Localization and Autonomous Navigation of a Mobile Robot: Robomuse 5.0

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Introduction

Collaborative Mobile Robots-Designed to work with humans
(Taken from Peer Robotics Company)

- Mobile robotics is the field of robotics concerned with robots that can move around in an environment
- Awareness of its environment is crucial for attaining Autonomy
- The major research areas in this field are Navigation, motion planning, Context driven exploration, Simultaneous Localization, and Mapping (SLAM).
- We have various sensors and SLAM techniques for creating awareness to the robot

LITERATURE SURVEY
Sensors

Both Vision and Lidar based sensors are absolute sensors unlike sensors like IMUs which give only Relative measurements

Vision Sensors are cheaper than LIDAR sensors

Lidar sensors provide precise scan data than Vision sensors

We are using LIDAR based sensors for better autonomous navigation.

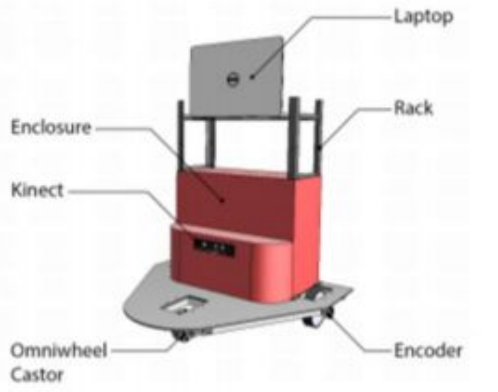
LITERATURE SURVEY
Robomuse

IIT Delhi has its own robot series called RoboMuse.

The last Robomuse 4.0 used the Kinect(Vision) Sensor to map and explore its surroundings, as well as Aruco Markers for odometry error correction that builds over time.

Robomuse 5.0 is to build with Lidar based SLAM technique such as Gmapping which uses scan matching as for the robots odometry. It has two lidars for measuring depth.

In contrast to the Kinect sensor used in Robomuse 4.0, which produces unreliable pseudo-laser scan results, Lidar sensors provide precise scan data.



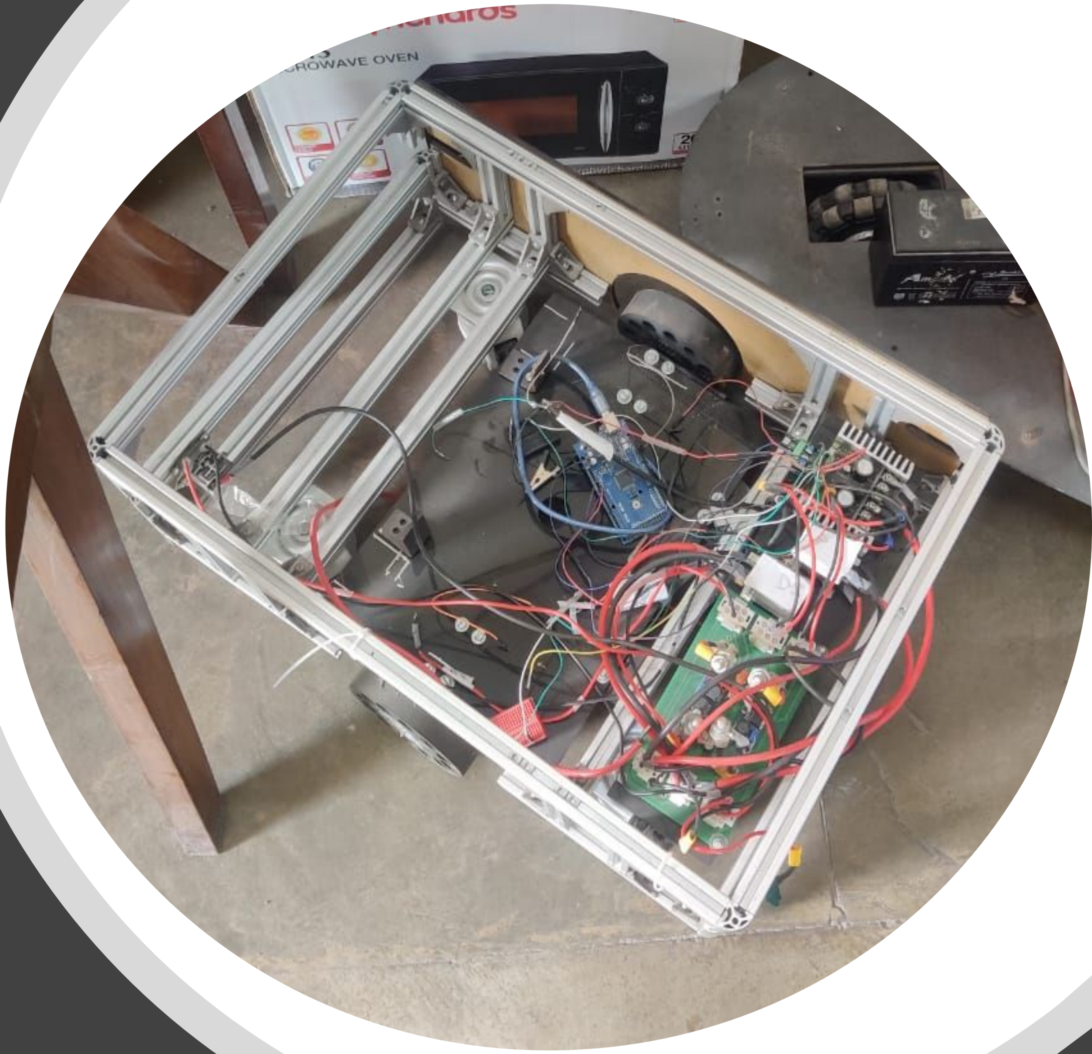
Project Objectives

- Solving the automation in the textile industries where barrels containing fabric materials are transported from one place to the other.

- At the beginning of the project, RoboMuse 5.0 frame is available. So, we will utilize the structure and integrate hardware/software stack to make it autonomous. We will test the system in a real environment.

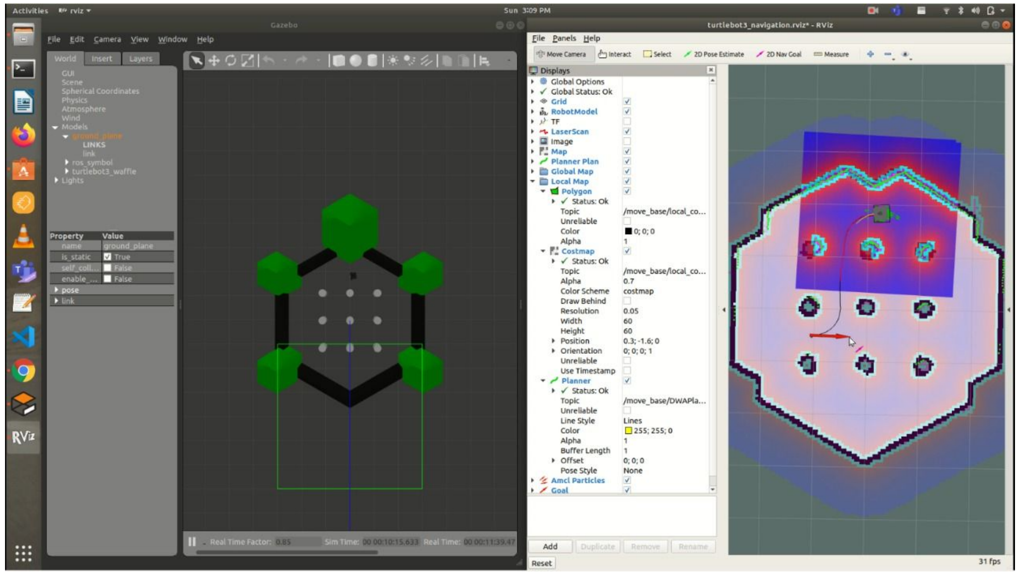
- We can divide the project into 3 parts - Mechanical, Electrical and installing Software stack, Testing in Real World.

- Installing the algorithm studied in the simulation. Redesign the Robomuse 5.0 and build it completely.



Methodology

1. Simulating TurtleBot robot on Gazebo
2. Testing Mapping and Navigation Stack on Turtlebot3 robot using ROS packages
3. We use GMapping packages for implementing SLAM, and AMCL package for implementing Navigation
4. Designing the Electric Circuit and required PCB
5. Building the complete RoboMuse 5.0
6. Testing RoboMuse 5.0 for Autonomous Navigation in real environment.



Gantt Chart

Current Situation

TASK	Week 1-2	Week 3-4	Week 5-6	Week 7-8	Week 9-10	Week 11-12	Week 13-14
Literature Review about Lidar-SLAM & Visual Inertial- SLAM							
Learning ROS & Simulating Turtlebot 3 Robot							
Implementing Lidar based SLAM & Navigation in Gazebo & Rviz							
Started Working on RoboMuse 5.0 PCB Design | AGV Control System							
Implement SLAM & Navigation in Robomuse 5.0							
Conducting Navigation in Real Environment							
Report Making							

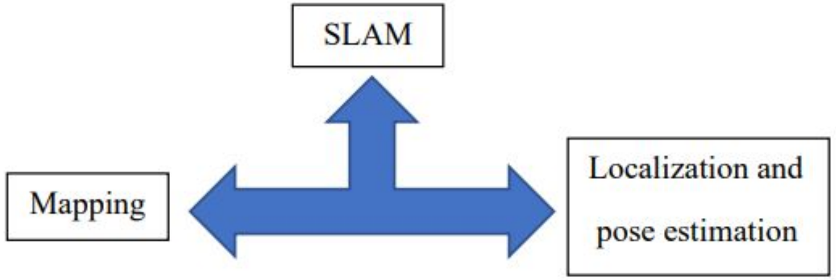
SLAM - THEORY

ROS SLAM GMapping:

- This package contains GMapping, from OpenSlam, and a ROS wrapper.
- The gmapping package provides laser-based SLAM, as a ROS node called slam_gmapping.

Adaptive Monte-Carlo Localization (AMCL):

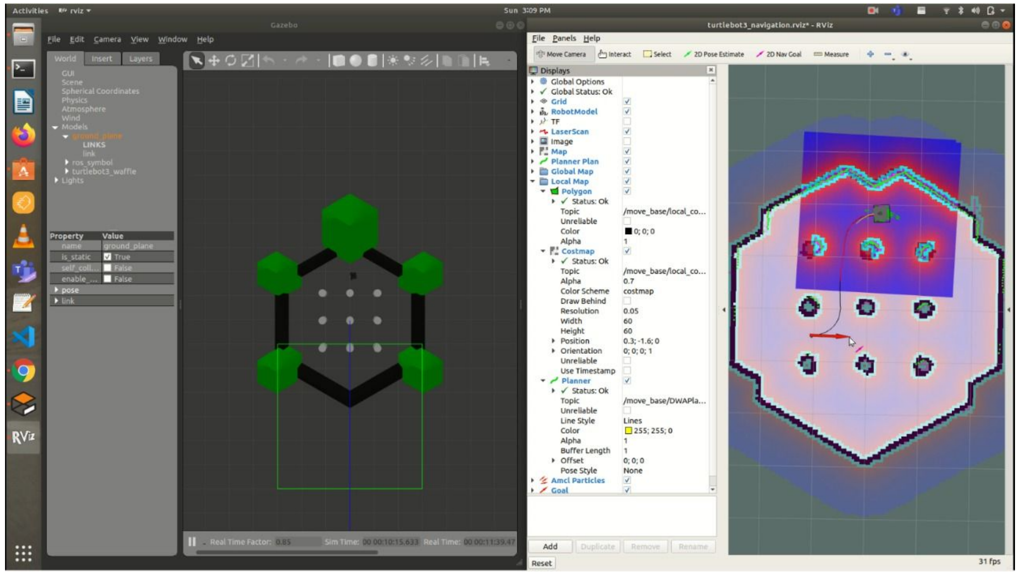
- AMCL, which is a particle filter based is used to localize the mobile robot in an indoor environment.
- Specifically, it refers to estimation of the position and orientation of a robot within the previously generated map.



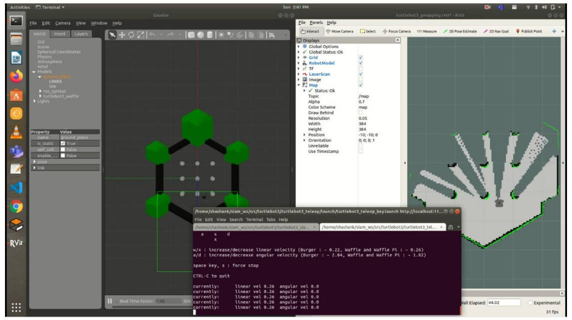
Experimental Setup

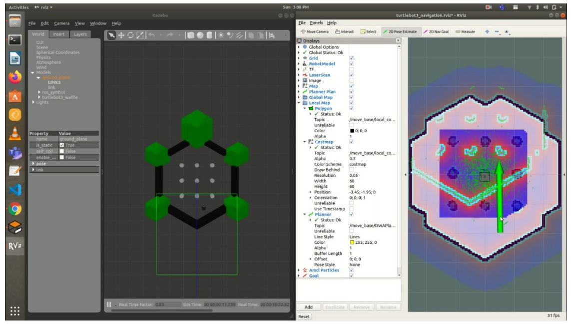
Simulation in ROS:

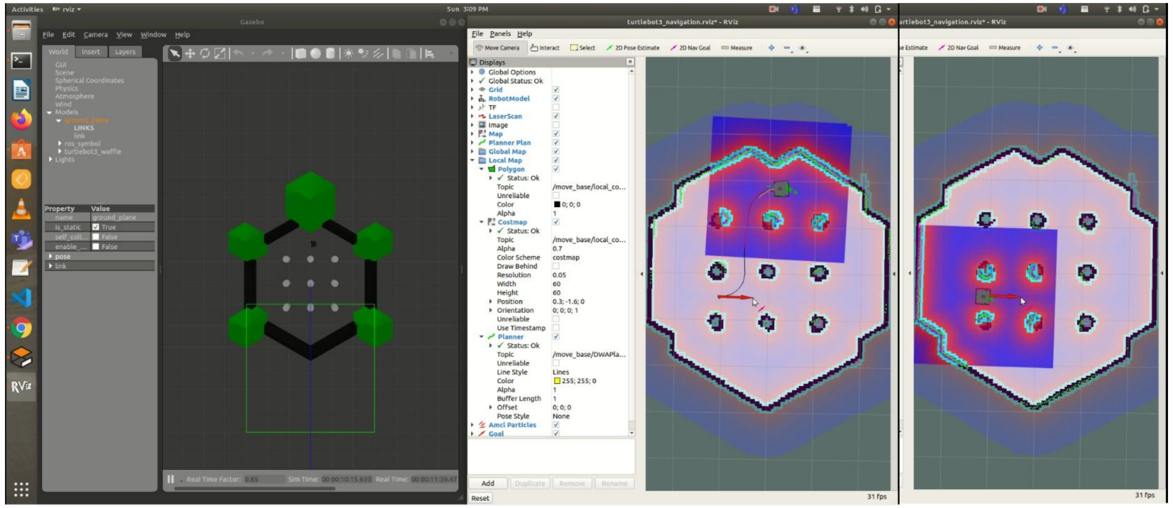
1. Spawned TurtleBot3 in Gazebo as a Node
2. Controlled Turtlebot3 using Teleop Node
3. Implement GMapping Stack using TurtleBot3 | moved robot using teleop Node
4. Saving the generated GridMap of the Environment
5. Loading the GridMap and implementing Navigation stack on TurtleBot
6. Implemention on the RoboMuse 5.0
7. Testing and Optimizing SLAM and Navigation stack parameters specific to our testing environment



RESULT







1. Launched Gazebo simulator node | GMapping Node
2. Initializing the robots current location in RViz (Navigation stack Node)
3. On the left we can see the global path planning and on the right we can see that the robot reached its goal
4. Current task ahead is to build the robot and run it using ROS.

Conclusion

Literature Review

Learning ROS & Simulating Turtlebot 3 Robot

Implementing Lidar based SLAM & Navigation in Gazebo & Rviz

Started Working on RoboMuse 5.0 PCB Design | AGV Control System

Implement SLAM & Navigation in Robomuse 5.0

Conducting Navigation in Real Environment

Report Making

Thank You