Using the Raspberry Pi with ROS as The Main Compute Unit for Turtlebot Robot

Poster · April 2017

DOI: 10.13140/RG.2.2.31475.12328

3 authors, including:

Hamza Aagela
University of Huddersfield
5 PUBLICATIONS **1** CITATION
SEE PROFILE

Violeta Holmes
University of Huddersfield
68 PUBLICATIONS **253** CITATIONS
SEE PROFILE

Investigation of Using the Raspberry Pi with ROS as The Main Compute Unit for Turtlebot Robot

University of Huddersfield | School of Computing and Engineering

Authors, Maha Al-Nesf, Hamza Aagela : Dr, Violeta Holmes

Aim

The aim of this project is that to develop an affordable robot, which can create an indoor map for unknown area.

Abstract

Robot become popular in may implementation in education and industrial. the development of path planning algorithm and localization have significantly increase the usability of the robot this day. by using a software such as a SLAM and Gmapping the robot will be able to create a map for the surrounding area. the created map will be available for the robot to use in the future. this research use the SLAM and Gmapping with a robot called Turtlebot, there are three cases the research investigated. First one, a virtual environment with a virtual robot have been created, where the simulated robot has the real Turtlebot robot features. The second case, we used the Turtlebot robot indoor to create a map for the lab room using the Gmapping ROS package. Last case was the most important achievement for this study, where we used the raspberry pi 3 as a replacement of the laptop that use to control the Turtlebot. the same implementation as the second task have been repeated to compare the performance. in addition, the new system used to create a 3D model for lab room. The raspberry pi accomplish the given tasks successfully, however, there is some delay due to the different on the CPU power.

Objectives

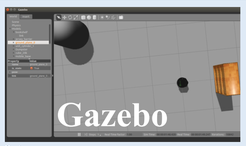
To Investigate the ROS framework and determine the requirement to run it into a raspberry pi 3.
To run a Turtlebot robot on a simulation environment called Rviz.
To Install Linux Ubuntu 16.04 into a laptop.
To configure a Wi-Fi network that is linked to the master node with the laptop or the raspberry pie.
To run a real experiment with Turtlebot robot that is using a laptop as the main processing unit.
To Install ROS into the raspberry pi 3.
To run SLAM (Simultaneous Localization and Mapping) mapping software on both laptop node and the raspberry Pi, in order to create a map.

System requirement

Hardware requirement:

- Laptop
- Raspberry Pi 3
- Wireless router:
- Xbox 360 controller
- Software requirement:
- ROS
  - Gazebo
  - Rviz
  - Turtlebot
  - Telpot
  - Gmapping
  - Move_Base
  - Navigation

Python
Linux Ubuntu 16.04
Linux Ubuntu Mate 16.04
Slam and Gmapping



Design and Implementation

1. Case 1 Simulation

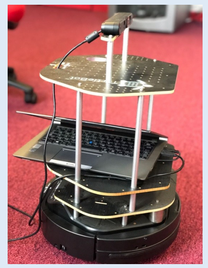
In the first case the Turtlebot will run in a simulation environment managed by Gazebo and Rviz software,

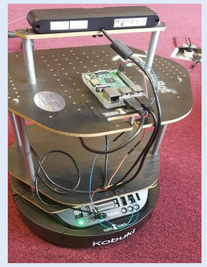
2. Case 2 Create the Map 3D model using the laptop

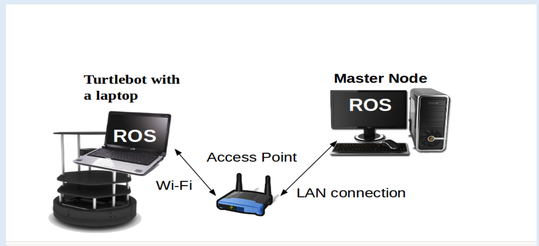
The target of this experiment is to create a map by using ROS gmapping software by using laptop as a the main compute unit for the Turtlebot robot, also, control the robot via a Xbox 360 controller. Moreover, there is another task, which is creating a 3D module for objects inside the lab room. For each side of the system there are a number of command that need to be executed to allow those task to be applied.

3. Case 3 Create the Map and 3D model using raspberry pi

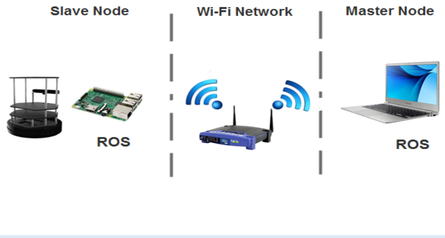
The only deferent that the previous point, we replace the laptop with a raspberry pi 3. and it use Ubuntu Mate16.04





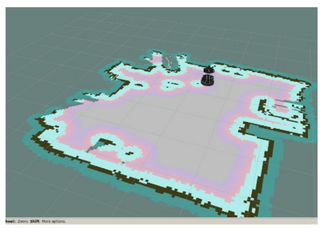


System design using a master node and the turtle robot with the laptop

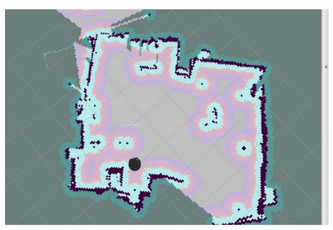


System design using a master node and the turtle robot with the Raspberry Pi

Testing and Results

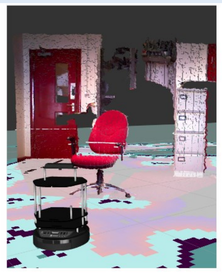


Map using Laptop



Map using Raspberry pi 3

Map using Laptop



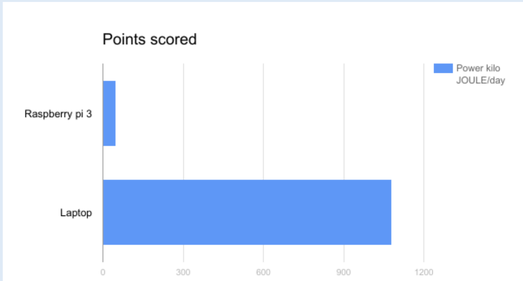
Map using Raspberry pi 3

performance

n contrast, between the use of the laptop and the raspberry pi in regard to the performance, it will be idea to compare the generated MAP and the 3 Model from both cases. as we can see in next figures, which are showing the outcome of using the laptop and in the right side the outcome of using the raspberry pi. In terms of the quality, the laptop have slightly better quality. But, the accuracy level of both very close to each other in generating MAP ant creating 3 D model.

Power Consumption

In comparison between the power consumed by the raspberry pi and the laptop. the laptop will require 5 time more power than the raspberry pi. For long term operation this power will be considerable amount.



Conclusion

In conclusion, the aim of the research is to study the ROS framework as well as applying some of the important robot tasks, such as navigation and planning, which required using SLAM algorithm with ROS. First experiment was leaning how simulate the Turtlebot robot in virtual environment using gazebo. Then followed by creating a 2D MAP, which have been done twice, first time using the laptop with the Turtlebot robot as a main compute unit. The second time using the raspberry pi with the Turtlebot as the main compute unit, which replace the laptop. Therefore, the proposed solution had succeeded to prove the usability of the raspberry pi with robot and ROS system, in order to reduce the cost of developing such a robot (Turtlebot).

The system have been designed to be used as dependent system. where the raspberry pi is powered from the base of the robot. The ROS system have been used as the main operating system for the robot.

Advantages
It has a small size that help in designing smaller robot.
It has built in Wi-Fi adapter in contrast to raspberry pi 2.
Cheap cost, the raspberry pi cost around that 30 £.
Require less power in contrast with the laptop.
Cheap in power usage for long term cost (less bill)

Disadvantages
No build in battery for the raspberry pi unit, where it will use the robot battery.
Low RAM 1GB.

Future

This study open various further study options, such as, analyzing the power usage for the robot after using the Pi, using the raspberry pi that has ROS into it to run more ROS applications, which could be a challenging. in the near future, if there are a newer raspberry pi released with higher specification or other type of single board computer, with higher processing power and RAM that will allow the project to give better performance.

Reference

ROS Wiki. (2017). Wiki.ros.org. Retrieved 11 March 2017, from http://wiki.ros.org /kinetic/Installation/Ubuntu
Ryan, G., & Roelofs, R. (2013). Simultaneous Localization and Mapping.
Claessens, R., Müller, Y., & Schnieders, B. (2013). Graph-based Simultaneous Localization and Mapping on the TurtleBot platform.
Open Source Robotics Foundation. What is TurtleBot?. Retrieved at the 20th of april from http://www.turtlebot.com/about/