Household Bot

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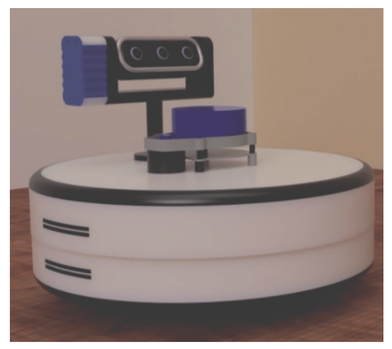


Introduction

It is a fully ROS-integrated mobile robot designed and fabricated to help in the day-to-day activities of an average household. The bot can autonomously navigate in indoor environments using vision data from an onboard RGBD camera and is also equipped with a vacuum cleaning system. Other than autonomous navigation, the bot uses deep learning algorithms to achieve human following, face recognition, and thereat detection abilities. The application of these abilities ranges from baby monitoring to security and surveillance. Along with hardware, we have a simulation model of the bot with all the features implemented in the Gazebo 3-D simulator. The bot is fully open-sourced and can be used as a test bed for research on autonomous navigation in indoor environments.

Hardware

The bot uses Jetson Nano as its brain along with an STM32 microcontroller to control wheels at high frequency. It equips two 12V D.C. motors which are driven by an L23D motor driver. There is separate power for motors and Jetson Nano, a 5500 mAH 12 V battery and a 5V 10000 mAH power bank respectively.

Simulation

For simulation, we first designed the bot in Solidworks and conducted various tests like airflow analysis to determine its durability and performance. Then we exported the model as URDF into the Gazebo physics simulator where we tested all our algorithms on autonomous navigation and machine learning on it.

Features

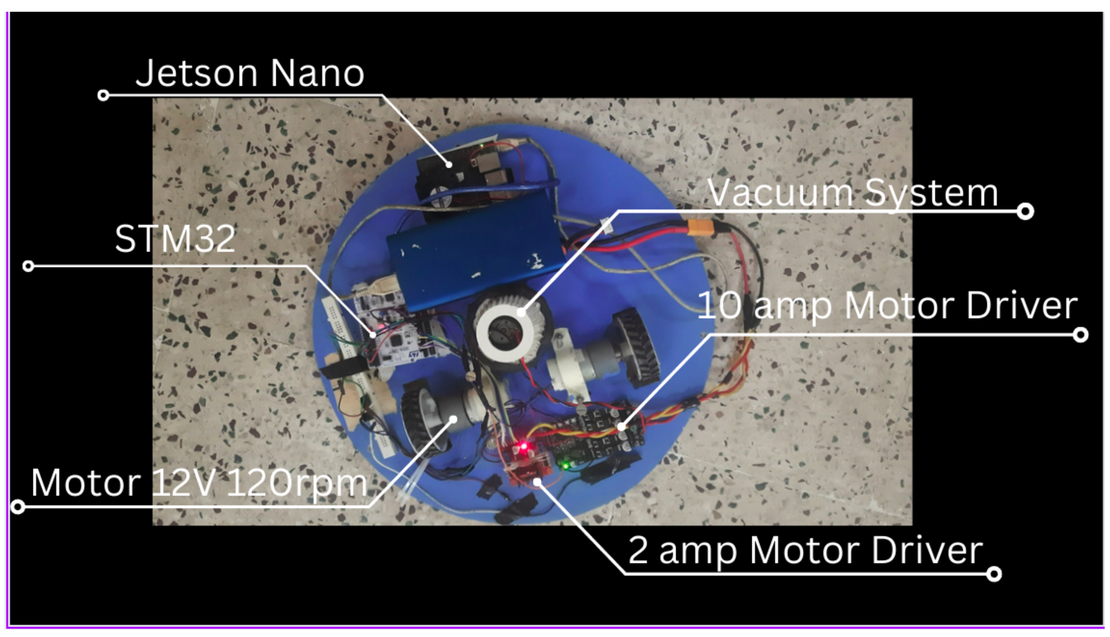
1. Autonomous Navigation:

We used onboard RGBD data along with ROS Navigation Stack on our Bot to autonomously navigate.We developed 4 modes for its navigation:
A) Teleop Controlled: In this, you can simply control bots' motion.
B) Autonomous Mapping: This will be used when a new bot comes to the home, this bot will autonomously map the whole house by finding regions that are not mapped.
C) Autonomous Navigation: This will allow you to autonomously send the bot anywhere in generated also avoiding both static and dynamic obstacles.
D) Autonomous Complete Coverage: At night you can simply run this mode and the bot will autonomously vacuum your whole house following an optimal complete coverage path.

2. Baby Monitoring and Surveillance:

We use deep learning models to implement the following features in the bot-
A) Baby Following- In this mode, the bot estimates the position of the baby and tries to follow its central point constantly monitoring it.
B) Threat Detection- In this mode, it detects potential threats in the environment like knifes using object detection algorithms.
C) Human Recognition- The bot recognizes known faces and triggers an alarm for unknown/blacklisted persons.

Design and Components



Conclusions and Future Work

The bot is intended to act as a commercially viable product and a research bed for autonomous navigation algorithms. For, future work we are planning for a 2nd prototype with 3-D printed parts and better space management. We are also planning to develop novel algorithms to improve autonomous navigation for highly dynamic indoor environments such as houses.

QR Code for Presentation