Developing a robot that autonomously collects LIDAR data and improving loop closure detection in SLAM

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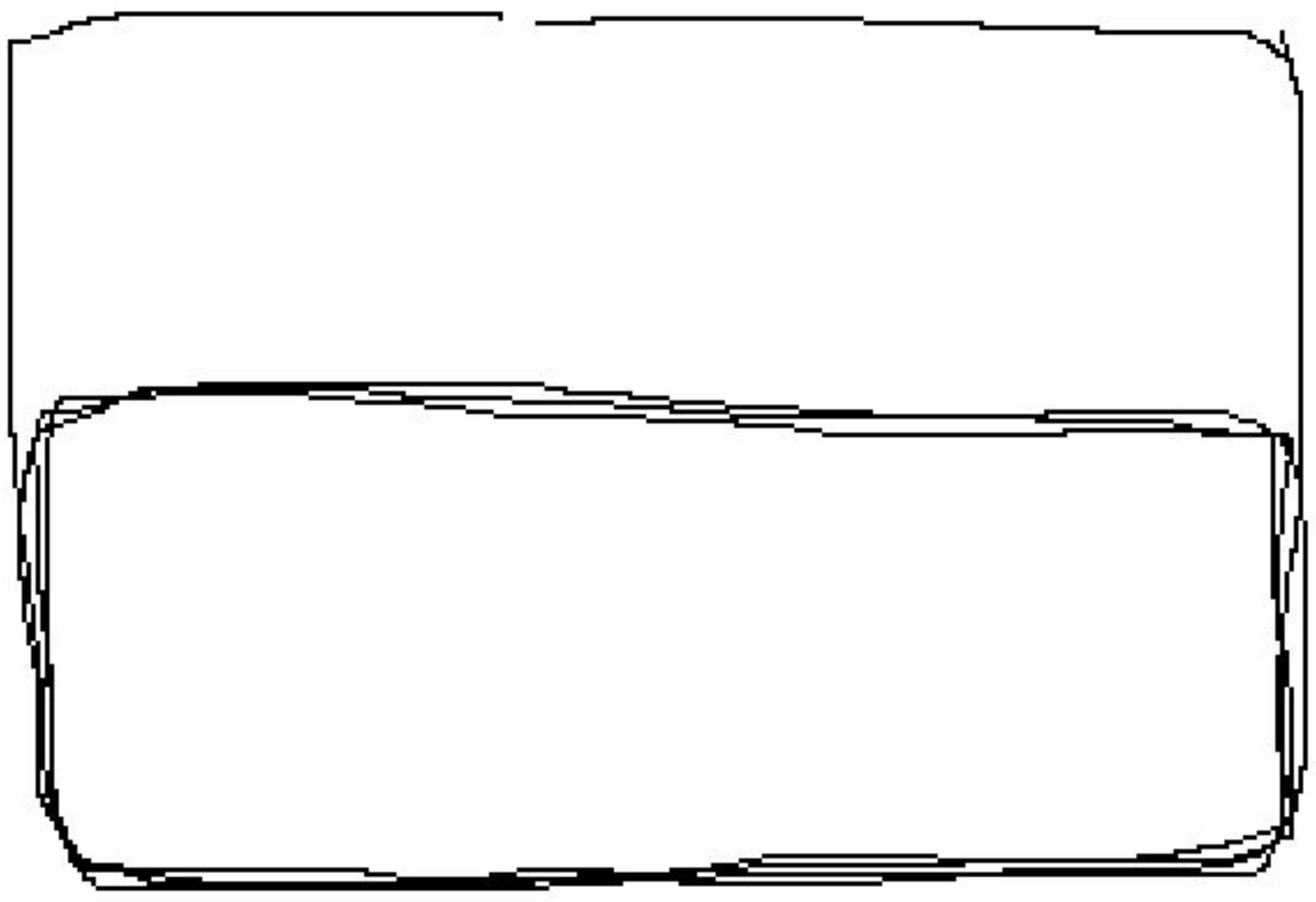
Data and Results

The robot drove on this path:

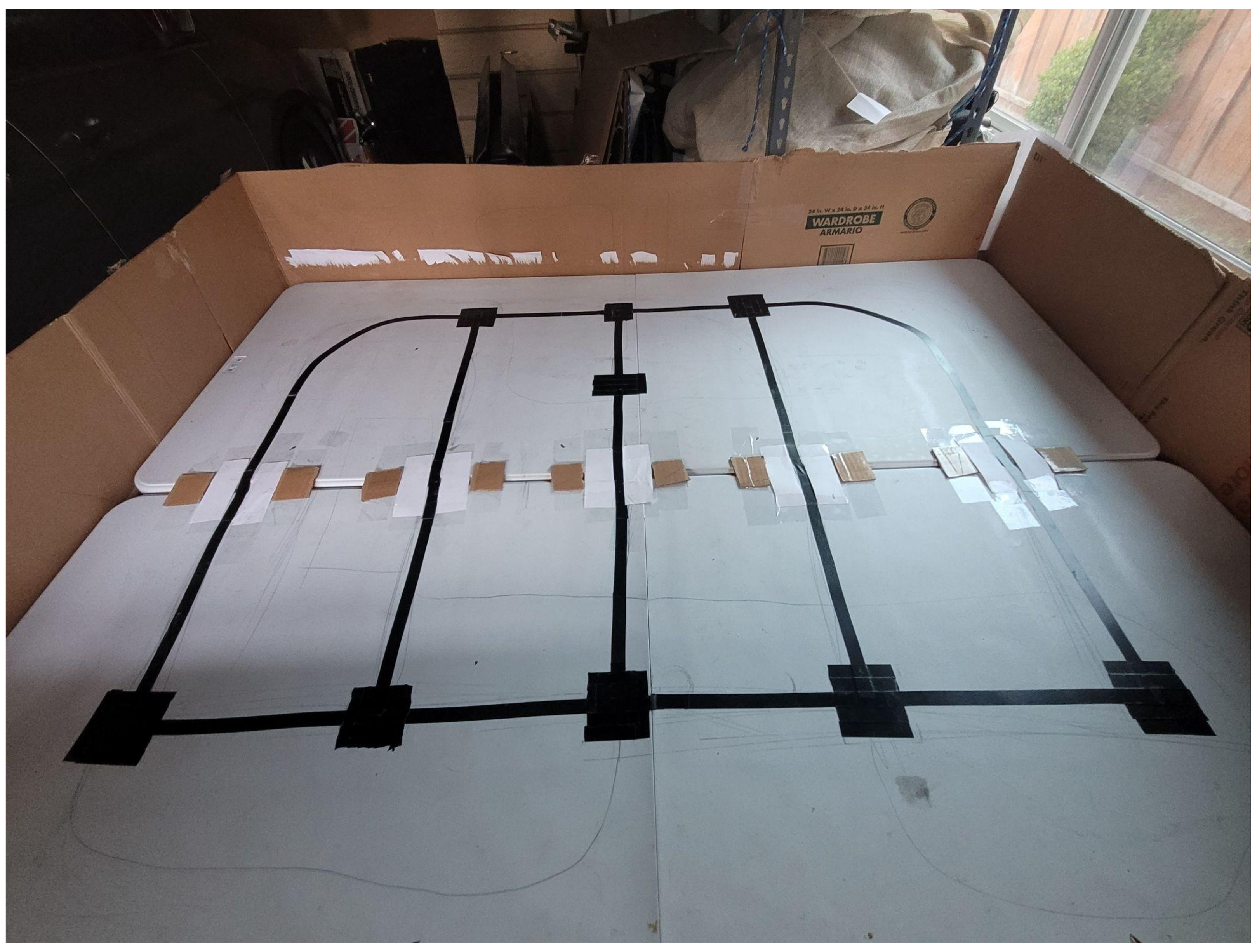


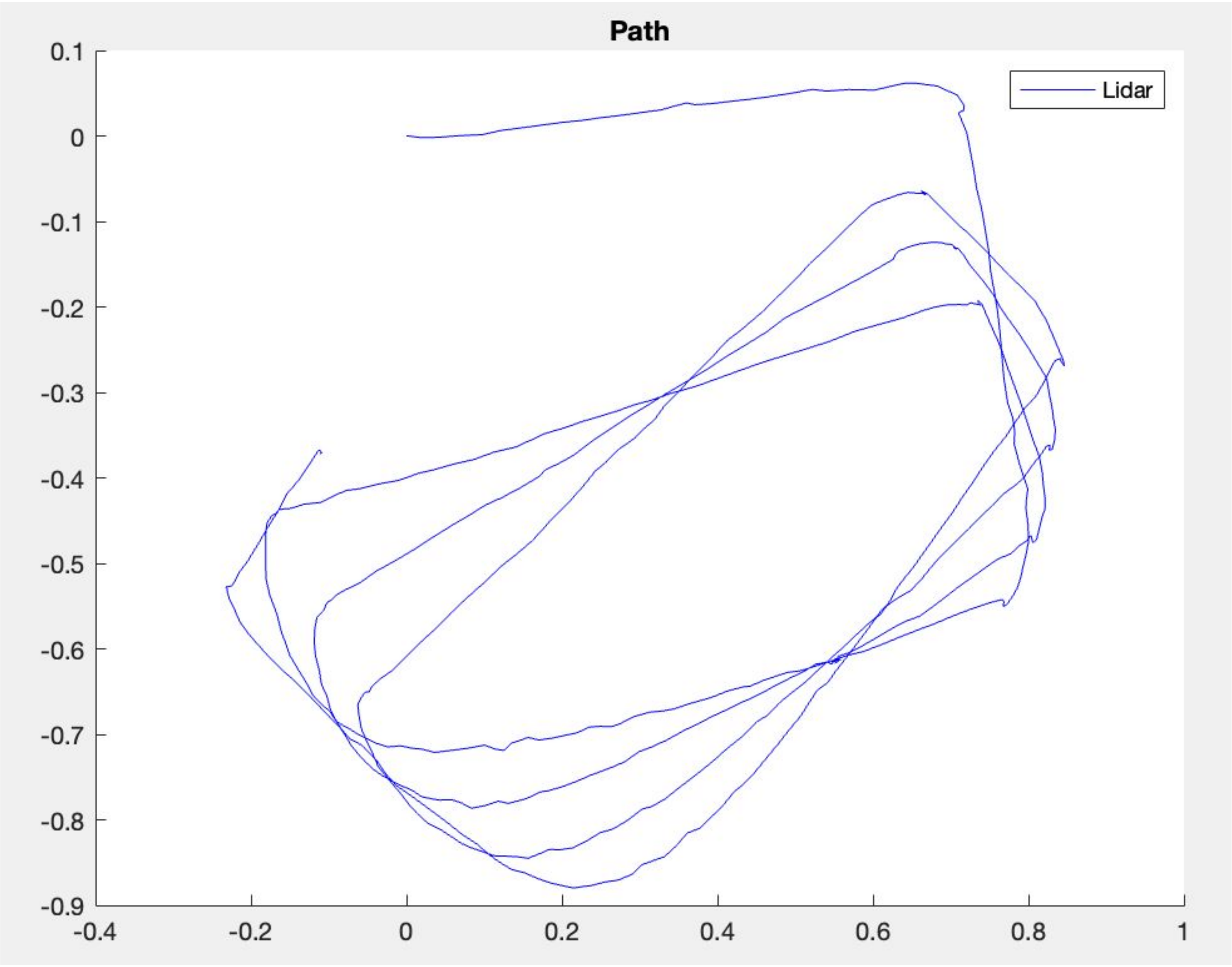
After the robot drove on the path, I imported the data it collected and calculated the path three ways:

- Using data only from the Lidar and calculating the robot's position over time using the Iterative Closest Point (ICP) algorithm
- Combining data from the Lidar with rotation data from the gyro sensor
- Combining data from the Lidar with rotation data from AprilTag detection

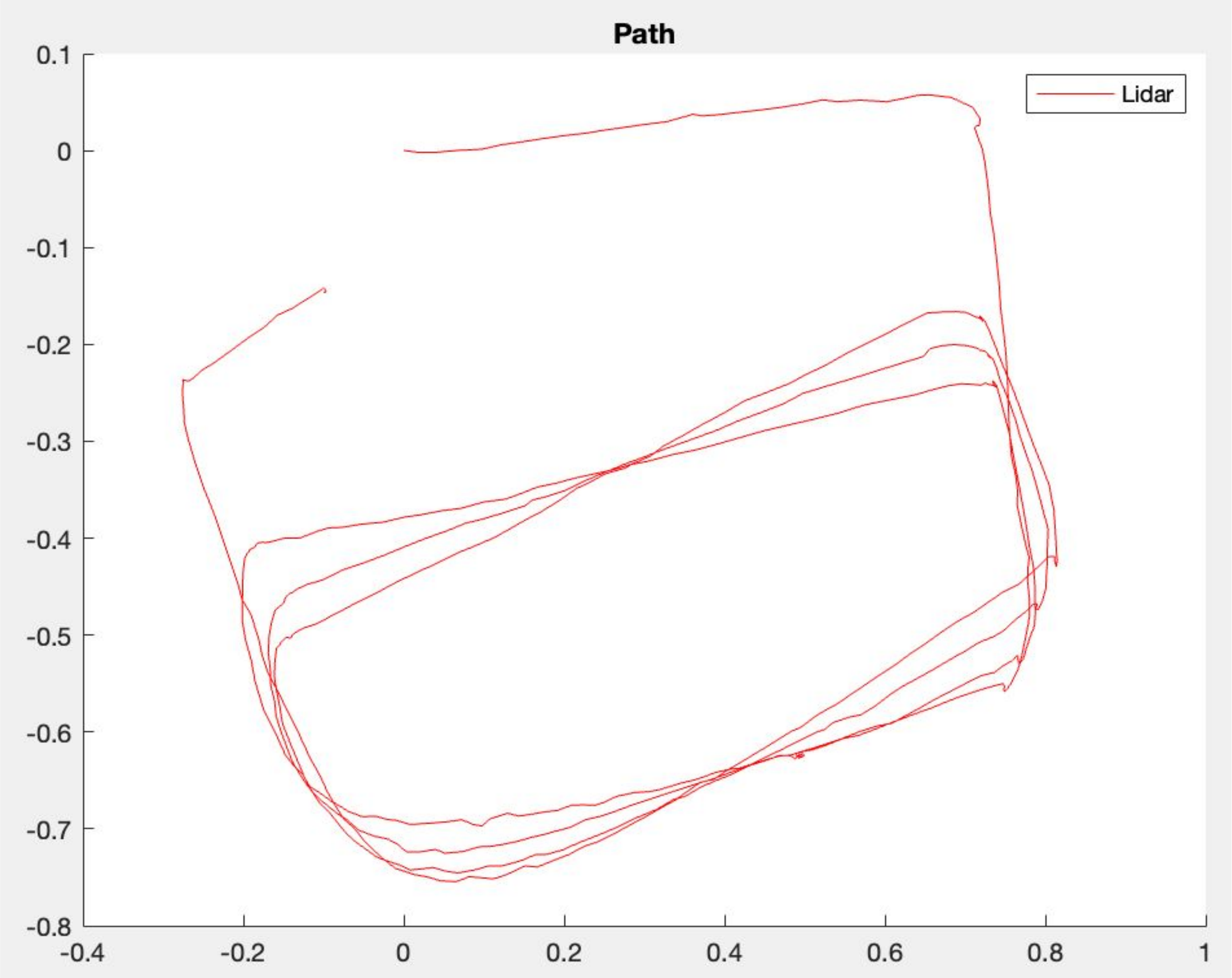
Robot field

- The robot drives on a set path on the field
- It followed the black lines using the reflectance sensor
- The robot is able to automatically return to the start position if it makes a mistake following the path

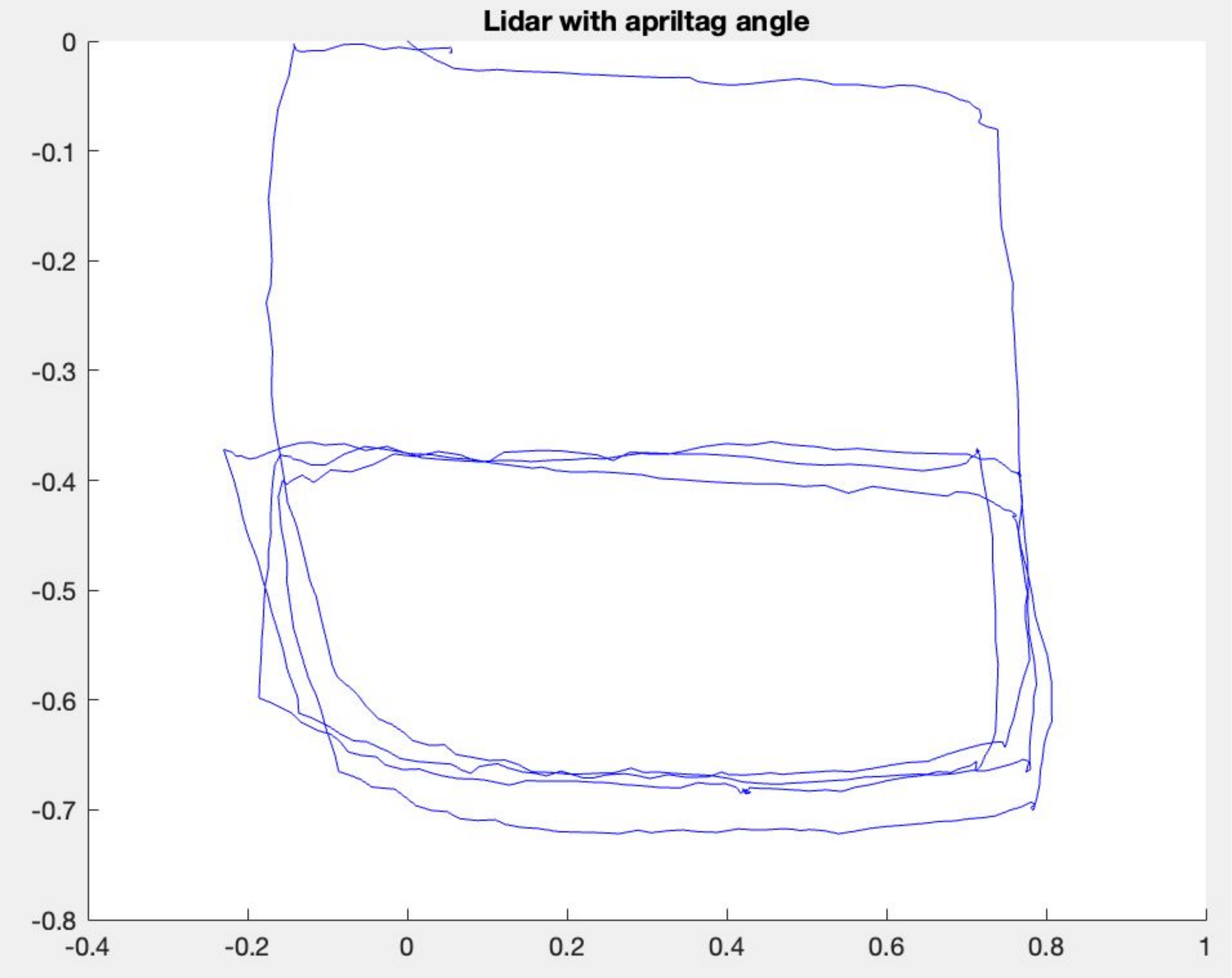




Using only data from the Lidar to calculate the path



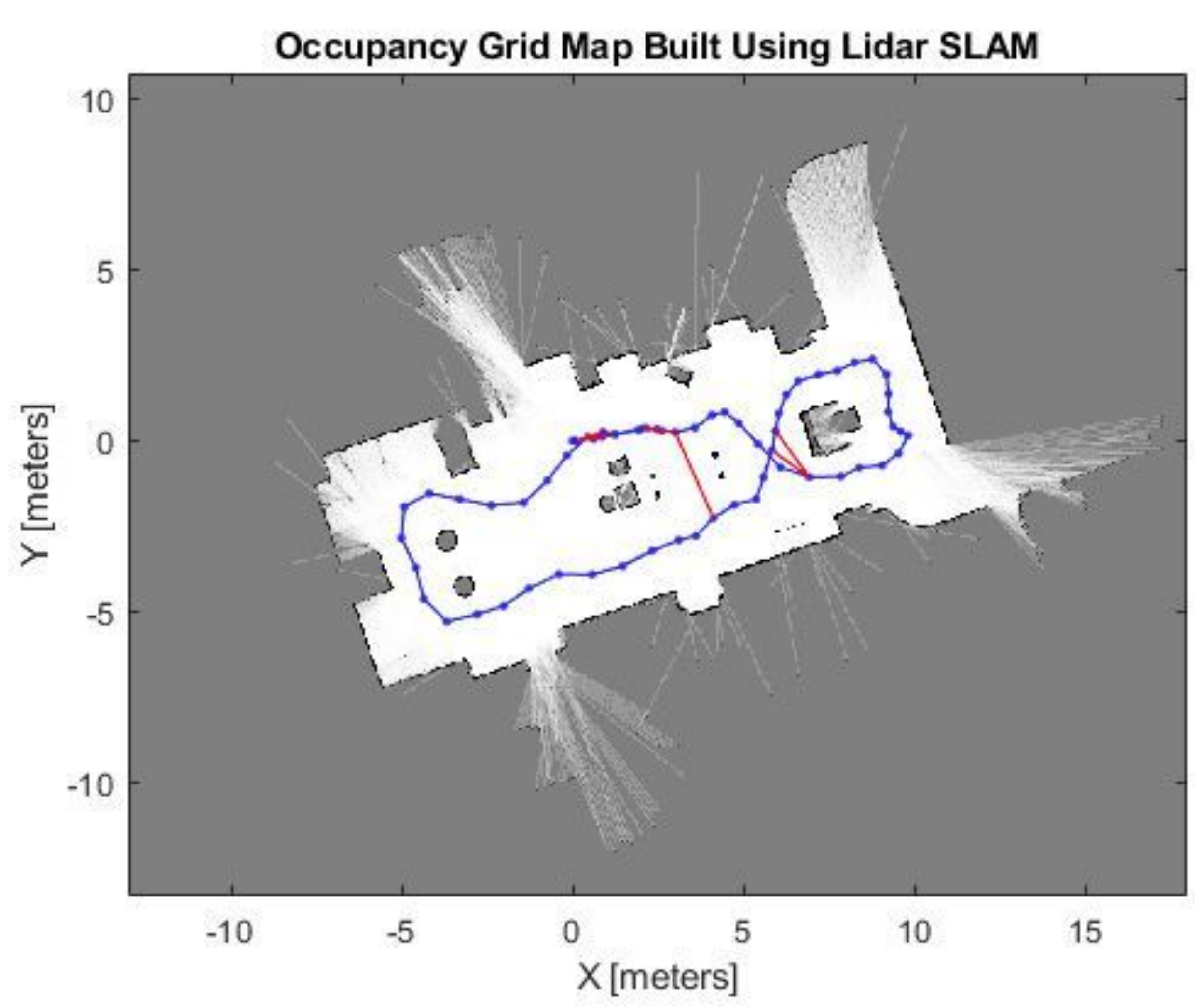
Calculating the path by combining Lidar data with rotation data from the gyro



Calculating the path by combining Lidar data with rotation data from the AprilTags

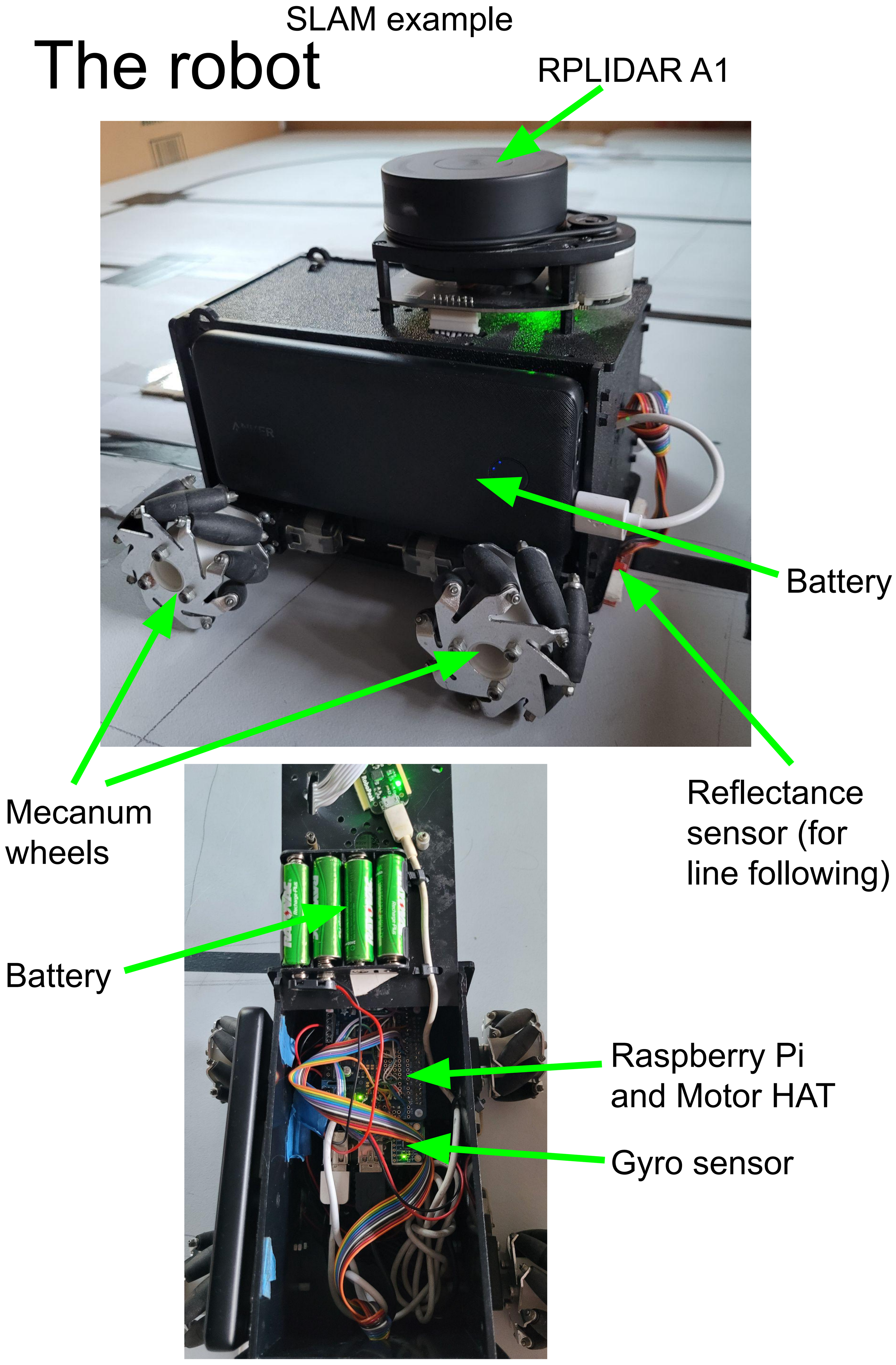
Introduction

- Simultaneous Localization and Mapping (SLAM) is used to track the position of a moving object and construct a map of its environment.
- SLAM has many real-world applications, like self-driving cars.
- Many sensors can be used for SLAM, but no sensor is 100% accurate. This is because sensors have noise and many sensors don't work well in certain environmental conditions.
- I built a robot with multiple sensors to collect data for my project. The robot has a Lidar, a camera for AprilTag detection, a gyro sensor, and an optic sensor.
- The goal of my project is to combine data from multiple sensors to be able to most accurately determine the robot's position.



SLAM example

The robot



Conclusion

- When I used only data from the Lidar and calculated the path of the robot using the ICP algorithm, the path was very inaccurate as the ICP algorithm wasn't able to accurately determine the rotation at sharp turns.
- When I combined data from the Lidar with rotation data from the gyro sensor, the accuracy of the path improved, but it still wasn't perfect.
- When I combined data from the Lidar with rotation data from the AprilTags, the path was very accurate.
- Hence, in this project, I demonstrated that by combining data from multiple sensors the accuracy of SLAM can be improved.

Next steps

- Use a Kalman filter to combine data from multiple sensors
  - When I combine Lidar data with AprilTag rotation data, the AprilTag rotation data always takes precedence over Lidar rotation data
  - A Kalman filter uses both data sources, so it can make the path more accurate
- Improve AprilTag detection accuracy in low-lighting conditions

Bibliography

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