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Autonomous Robot with Keyboard Control

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Abstract
We were thrilled when Robotic sent us a review unit of its TurtleBot3 because we are the team behind the robotics blog Automation on IEEE Spectrum. People who want to get their feet wet with the Robot Operating System, or Ros, can use this little robot as a platform. Despite its popularity among academic researchers and developers in industry, Ros's complexity can be daunting. The network-based TurtleBot2, which predates the Turtlebot3, is still an excellent ROS platform. However, the TurtleBot 3 makes use of a brand-new class of inexpensive computing and sensing hardware: The platform incorporates a complete ROS installation into the smallest, cheapest, and most user-friendly mobile robot that is capable of supporting it. Because the TurtleBot3 comes in two flavors—burger and waffle—Robotics actually sent us two units. The waffle is based on Intel's joule compute module, which appears to be in jeopardy right now, but it provides more advanced features. Therefore, the Raspberry Pi 3-based US $549 Burger will be our primary focus here. ROS, as previously mentioned, has a steep learning curve. If you're willing to learn ROS and other advanced robotics and computer science concepts over time, this is not the robot for you.

1. Introduction

In the past, investigation into the development of unmanned air, underwater and land vehicles has been fundamentally the domain of military related organizations. Nowadays, the technological context, availability of precise sensors, the spread of open- source software and the increasing of computation power, has led the largest companies to take an interest on the concept of automation and robotization and as a result autonomous navigation has become also one of hottest topics in the research's field.
In this thesis, we study the problem of autonomous navigation through an environment that is initially unknown, with the objective of reaching the farthest point in which the robot can move avoiding the obstacles. Without prior knowledge of the map, a moving robot must recognize its surroundings through onboard sensors and make instantaneous decisions to react to obstacles as they come into view. This problem lies at the intersection of several areas of robotics, including motion planning, perception, and exploration.
Different techniques could be used to implement the navigation that is generally separated into global motion planning and local motion control. The algorithms introduced in this work are linked to the local motion planning; therefore, using the sensor mounted on it, the robot is capable of avoiding the obstacles by moving toward the free area.
This document explains three possible algorithm solutions, based on Obstacle Avoidance, that address a complete autonomous navigation in an unstructured indoor environment. The

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algorithms raise in complexity taking into consideration the evolution and the possible changed in which the robot will have to move, and all are tested on the TurtleBot3 robot (Waffle and Burger), where only LiDAR was used as sensor.

The implemented techniques necessitate the robot to select actions based on the construction of the environment that it has perceived. As we will observe in this thesis, standard motion planning techniques often limit performance to be conservative when deployed in unknown environments, where every unexplored region of the map may,in the worst case, poses hazard.

To guarantee that the robot will not collide with potential obstacles, motion planners limit the robot's speed such that it could come to a stop, if need be, before the collisions.

The trajectory and the speed of the robot depend on many factors such as the type of floor, the limitations of the hardware, the size and the material of the wheels and the type of algorithm that manages the movement of the robot.

The map is built with two-dimensional Cartesian histogram grid based on the RViz software that is the official software used in ROS environment, which is updated continuously with range data sampled by onboard sensors.

In order to make this work more complete a different solution to the automatic creation of the map, has been proposed; this map will be analyzed and compared with the one created by the ROS tool.

Fig.1 TurtleBot

2. Literature Review

TurtleBot is a platform robot that runs on ROS. The Turtle robot, which was driven by the educational computer programming language Logo in 1967, is the inspiration for the Turtle game. Additionally, a program that imitates the Logo turtle program's command system is the turtlesim node, which first appears in the ROS basic tutorial. Additionally, it is used to create

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the ROS-themed Turtle icon. The turtle's back shell served as inspiration for the ROS logo's nine dots. TurtleBot, whose design is derived from Logo's Turtle, is intended to teach computer programming languages using Logo as well as ROS to novices with ease. TurtleBot has since evolved into the ROS platform of choice, which is also the most widely used platform among students and developers.

The TurtleBot model comes in three different versions. Tully, Platform Manager at Open Robotics, and Melonee, CEO of Fetch Robotics, from Willow Garage built TurtleBot1 for ROS deployment on top of iRobot's Roomba-based research robot Create. It was made in 2010 and has been available for purchase since 2011. Based on the research robot iClebo Kobuki, Yujin Robot created TurtleBot2 in 2012. In 2017, TurtleBot3 was made with features to make up for the lack of features in its predecessors and meet user demands. For driving, the TurtleBot3 makes use of the ROBOTIS smart actuator DYNAMIXEL. Please follow the link to learn more about the TurtleBot series.

The ROS-based TurtleBot3 is a compact, affordable, programmable mobile robot that can be used for hobby, research, education, and product prototyping. The objective of TurtleBot3 is to offer expandability while drastically reducing the platform's size and price without compromising its functionality or quality. Depending on how the mechanical components are reconstructed and optional components like the computer and sensor are utilized, the TurtleBot3 can be customized in a variety of ways. In addition, TurtleBot3 features a small, low-cost SBC that is suitable for a robust embedded system, a 360-degree distance sensor, and technology for 3D printing.

The TurtleBot3's SLAM, Navigation, and Manipulation, core technology makes it suitable for home service robots. The TurtleBot can drive around your room and use SLAM (simultaneous localization and mapping) algorithms to build a map. Additionally, a laptop, joypad, or Android-based smart phone can be used to control it remotely. The TurtleBot is also able to follow a person's steps through a room. By attaching a manipulator like Open MANIPULATOR, the TurtleBot3 can also be used as a mobile manipulator that can manipulate an object. The Open MANIPULATOR is advantageous because it is compatible with Waffle Pi and TurtleBot3 Waffle. Compatibility can make up for a lack of freedom in this way

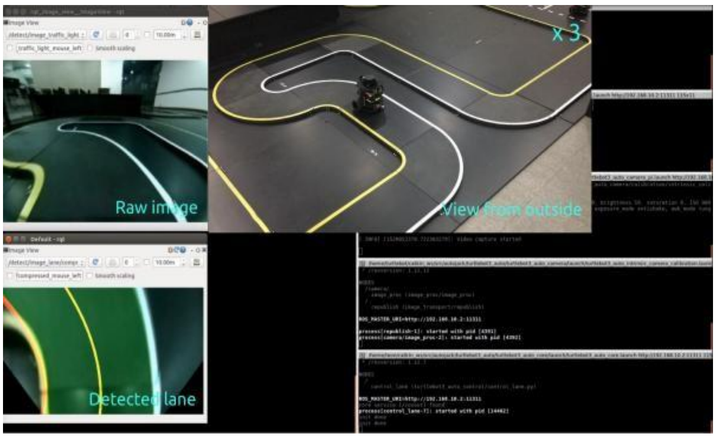

Fig.2 TurtleBot3 Auto Race

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3. Proposed System

TurtleBot3 Burger is a new generation mobile robot that is modular, compact and customizable, just like its sidekick the Waffle. This new programmable robot from Robotis includes a Raspberry Pi 3, with which the robot can run ROS and Ubuntu (the first open-source operating system for PCs, connected objects...). It has software that runs on Apache 2.0 and runs completely in Open Source. Another interesting aspect is its open CR operation. This means that it is possible to print the elements in 3D or to buy them ready for assembly. Turtlebot3 Burger works with the latest versions of Ubuntu Linux (13.04.2 LTS) and ROS (Kinetic). It uses single-card computer interfaces with a control panel. In addition to using ROS to control the robot, you can also program additional behaviors using the C/C+ functions and Arduino libraries.

Popular ROS platform: TurtleBot is the most popular open source learning and search robot in the world.

TurtleBot is the most widely available platform for training, development and prototyping.

Compact: The small size of the robot is a distinctive feature.

Possibilities for improvement: Different sensors, motors, a single board computer, a modular box will allow you to realize all your ideas.

Modular servo drive: The servo drive is easy to install, replace and reconfigure.

Free Software: The user has access to a variety of free software and can modify the source code.

Open equipment: Accessories (circuits, printed circuit boards) are in the public domain.

Powerful sensors: The robot is equipped with a 360° laser rangefinder (LiDAR), a 9-axis gyrostabilizer (IMU) and a high-precision encoder.When the output variable is categorical, such as Yes-No, Male-Female, True-False, etc., classification algorithms are utilized. Classification is a type of "pattern recognition" in which classification algorithms are applied to the training data in order to locate the same pattern in subsequent data sets. Data augmentation is a method for using your dataset's existing data to expand or enlarge it. In order to assist in better training our model with a large dataset, we employ a variety of methods to expand our dataset. if you use a small dataset to train your model and overfit the data, or if you have a small dataset. Therefore, in order to train our model and improve its capabilities and performance, or in order to make it more applicable to other situations, we require a suitable dataset. This is made possible by Data Augmentation.

The input data will go through a series of transformations as part of the data augmentation process. As a result of the variations in the data samples, our dataset will become more rich.

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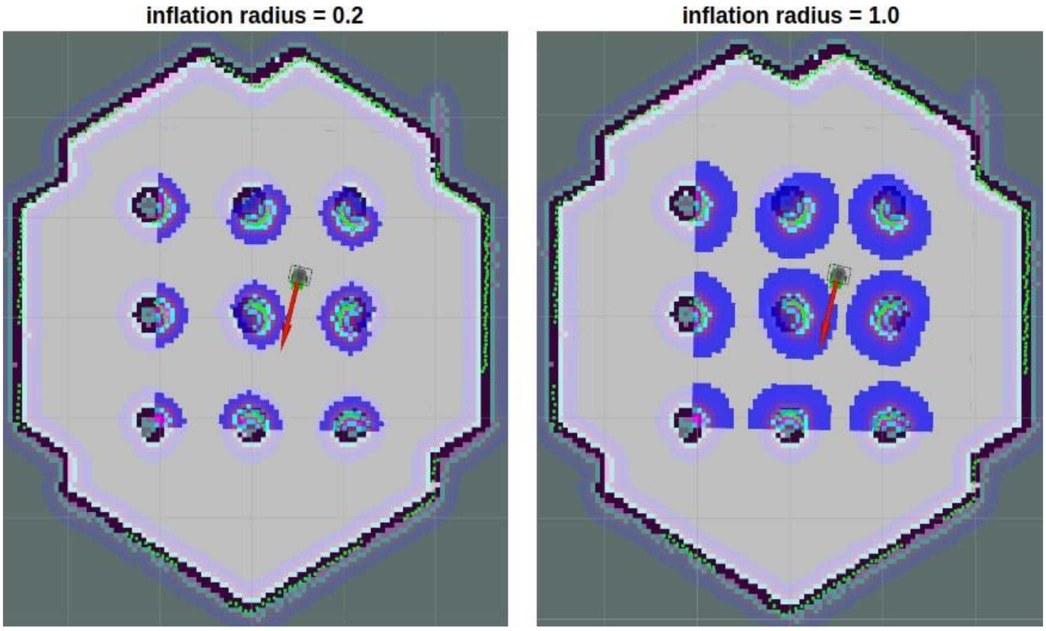

Fig.3 Navigation

4. Conclusion

The ROS system and TurtleBot3's middleware and necessary hardware were set up successfully. Additionally, the aforementioned use cases could be successfully tested and evaluated for performance, accuracy, and feasibility. Overall, we were pleased with those outcomes and the current ecosystem of libraries and modules for service robot application development. Despite the fact that we encountered some difficulties with the TurtleBot 3's relocalization and that bad configuration occasionally caused us to take longer to complete a single traversal, However, these issues may be resolved once users become more accustomed to tuning the parameters and learning about the dynamic reconfiguration. With the help of the robot operating system and, in particular, the TurtleBot 3 robot, we can now establish a solid foundation for subsequent research and development. In the future, it ought to be possible to utilize additional information sources like a camera or an ultrasonic sensor, combine the data that has been collected, and attain even higher performance outcomes. A cross-section of the TurtleBot 3 can be seen here through our Munich office space.

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