Navigation, SLAM and Speech Recognition and Synthesis)

Unit objectives

After completing this unit, you should be able to:

- Understand the Simultaneous Localization And Mapping problem (SLAM)
- Gain knowledge on developing solution for the SLAM problem and implement it
- Understand the concept of Speech Recognition and Synthesis and implement it
- Gain an insight into how ROS could be used for such application development

Navigation (1 of 3)

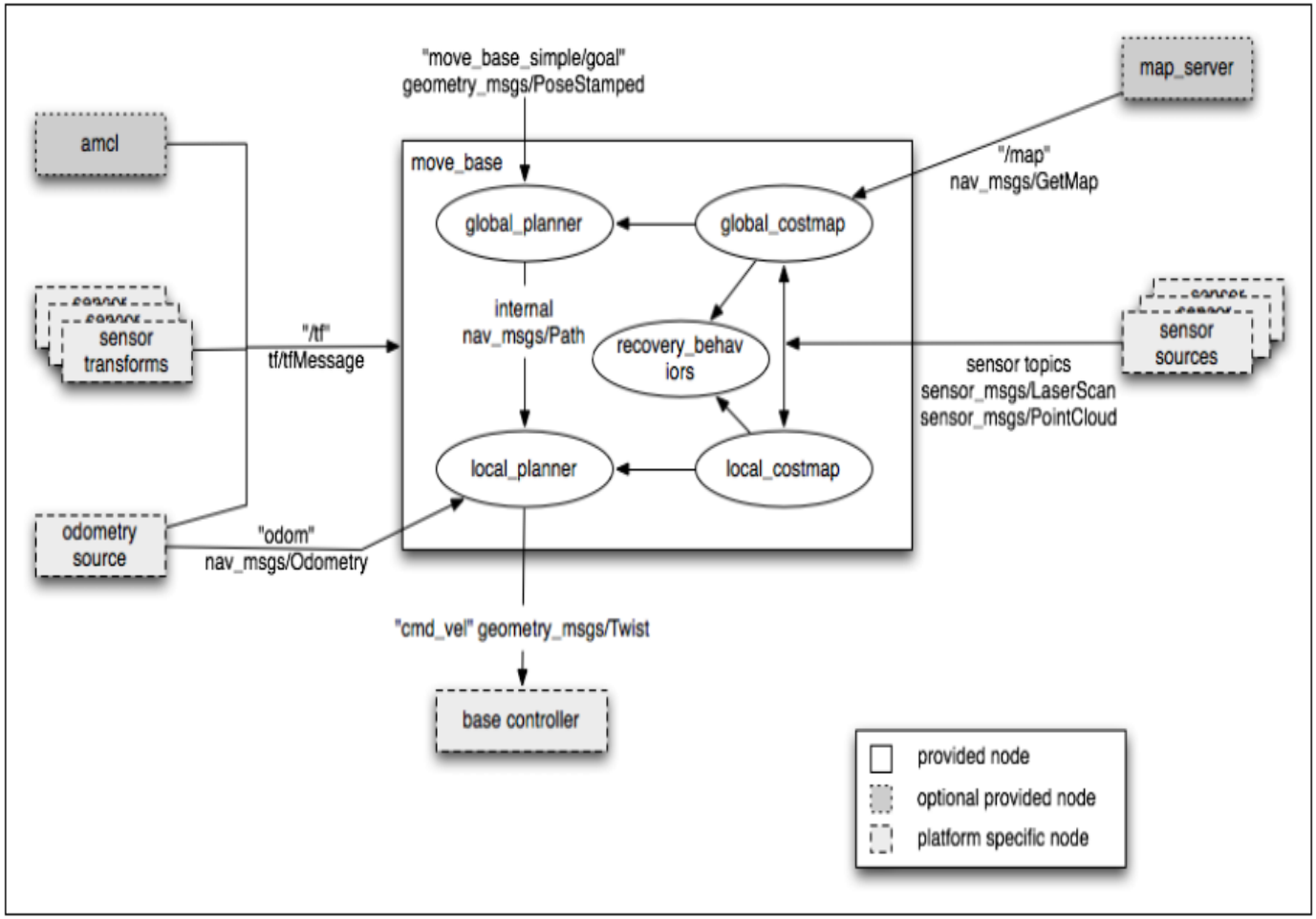

Figure: ROS Navigation Stack

Source: https://robots.ieee.org/learn/types-of-robots/https://docs.fetchrobotics.com/gazebo.html, https://www.pirobot.org/blog/0014/

Navigation (2 of 3)

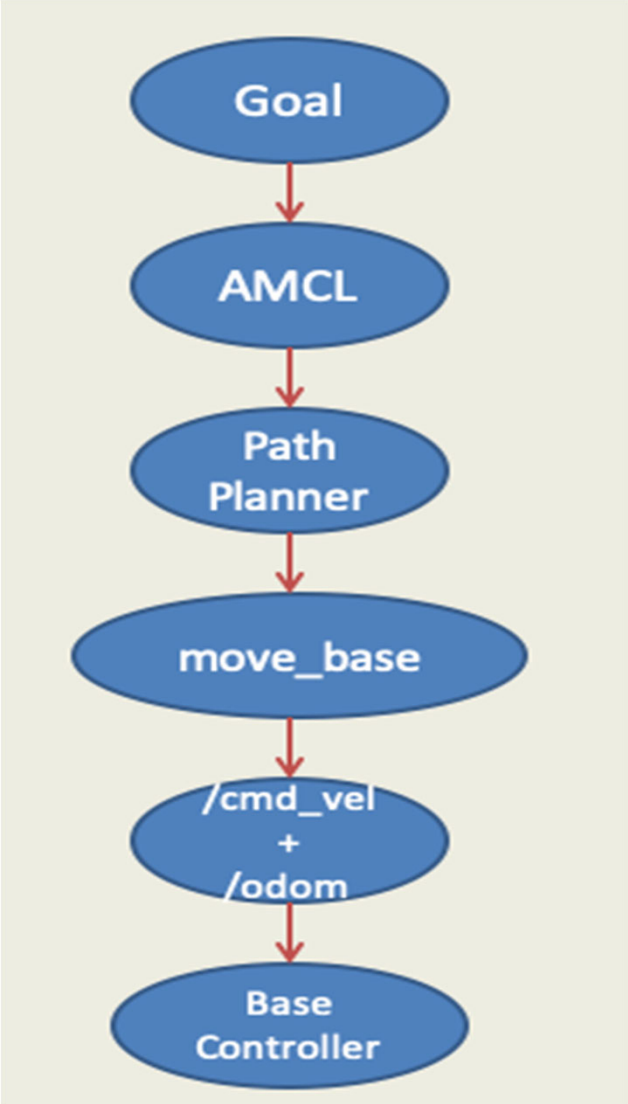

Figure: Navigation Main Steps

Source:https://robots.ieee.org/learn/types-of-robots/https://docs.fetchrobotics.com/gazebo.html, https://www.pirobot.org/blog/0014/

Navigation (3 of 3)

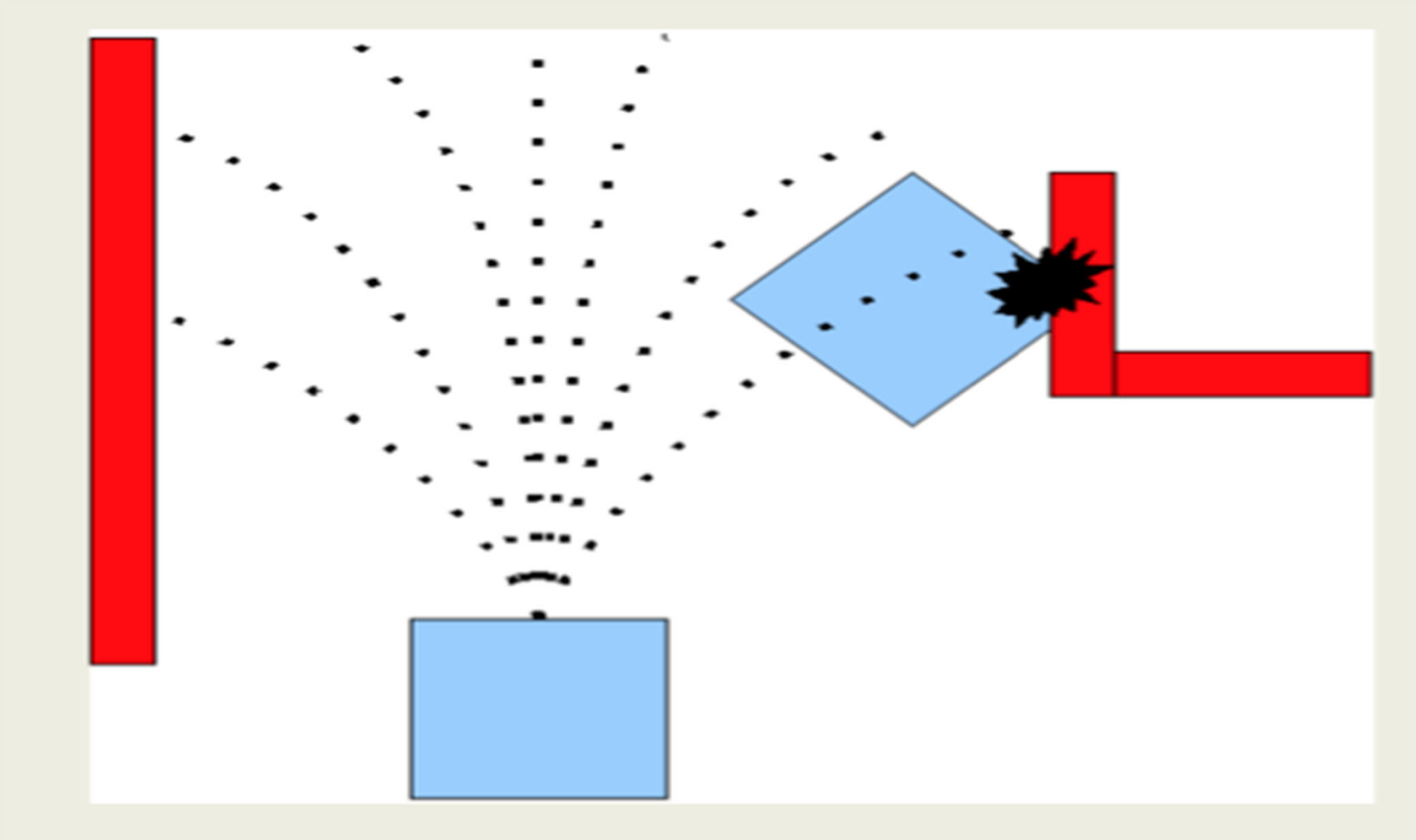

Figure: Trajectory roll out algorithm

Source: http://library.isr.ist.utl.pt/docs/roswiki/base_local_planner.html

Simultaneous localization and mapping

- Various SLAM techniques:
  - EKF SLAM.
  - Fast SLAM.
  - Graph-based SLAM.
  - Topological SLAM (mainly place recognition).
  - Scan Matching / Visual Odometry (only locally consistent maps).
  - Approximations for SLAM: Local submaps, Sparse extended information filters.
  - Sparse links, Thin junction tree filters, etc.

Setting up rviz for navigation stack

- 2D pose estimation.
- 2D nav goal.
- Static map.
- Particle cloud.
- Obstacles.
- Global plan.
- Local plan.
- Planner plan.
- Current goal.

Adaptive Monte Carlo Localization

- Monte Carlo localization (MCL), also known as particle filter localization.
- is an algorithm for robots to localize using a particle filter.

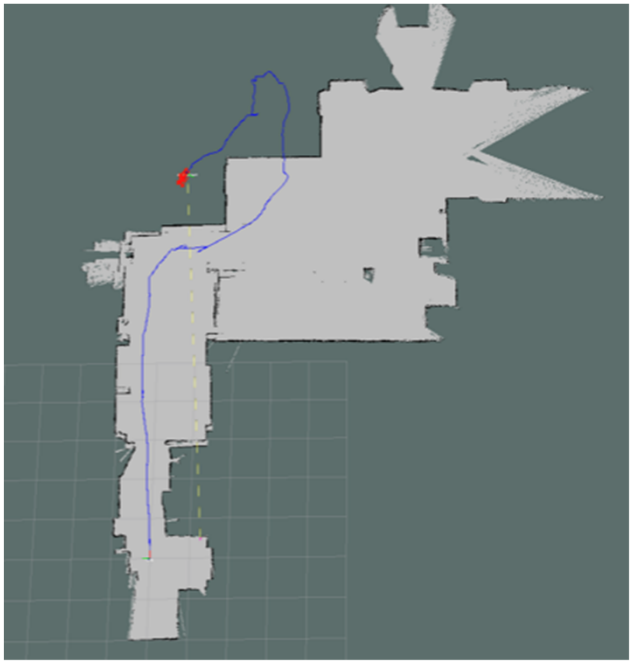

Figure: (AMCL) Adaptive Monte Carlo Localization

Source: https://answers.ros.org/question/216613/amcl-acceptable-robot-speed/

Avoiding obstacles

- Avoiding obstacles during the movement.

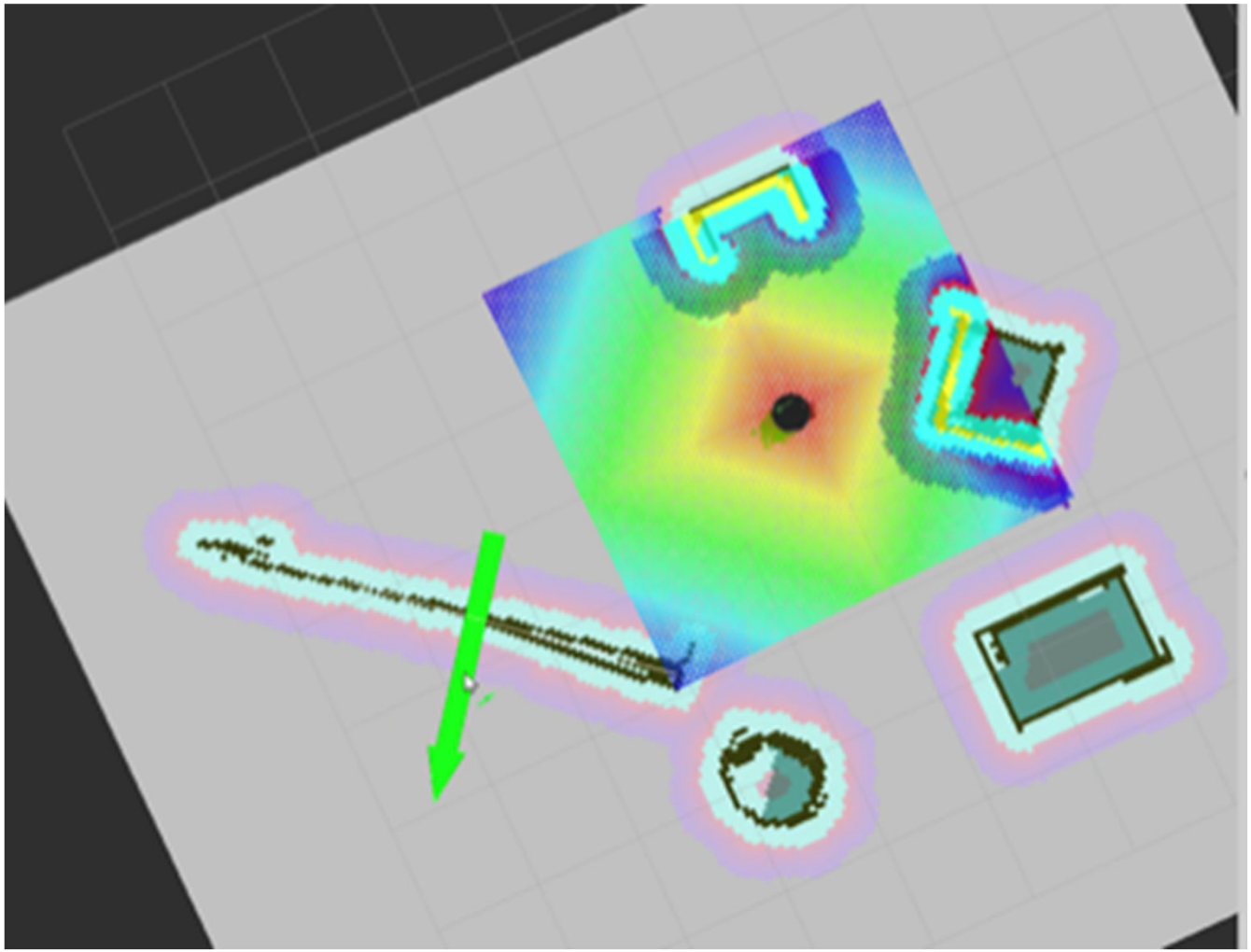

Figure: Avoiding obstacles

Source: https://learn.turtlebot.com/2015/02/03/10/

Speech recognition and synthesis

- Speech: Perception is that the speech is built with words and each word consists of phones
  - Acoustic properties - phones.
  - Diphones.
  - Three states in a phone.
  - Tri phones.
  - Phones ➔ subwords ➔ words.

- Recognition process:
  - Take a waveform.
  - Split it by utterances by silences.
  - Then try to recognize what's being said in each utterance.
  - Take all possible combinations of word and try to match them with audio.

Checkpoint (1 of 2)

Multiple choice questions:

1. Which of these is not a part of the ROS navigation Stack.
   a) Global_planner
   b) Local_planner
   c) AMCL
   d) Gazebo

2. gmapping provides _____.
   a) Map data as a ROS Service
   b) Laser based SLAM
   c) Probabilistic localization system
   d) None of the above

3. Performance as per literature can be best achieved with robots that are _____.
   a) Square
   b) Circular
   c) All of the above
   d) None of the above

Checkpoint solutions (1 of 2)

Multiple choice questions:

1. Which of these is not a part of the ROS navigation Stack.
   a) Global_planner
   b) Local_planner
   c) AMCL
   d) Gazebo

2. gmapping provides .
   a) Map data as a ROS Service
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   d) None of the above
3. Performance as per literature can be best achieved with robots that are
   a) Square
   b) Circular
   c) All of the above
   d) None of the above

Checkpoint (2 of 2)

Fill in the blanks:

1. _____ provides a fast interpolated navigation function.
2. Local planner uses algorithm named _____.
3. Robot configuration is a parameter defined for _____.
4. _____ is one of the method of creating a map of the environment.

True or False:

1. EKF SLAM is one of the SLAM techniques. True/False
2. Monte Carlo localization is also know as random filter localization. True/False
3. There are three states in a phone. True/False

Checkpoint solutions (2 of 2)

Fill in the blanks:

1. **NavFn** provides a fast interpolated navigation function
2. Local planner uses algorithm named **Trajectory rollout and dynamic window algorithm**
3. Robot configuration is a parameter defined for **local planner**
4. **Cellular decomposition** is one of the method of creating a map of the environment.

True or False:

1. EKF SLAM is one of the SLAM techniques. **True**
2. Monte Carlo localization is also know as random filter localization. **False**
3. There are three states in a phone. **True**

Question bank

Two mark questions:

1. Why is ROS Navigation stack used for?
2. What is AMCL .
3. What is the use of map_server?
4. What does gmapping used for?

Four mark questions:

1. Which are the various packages of navigation stack.
2. Describe the two types of navigation.
3. Explain the concept speech recognition and synthesis.
4. Explain the need of Maps and how do you create them?

Eight mark questions:

1. Explain the various steps of the trajectory rollout algorithm.
2. Explain SLAM in detail.

Unit summary

Having completed this unit, you should be able to:

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