Robo-Making Documentation

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1 Complete and Exhaustive Description of All Logical Steps in the Working of Robot

- **Description of Robot:** The robot is an optimized maze-solving device designed for both compactness and efficiency. It utilizes ultrasonic sensors (US-100) in conjunction with the VL53L0X time-of-flight sensor to enhance the accuracy of sensory inputs. This combination compensates for variations in the speed of sound due to temperature fluctuations, resulting in more stable and precise measurements for the robot's processing capabilities. The robot begins by exploring the maze to create a comprehensive map, which is subsequently fed into the floodfill algorithm. This algorithm then identifies the most efficient path through the maze.

- **Electronics Description:** Our maze-solving robot is built on a custom PCB using an ESP32-S3 for processing sensor data and motor control. The US-100 ultrasonic sensor detects obstacles, while the MPU6050 ensures stability and precise turns. The robot uses a TB6612FNG motor driver to control two N20 DC motors with encoders, providing accurate movement.

  Powered by a 1500 mAh 3.7V LiPo battery, the robot navigates the maze by detecting walls, junctions, and dead ends. All components are integrated on the PCB to streamline wiring and improve reliability.

- **Features:**

  - Compact Design: The robot's optimized size allows for efficient navigation through tight spaces in maze environments.
  - Advanced Sensing Technology: Utilizes ultrasonic sensors (US-100) and VL53L0X time-of-flight sensor for enhanced accuracy in distance measurement.
  - Temperature Compensation: Adjusts for changes in the speed of sound based on temperature variations, ensuring stable and precise sensory inputs.
  - Maze Mapping Capability: Capable of exploring and mapping mazes autonomously, enabling effective pathfinding.

- Efficient Pathfinding: Integrates the floodfill algorithm to compute the most optimal route through complex maze structures.
- Real-time Processing: The robot processes sensory data in real time, allowing for immediate adjustments to its navigation strategy.
- Robust Performance: Designed to operate effectively in dynamic environments, adapting to various maze configurations.

2 Complete and Exhaustive Listing of All the Hardware / Components / Equipment (Electronics and Mechanical)

2.1 Electronics Components

- **Electronics Modules**
  - 1. Espressif ESP32-S3-DevKitC-1-N8 Development board
    2. Motor Driver TB6612FNG
    3. MPU6050 3-axis Accelerometer Gyroscope
    4. US-100 Ultrasonic Sensor Distance Measuring Module
- **Electronics Components Used for Fabrication**
  - 1. N20 3V 150RPM Micro Metal Gear DC Motor With Encoder
    2. 3PI miniQ Car wheel Tyre 44mm N20 DC Gear Motor Wheel
    3.MINI 3PI car N20 Caster Robot Ball Wheel
- **Tools and Equipment Used**
  - 1. EASYEDA for PCB Designing
    2. Soldering Iron for PCB components soldering
    3. Wire strippers

2.2 Mechanical Components

- **Mechanical Fabrication Components**
  - 1. Battery holders
    2. Motor clamps
- **Tools and Softwares Used**
  - 1.Filers
    2.Pliers
    3.Tweezers
    4.3d printer (PLA)
    5.Small files
    6.Calipers
    7.Screwdrivers
    8.Fusion 360(cad modelling)

2.3 Electromechanical Components

- WLY103048 1500 mAh 3.7V single cell Rechargeable LiPo Battery

3 Complete and Exhaustive Listing of All the Software Used in Robo-Making

3.1 Software Used

The software utilized for the robot includes the Tremaux algorithm in conjunction with the floodfill algorithm. The Tremaux algorithm is employed to efficiently explore and map the maze. Once the maze is mapped, the resulting data is processed by the floodfill algorithm, which determines the most optimal path through the maze. This combination ensures both efficient maze exploration and optimal pathfinding.

3.2 Software Developed

We have implemented the Tremaux algorithm for a maze of predefined length. Currently, we are enhancing the algorithm to function in a dynamic environment where the maze dimensions are not predefined.

The floodfill algorithm has also been developed. Given the input of a 2D array generated by the Tremaux algorithm, it efficiently computes the most optimal path through the maze.

In addition, we have created a basic wall-following algorithm for simpler navigation tasks.

4 Additional Features in Actual Robo-Making

We have developed a basic wall-following algorithm to facilitate simpler navigation tasks. This algorithm allows the robot to follow the walls of the maze when mapping or navigating, providing an alternative method of movement that is particularly useful in constrained environments.

5 Concurrence / Deviation from Level 1 Documentation with Reasoning

- 1. As per our old design, we had both STM and ESP32 in the plan, but we went forward with ESP32 as it is easier to program.
  Note: We are not using the Bluetooth and the WiFi connection of ESP32.

- 2.During the testing phase, we identified inaccuracies in the measurements provided by the VL53L0X sensor. To ensure optimal performance and reliability, we made the decision to switch to the US-100 ultrasonic sensor module. This change was implemented in the final stages of development to enhance the accuracy and effectiveness of our robot's navigation capabilities. We changed our sensor from VL53L0X to US100 as the VL53L0X sensor, for some reason, was not accurate during testing. So, in the final moments, we shifted to the US100 module.
- 3. As we changed some of our components and some of our components were not of same dimension as mentioned in the website from where we ordered , so we also had to change the pcb designing .

6 Photos

Here are some photos of the robot:

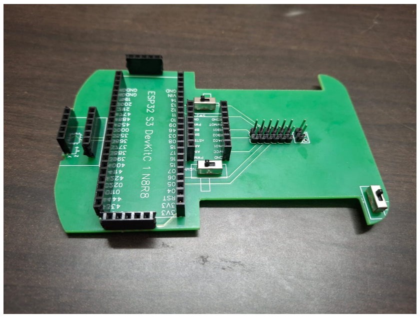

Figure 1: Robot PCB

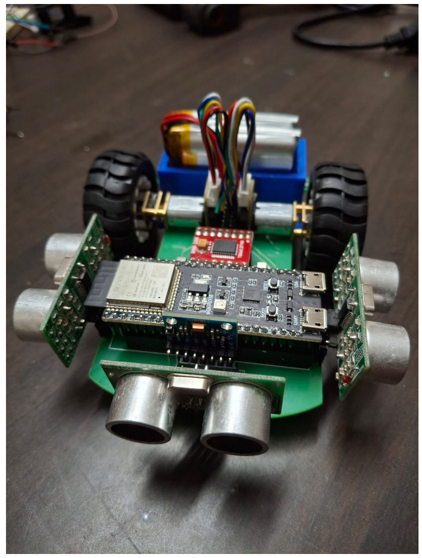

Figure 2: Robot close-up

7 Videos

A video demonstrating the robot's development can be viewed at the following link: Click here to view the robot video.