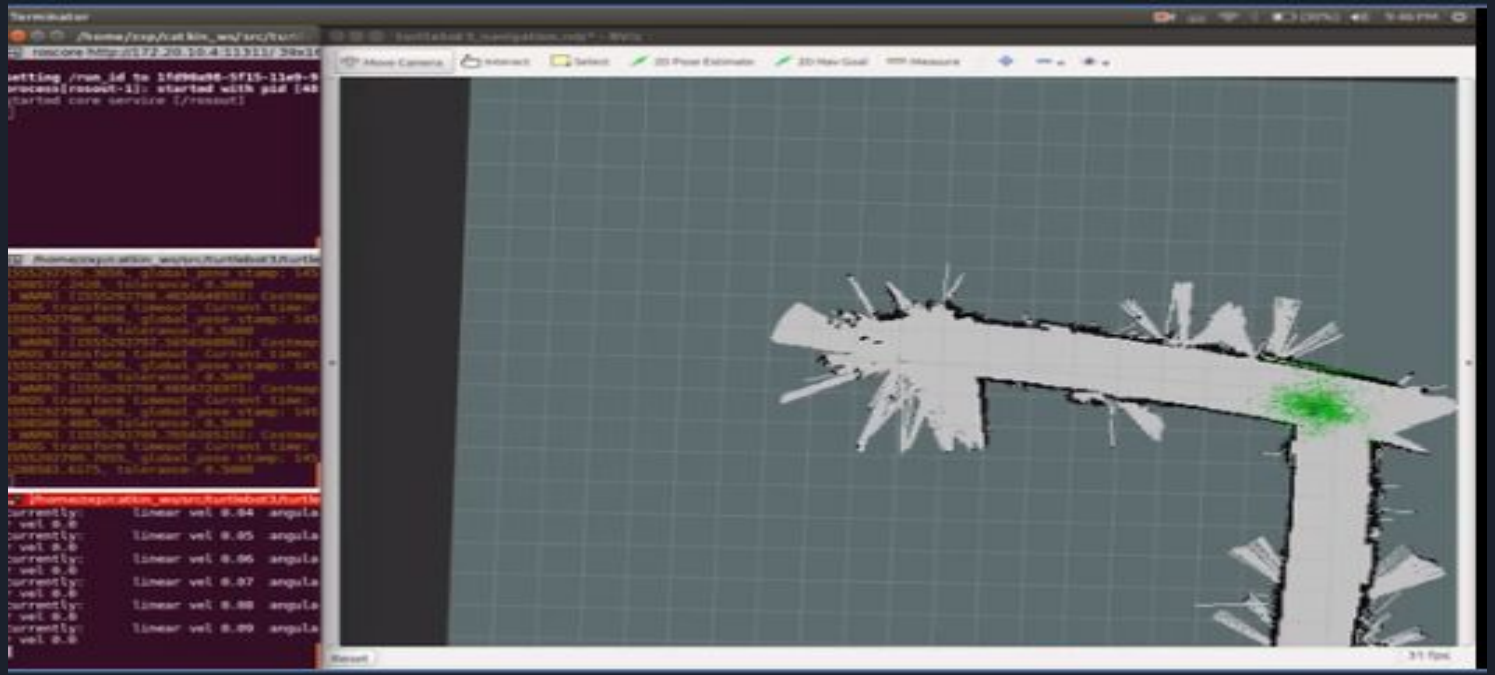
- RViz
- Real-time display
- Goal selected by user



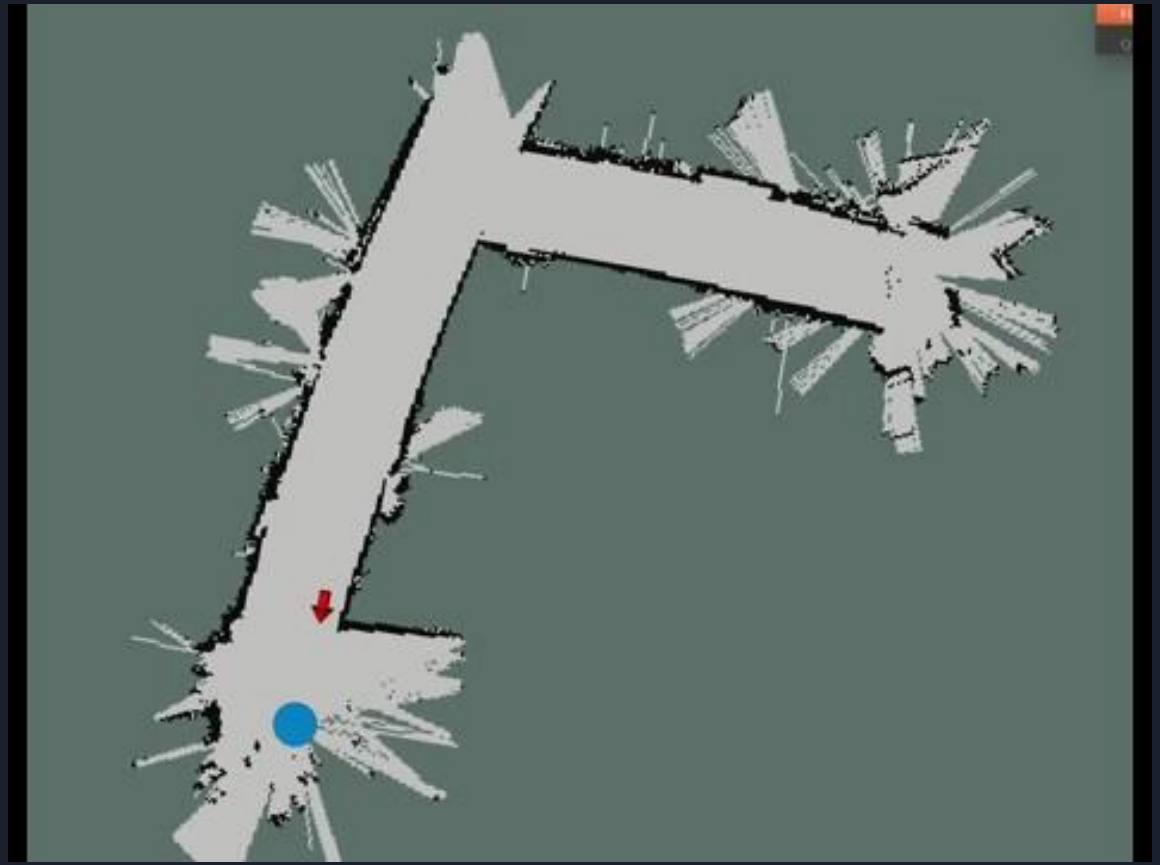
Current Results

- SLAM/Mapping
  - Complete
- Localization
  - Complete
- IMU Processing
  - Complete
- Visualization
  - Complete

Particle Filter using SLAM in Turtlebot



Visualization Demo



Questions