

# Where Am I?

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**Abstract**—In this project we will apply Adaptive Monte Carlo localization algorithm utilize ROS packages to accurately localize a mobile robot inside a provided map in the Gazebo and RViz simulation environments aims to solve robotic localization problem successfully.

**Index Terms**—Robot, IEEETran, Udacity, L<sup>A</sup>T<sub>E</sub>X, Localization, Adaptive Monte Carlo Localization (AMCL).

## 1 INTRODUCTION

LOCALIZATION is the challenge of determining robot's pose in a mapped environment. By implementing a probabilistic algorithm to filter noisy sensor measurements and track robot's position and orientation. The robot will moving around taking measurement try to figure out where it can be positioned in a space. With the probabilistic model the robot might have a few guesses as to where it locate and over time it should narrow down it's location. There are four localization algorithms such as Extend Kalman filter localization is the most common Gaussian filter which estimating the state of non-linear models and Markov Localization maintains a probability distribution over the set of all possible position and orientation the robot might be located at. The grid localization is referred to as histogram filter because it's capable of estimating the robot's pose using grids and finally Monte Carlo localization also know as particle filter because it estimate robot's pose using particles.

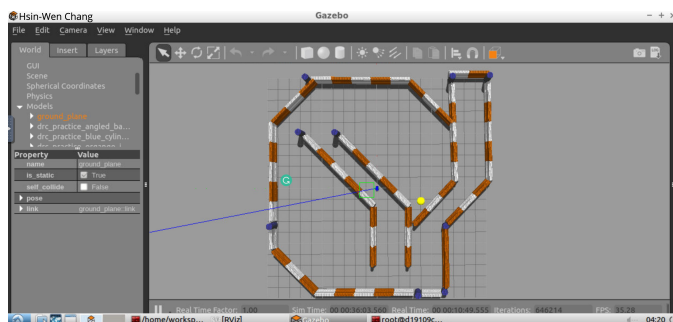


Fig. 1. Robot Revolution.

### 1.1 Subsection Heading Here

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#### 1.1.1 Subsubsection Heading Here

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## 2 BACKGROUND

At this stage, you should begin diving into the technical details of your approach by explaining to the reader what are the characteristics of the filters, what localization method

was chosen, and the reason that it was selected (i.e. particle filters). This should be factual and authoritative, meaning you should not use language such as "I think this will work" or "Maybe Monte Carlo Localization with these parameters is better...". Instead, focus on items similar to, "Adaptive Monte Carlo Localization was chosen because..." Provide a sufficient background into the scope of the problem technologically while also identifying some of the current challenges in robot localization and why the problem domain is an important piece of robotics. [1]

### 2.1 Kalman Filters

Briefly describe Kalman filters. Explain how they work and why they are used for localization. Additionally, discuss the drawbacks of linear Kalman filters and how Extended Kalman Filters (EKF) help resolve some of these issues.

### 2.2 Particle Filters

Briefly explain what a particle filter is, how it is used, and why it is useful.

### 2.3 Comparison / Contrast

Explain the benefits and disadvantages of using a Kalman Filter / Particle Filter. Why would you use one over the other? Also inform the reader that the work presented here will be using only particle filters.

	MCL	EKF
Measurements	Raw Measurements	Landmarks
Measurement Noise	Any	Gaussian
Posterior	Particles	Gaussian
Efficiency(memory)	✓	✓✓
Efficiency(time)	✓	✓✓
Ease of Implementation	✓✓	✓
Resolution	✓	✓✓
Robustness	✓✓	x
Memory & Resolution Control	Yes	No
Global Localization	Yes	No
State Space	Multimodel Discrete	Unimodal Continuous

Fig. 2. MCL VS EKF.

### 3 SIMULATIONS

This section should discuss the performance of robots in simulation. Items to include are the robot model design, packages used, and the parameters chosen for the robot to properly localize itself. The information provided here is critical if anyone would like to replicate your results. After all, the intent of reports such as these are to convey information and build upon ideas so you want to ensure others can validate your process. You should have at least two images here: one that shows your standard robot used in the first part of the project, and a second robot that you modified / built that is different from the first robot. Remember to watermark all of your images as well.

#### 3.1 Achievements

You should describe what you achieved for localization in the project with the benchmark model and your own model. Includes charts and graphs show how parameters affect your performance.

#### 3.2 Benchmark Model: Udacity Bot

##### 3.2.1 Model design

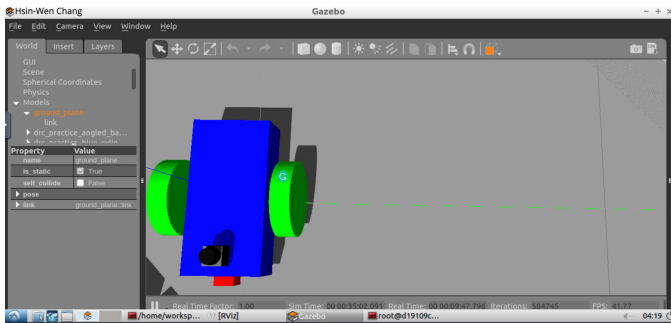


Fig. 3. Robot model with a camera and laser rangefinder.

The Robot's design considerations should include: the size of the robot, the layout of sensors. This information can be shown in the form of a chart / table.

TABLE 1  
Table

One	Two
Three	Four

##### 3.2.2 Packages Used

Udacity Bot package

- config
- launch
- maps
- meshes
- src
- urdf
- worlds
- rviz

##### 3.2.3 Parameters

Localization parameters in the AMCL node should be described, as well as move\_base parameters in the configuration file. You should be able to clearly demonstrate your understanding of the impact of these parameters.

#### 3.3 Personal Model

##### 3.3.1 Model design

##### 3.3.2 Packages Used

##### 3.3.3 Parameters

### 4 RESULTS

Present an unbiased view of your robot's performance and justify your stance with facts. Do the localization results look reasonable? What is the duration for the particle filters to converge? How long does it take for the robot to reach the goal? Does it follow a smooth path to the goal? Does it have unexpected behavior in the process?

For demonstrating your results, it is incredibly useful to have some watermarked charts, tables, and/or graphs for the reader to review. This makes ingesting the information quicker and easier.

#### 4.1 Localization Results

##### 4.1.1 Benchmark

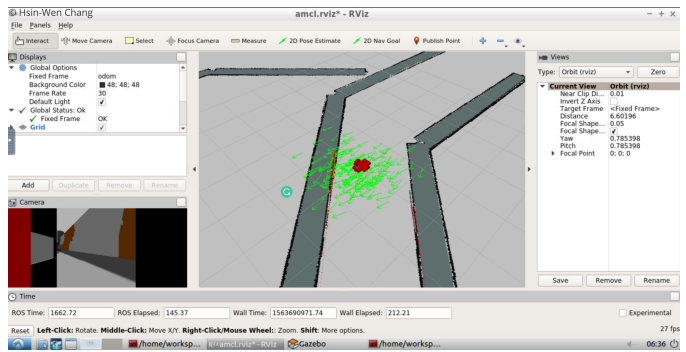


Fig. 4. Robot model with a camera and laser rangefinder.

##### 4.1.2 Student

#### 4.2 Technical Comparison

Discuss the difference of the layout, parameters, performance etc. between the benchmark robot and your robot. It is acceptable for your custom robot to perform worse than the provided robot. The focus is on learning and understanding, not performance.

### 5 DISCUSSION

This is the only section of the report where you may include your opinion. However, make sure your opinion is based on facts. If your robot performed poorly, make mention of what may be the underlying issues. If the robot runs well, which aspects contribute to that? Again, avoid writing in the first person (i.e. Do not use words like "I" or "me"). If you really find yourself struggling to avoid the word "I" or "me"; sometimes, this can be avoided with the use

of the word one. As an example: instead of : "I think the robot cannot localize itself because the sensor does not provide enough information for localization" try: "one may believe the localization performance is poor because the sensor layout is not able to provide enough information for localization". They say the same thing, but the second avoids the first person.

## 5.1 Topics

- Which robot performed better?
- Why it performed better? (opinion)
- How would you approach the 'Kidnapped Robot' problem?
- What types of scenario could localization be performed?
- Where would you use MCL/AMCL in an industry domain?

## 6 CONCLUSION / FUTURE WORK

This section is intended to summarize your report. Your summary should include a recap of the results, did this project achieve what you attempted, how would you deploy it on hardware and how could this project be applied to commercial products? For Future Work, address areas of work that you may not have addressed in your report as possible next steps. This could be due to time constraints, lack of currently developed methods / technology, and areas of application outside of your current implementation. Again, avoid the use of the first-person.

### 6.1 Modifications for Improvement

Examples:

- Base Dimension
- Sensor Location
- Sensor Layout
- Sensor Amount

### 6.2 Hardware Deployment

- 1) What would need to be done?
- 2) Computation time/resource considerations?

## REFERENCES

- [1] L. Lamport, *LATEX: a document preparation system: user's guide and reference manual*. Addison-wesley, 1994.