Autonomous Target Robot

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Objective

Our goal with this project was to create an Autonomous Target Robot - a robot that travels to a predetermined set of locations and presents a target for a user to shoot at, counts the hits, and returns to the original starting point after it has completed its task. Our project is built specifically to incorporate the following features:

1. Customizable GPS Navigation(4 coordinate)
2. User input and graph of travel via User Interface
3. Constant heading calculation and user facing target

Materials & Methods

Components of this project

- Arduino Mega/Uno
- Vehicle Chassis with Motors
- Rechargeable 9v Batteries
- NRF24L01 Wireless RF Transceiver
- 3x L298N Motor Driver
- Nema 17 Bipolar Stepper Motor
- SW-420 NC Vibration Sensor Module
- Adafruit 9-DOF Absolute Orientation IMU Fusion Breakout - BNO055
- NEO 6M GPS Module

Distance

$$a = \sin^2(\delta_\phi/2) + \cos\phi_1 \times \cos\phi_2 \times \sin^2(\delta\lambda/2)$$
$$c = 2\arctan 2(\sqrt{a}, \sqrt{1-a})$$
$$\text{Distance} = \text{Radius of earth} \times c$$

Bearing

Start pt: $\sin\Delta\lambda \times \cos\phi_2$

End pt: $\cos\phi_1 \times \sin\phi_2 - \sin\phi_1 \times \cos\phi_2 \times \cos\Delta\lambda$

Bearing: arctan2(start point, end point)

Introduction

Soldiers across the world train day in and day out practicing their guns. They spend hours in weapons training to learn how to fire with accuracy and precision. However, they are only able to train with targets that are set up in the same location every time. We created an autonomous, GPS-based target robot to improve the way that soldiers perform target practice. Our vehicle will allow soldiers to select custom destinations for the vehicle to travel to, create a target, and record if the soldiers were able to hit the target. Our system's accuracy, in-motion course correction, hit recording system, and navigation features will make it a viable replacement for current systems in place at target ranges.

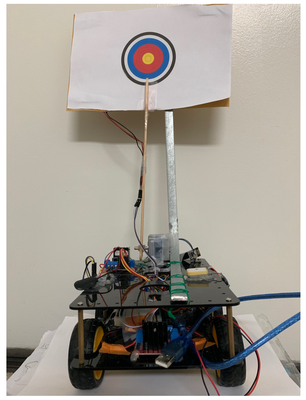
Results 2

Beyond qualitative and whole-system checking, we performed individual quantitative tests to perform our vehicle met our standards. The results of these tests and specifications are below.

Test	Objective	Result
GPS accuracy	2.5-6m	3-7m
RF communication time	< 1s	< 1s
GUI transmission range	30m	30m
PWM control	4WD	4WD
Startup time	< 1 minute	30s
Heading accuracy	10°	10°
Batteries	9V	9V

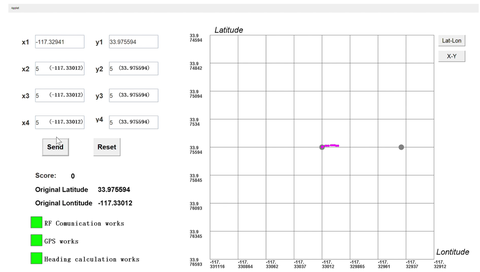
- Overall GPS accuracy was less than desired results but still acceptable for our purposes
- Heading accuracy, RF communication time/range, and startup time were consistent with desired results

Results 1

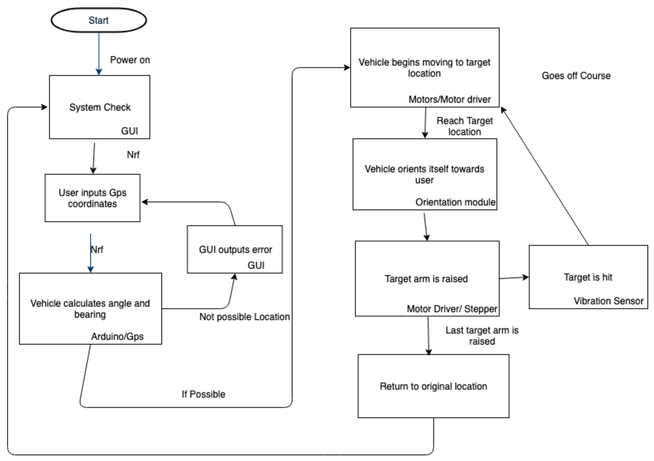


We found that our Autonomous Target Robot was most successful on flat, hard surfaces such as concrete or asphalt. We also found that the further away we got form buildings, the more accurate our GPS coordinates were. This helped us to determine the optimal conditions for operating our vehicle - a long-distance target range with flat, solid ground. Our vehicle was also able to operate in conditions of wet ground and in grass with more limited mobility.

In our testing of the Autonomous Target Robot, we were able to issue the robot a set of four coordinates that it traveled to with relative ease. The vehicle was able to consistently send the coordinates to the base station to be plotted, rotate to face the proper heading, and display a target facing the user. We tested our vehicle with different targets, trajectories, and initial positions to gather these results.



Conclusion



- Created an Autonomous Target Robot that navigates to coordinates specified by the user in the GUI and puts up a target for shooting practice, records hits, and returns to original location when finished.
- Has a self system check to let the user know it is ready to be used.
- Capable of calculating distance and bearings as it is moving to it's target location.
- Communicates with the base station to let the user know of GPS locations and target hits.

References

Bullock, R. "Great circle distances and bearings between two locations." MDT, June 5 (2007).

Future Research

In the future our main objective is to improve with increased GPS accuracy on our vehicle. We would like to implement different types of GPS modules so that we may obtain a more precise location desired by the user. In addition we would like to expand on being able to input more gps coordinates so that the user has a wider range of options to try to hit the target.

Contact Information

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