REPORT

Obstacle Avoidance in Ground Robotics

Team - Mind Bogglers

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1. Introduction

This project explores obstacle avoidance in ground robotics, aiming to build a robotic vehicle capable of navigating autonomously using sensors.

2. Components Used

- Ultrasonic Sensors
- Servo Motors
- DC Motors
- Arduino
- Motor Driver
- Rechargeable Battery

3. Initially Discussed Deliverables

1. **Hardware Implementation:** Integration of sensors, motors, and drivers.

2. **Software Development:**To make 2 different modes user and automatic as well as an on/off switch which can be controlled from user's local PC.In user mode one can control directions of the robot from the website.

3. **Simulation and Testing:** Testing of the working of sensors individually and after combining the different components and thus further functional prototype display.

4. **Data Collection:** Graphical representation of sensor performance,distance-delay analysis.
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5. **Website-Based Control:** A system for controlling the robot via a web interface.

4. Project Timeline

Timeline	Tasks
Week 1	Component selection, defining objectives, sensor checking,working on initial code.
Week 2 - Mid Evaluations	Integration of servo motor and ultrasonic sensor.Also individual movement of DC motors.
Week 3	Hardware integration of sensors with Motor Driver and making obstacle avoidance fully functional.Initiating the software component of code.
Week 4 - Final Report	Making a suitable website for user to control the movement of the robot autonomously as well as defined by the user.

5. Procedure

1. **Hardware Setup:**
    - Assembling the motors, wheels, motor driver and the arduino.
    - Integrating of sensors and servo motors for obstacle detection.

2. **Sensor Calibration:**
    - Configuration ultrasonic sensors for accurate distance measurement.
    - Tested synchronization with motor controls i.e. the speed of vehicle and distance covered ratios.

3. **Software Development:**
    - Wrote and tested code for real-time obstacle avoidance.
    - Implemented a web interface for control and monitoring.
    - Displayed graphs corresponding to different components on the website.

4. **Testing:**
    - Conducted obstacle tests in controlled environments.

6. Challenges and Drawbacks

- **Sensor Limitations:** Issues with sensor range, accuracy, and environmental interference.

- **Power Consumption:** High processing demands reduce operational time.
- **Mobility Issue:** Data collection as well as mobility control is not functional when USB cable is disconnected from the PC.
- **Delays:** The script reads data from the serial port continuously, but there is a `time.sleep(0.01)` (10 milliseconds) delay before processing the next piece of data.If data arrives faster than the script can process and send it to ThingSpeak, some data points may be missed.
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7. Calibration Techniques

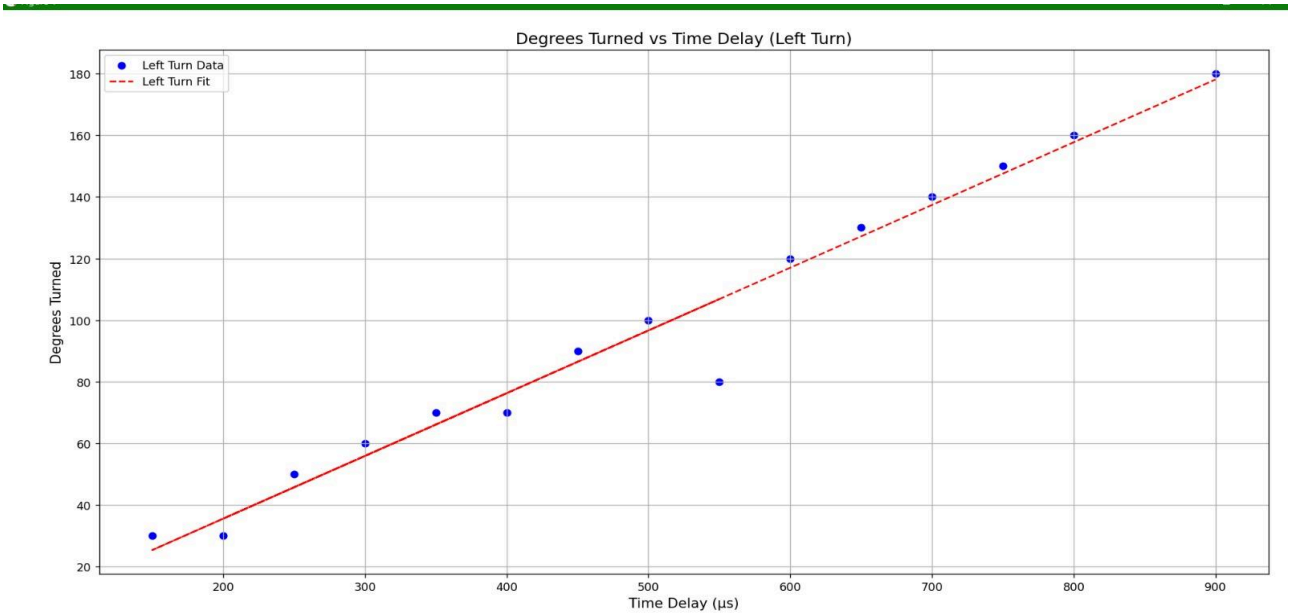
To optimize the robot's performance:

- Fine-tune sensor thresholds for obstacle detection.

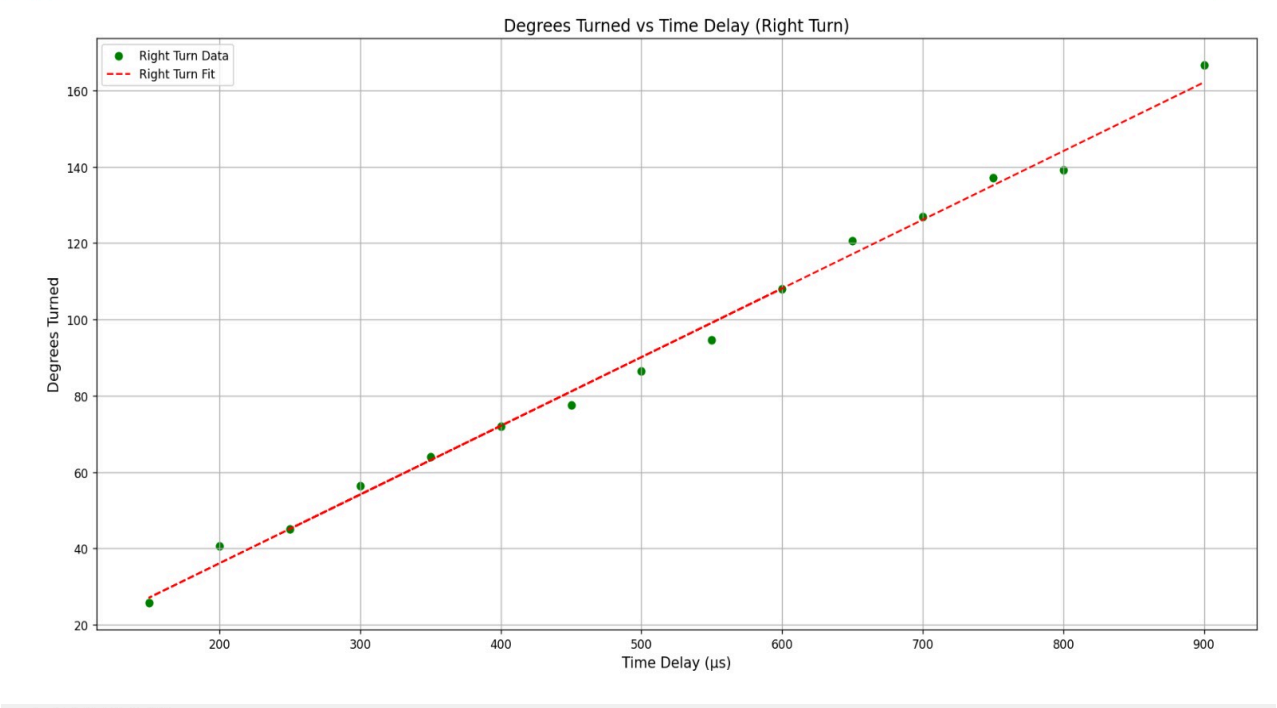
- Regularly test sensor alignment with the servo motors.

- Tuning the delay in code with the distance covered as well as angles rotated.

Graph of distance vs Delay in code to get an idea about speed.



Graph of Angle rotated vs delay(ms) Left Turn

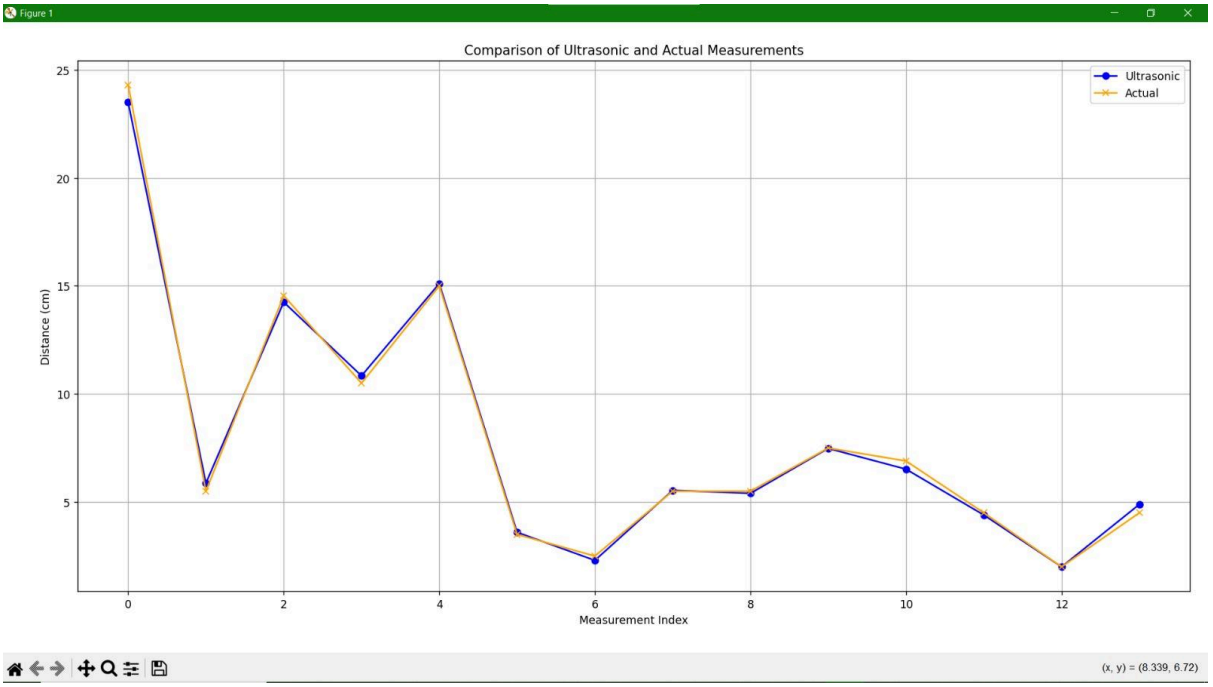


Graph of Angle rotated vs delay(ms) Right Turn

8. Data Collection and Analysis

- **Types of Data Collected**: Sensor readings, obstacle detection logs, robot path data.

- **Graphs**:



Graph of Ultrasonic Readings vs Actual Distance

9. Simulation and Testing

- **Video Demonstration:**

  Click here to view the test run.

- **Github code:**

  Click here to view the github repository.

- **Sensor Testing:** Data collected from ultrasonic have been analyzed for synchronization with motor movements. The robot successfully avoided obstacles in controlled environments, showing potential for real-world applications with further refinements.

10. Contributions

- **Virat Garg:** Code implementation and GitHub management.Data analysis and graph generation.

- **Bibek Dhody:**Hardware integration, including motors and sensors.Calibration of sensors for accuracy.

- **Navishaa Agarwaal:** Slide preparation, video creation, and motor integration.

- **Aditya Gaur:** Data collection and preliminary analysis.

11. Real Life Applications

1. **Warehouse Automation**: Robots navigate warehouses to pick and place items efficiently, avoiding shelves and workers.
2. **Autonomous Delivery**: Robots deliver packages or food while avoiding pedestrians and obstacles in urban environments.
3. **Home Cleaning**: Robotic vacuum cleaners, like Roomba, avoid furniture and walls to clean floors autonomously.
4. **Agricultural Assistance**: Robots avoid trees and rocks while planting, spraying, or harvesting crops.

12. Conclusion

The project successfully demonstrated obstacle avoidance in ground robotics. Key insights include the importance of sensor calibration and efficient algorithms for real-time processing. While effective in static conditions. Future improvements will focus on dynamic environment handling and enhancing energy efficiency.