Autonomous Mapping Robot With RF Remote Control

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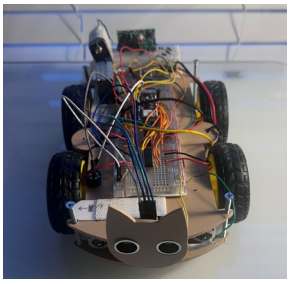
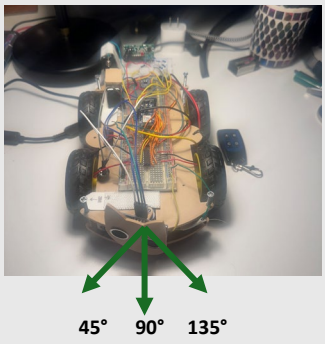
What is it?



This project is an Autonomous Mapping Robot that combines manual control, autonomous exploration, and real-time environmental mapping. The system operates in two distinct modes such as Manual Control and Autonomous Exploration. Auto mode uniquely includes that Return-to-Home controlled via a RF remote control. When the robot is connected to serial monitor, it can display a 16x16 grid map with approximately 12-inch cell resolution, and this is suitable for mapping an indoor environment.

How it works



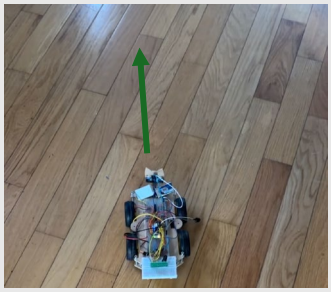
• Sensor Scan

Ultrasonic sensor, mounted on the servo motor, rotates at three angles: 45°, 90°, and 135° to measure distance from the obstacle.
The IMU provides acceleration data for collision detection and compass data for movement direction estimation.

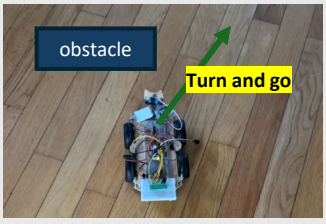
• Decision-making

If the forward path is empty, the robot advances by one grid cell.
When an obstacle is detected, the left-right distance values are compared and rotated in a more open direction.
If all directions are blocked, reverse and rotate 180°.

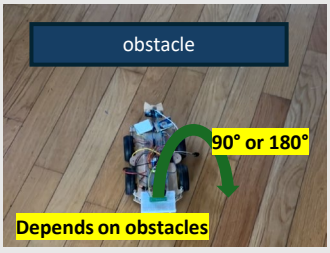
1) empty



2) Obstacle and choose

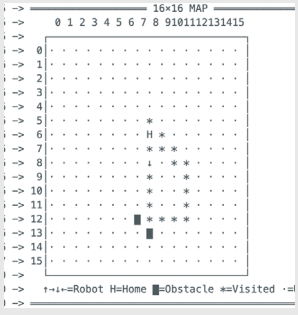


3) Fully blocked



• Switch mode

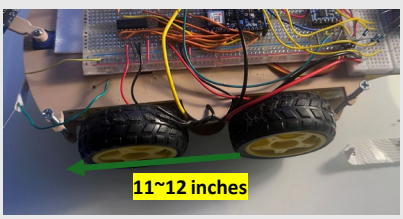
Switching between Manual Control, Autonomous Exploration, and Return-to-Home modes is performed according to the mode switching RF remote control input.



• Update Map (required to connect to serial monitor to display)

After each movement, the robot updates obstacles, empty spaces, visits, and collision information on the 16×16 occupancy grid.

Thank you ☺



• Movement Execution

The motor time is calibrated to ensure all movements correspond to one grid cell (about 11~12 inches).

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What we learned

- **Power system design is critical in mobile robot environments.**

  High motor current draw caused voltage brownout, which made Bluetooth communication unreliable and led us to redesign the control interface.

- **Real-world sensor data is noisy and highly environmentally dependent.**

  The ultrasonic sensor had a ±3 cm error, and since the compass (IMU) data was affected by motor current and peripheral metals, which resulted in poor accuracy, the timing and filtering of the sensor were required.

- **Simpler communication can be more robust.**

  Bluetooth Low Energy proved overly complex and sensitive to power instability, while a 433 MHz RF remote provided reliable control under real-world conditions.

- **Accurate calibration plays a key role in autonomous behavior.**

  In order to match the robot's actual movement distance with logical grid movement, the motor operating time and rotation angle had to be repeatedly calibrated.

How to operate (Demo)

RF Remote Control

- A: Move forward by one cell in the grid
- B: Back up a step
- C: Rotate 90° left
- D: Switch mode (2 modes)

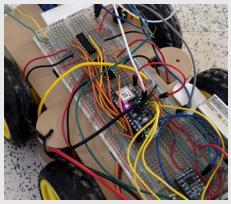
  Manual Control → Autonomous Exploration

  Autonomous Exploration → Return-to-Home

LED Status

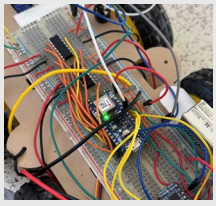
Magenta color:

- Return-to-Home



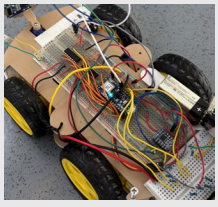
Green:

- Manual control



Cyan:

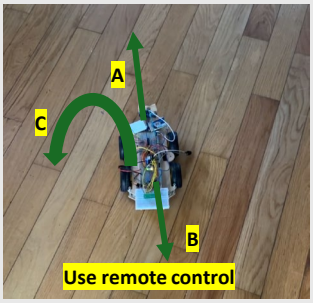
- Autonomous Exploration



- Additional LED colors means processing in movement and rotation

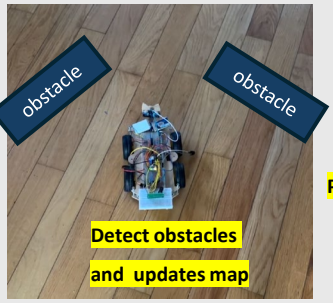
Demo Flow

1) Manual Control



Press D

2) Autonomous



Press D again

3) Return-to-Home