Mechanical Design and Control of Mobile Robots Integrated with Multiple Sensors

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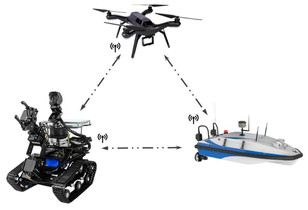
Introduction

Motivation: Cooperative control of multiple vehicle systems has potential impact in numerous applications:

- Civilian: monitoring forest fires, tracking wildlife...
- Industry: transportation, manipulation, painting...
- Military: search and rescue, reconnaissance, surveillance...

Goal: Create a mobile robot that responds to obstacles in its environment and synchronization with other robots.



Discussion

We will prioritize achieving dynamic and precise movement while establishing a robust integration between the robot's software and hardware. This project holds significant real-world applications across various fields by integrating control algorithms, *e.g.,*

- Trajectory and formation tracking
- Automatic parking (stabilization)
- Source seeking (optimization)

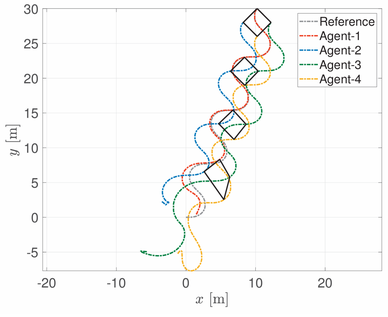


Fig. Formation control

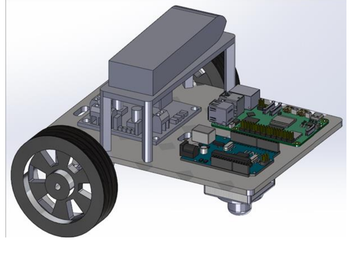
Results

Currently,

- The model is designed, printed, and assembled
- A control program to instruct movement has been made

Further efforts will focus on establishing the connection between the hardware and software.

Multiple robots will be produced, and the team of robots will be capable of moving in synchronization.



Acknowledgements

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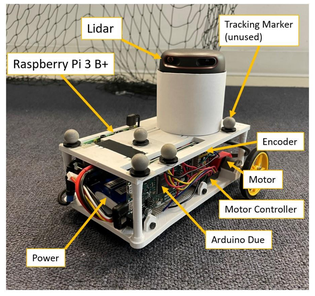
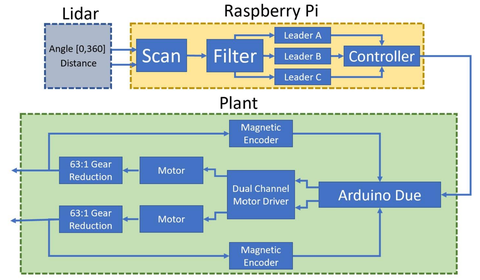
Methods

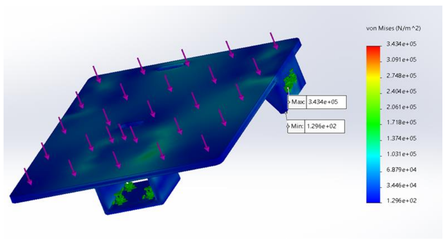
System structure overview:

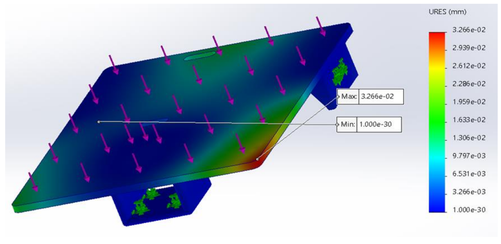




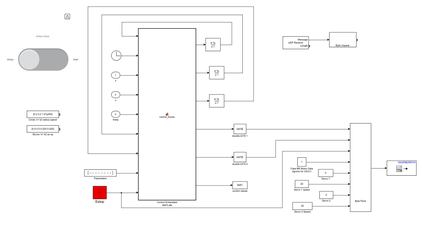
The project was separated into the mechanical design and programming sections:

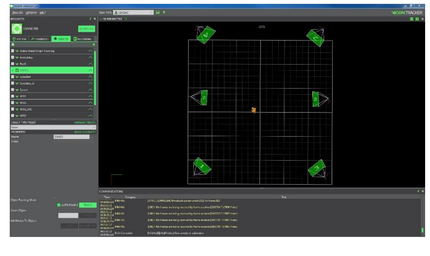
- A prototype of the design was configured in SolidWorks to find the optimal spatial layout of the chassis and was then 3D printed with polylactic acid (PLA)
- A finite element method (FEM) analysis was conducted on the chassis to eliminate risks of deformation and material failure.





- The Arduino and Raspberry Pi were programmed to control the servo motors at varying speeds and durations. The user can input the desired speed, time, and direction of movement using a keyboard.
- Integrating various control algorithms via MATLAB/Simulink Real-Time and Vicon cameras.





References

[1] B. Wang, S. Nersesov, and H. Ashrafiuon, “Formation Regulation and Tracking Control for Nonholonomic Mobile Robot Networks Using Polar Coordinates,” *IEEE Control Systems Letters*, Volume 6, 2022, pp. 1909-1914.