Modular IEEE SECON Robot

Luke Chapman, Reid Crews, Isaac Hoese, Isaac Jennings, Abigail Kennedy, Mabel Olson

Tennessee Technological University

Introduction

Problem Statement

The annual IEEE SECON competition always requires the same basic robot functionalities: sensing, motor control, power management, and autonomous navigation. The objective of this capstone project was to develop an adaptable robot platform that contains all of the basic functionality so that future teams can focus on the specific challenges given each year.

Overview of Constraints

The robot must navigate autonomously, and it must do so accurately and reliably while holding to the yearly standards set by the IEEE SECON competition. The robot should be designed to be easily adapted to future competition boards.

Design

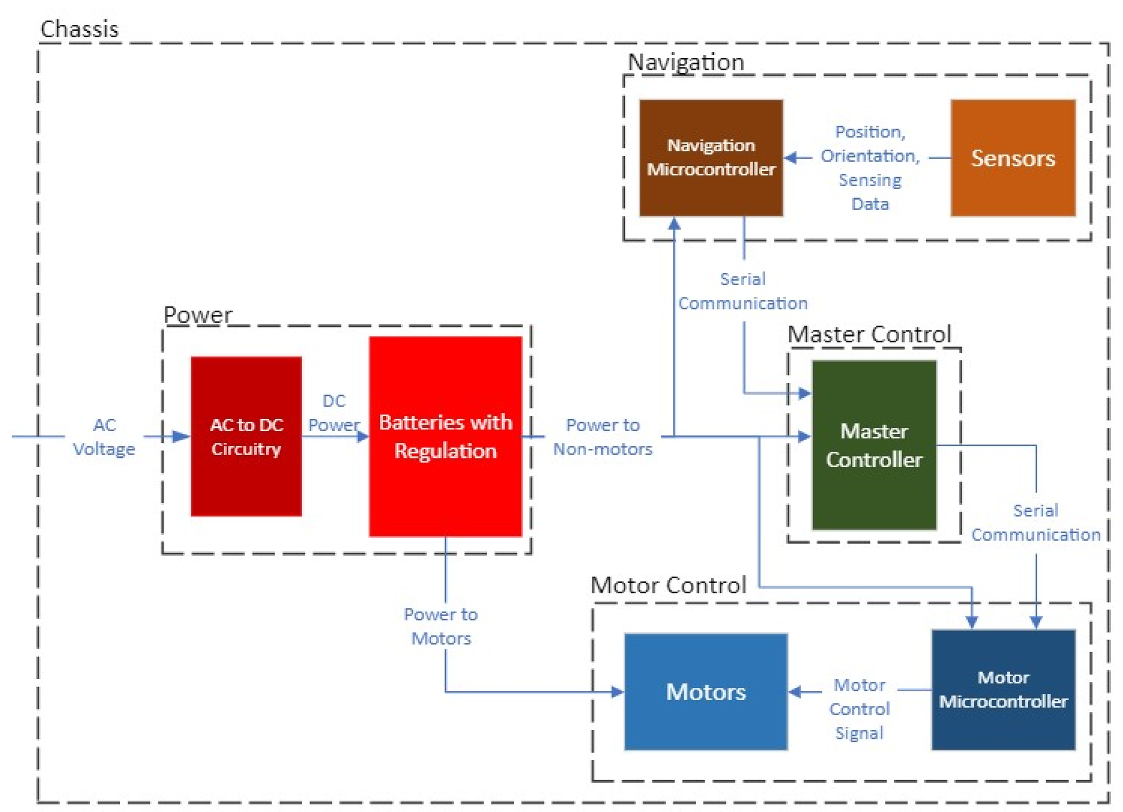

Figure 1. System Block Diagram

- Chassis: The robot's frame utilized extruded aluminum with t-channels and 3D-printed, slotted sheets to give the robot the flexibility to add, remove, or reorganize the robot's components.
- Motor Control: Mecanum wheels and brushless DC motors controlled by PWM signals were used to achieve full range of motion.
- Navigation: The robot uses orientation, line following, and distance sensors to navigate the board.
- Master Control: A Jetson Nano was used to provide ROS2 navigation and localization.
- Power: Power was distributed by a PCB designed using KiCad that supplied power from the battery to the motors, microcontrollers, and sensors.

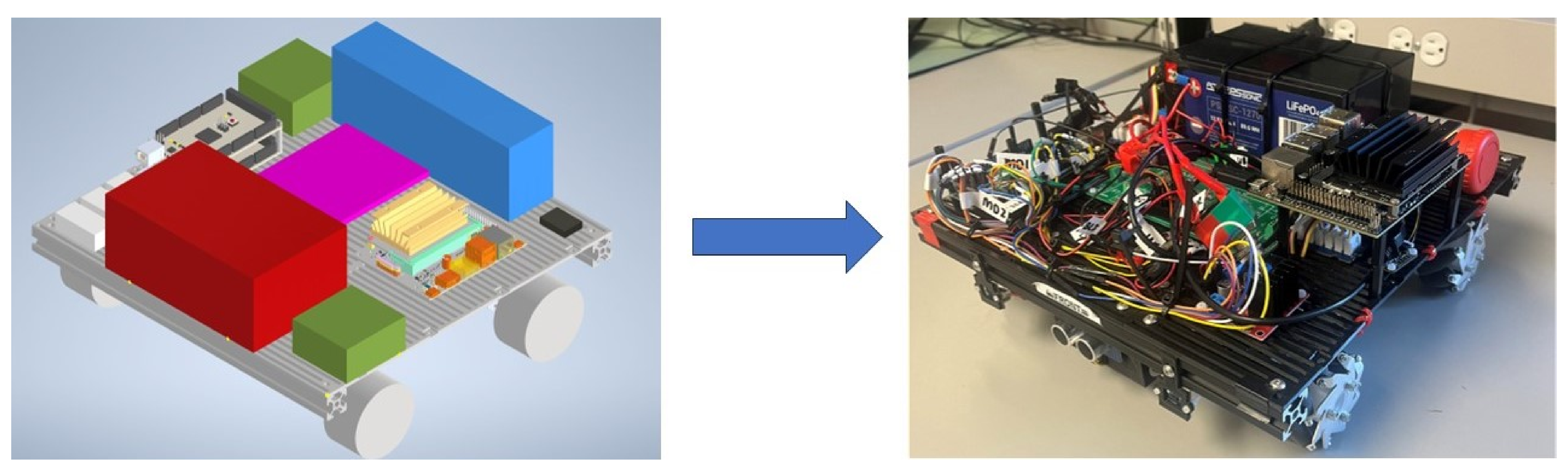

Figure 2. Modeled vs. Completed Robot

Top Row: Reid Crews, Isaac Hoese, and Isaac Jennings
Bottom Row: Mabel Olson, Abigail Kennedy, and Luke Chapman

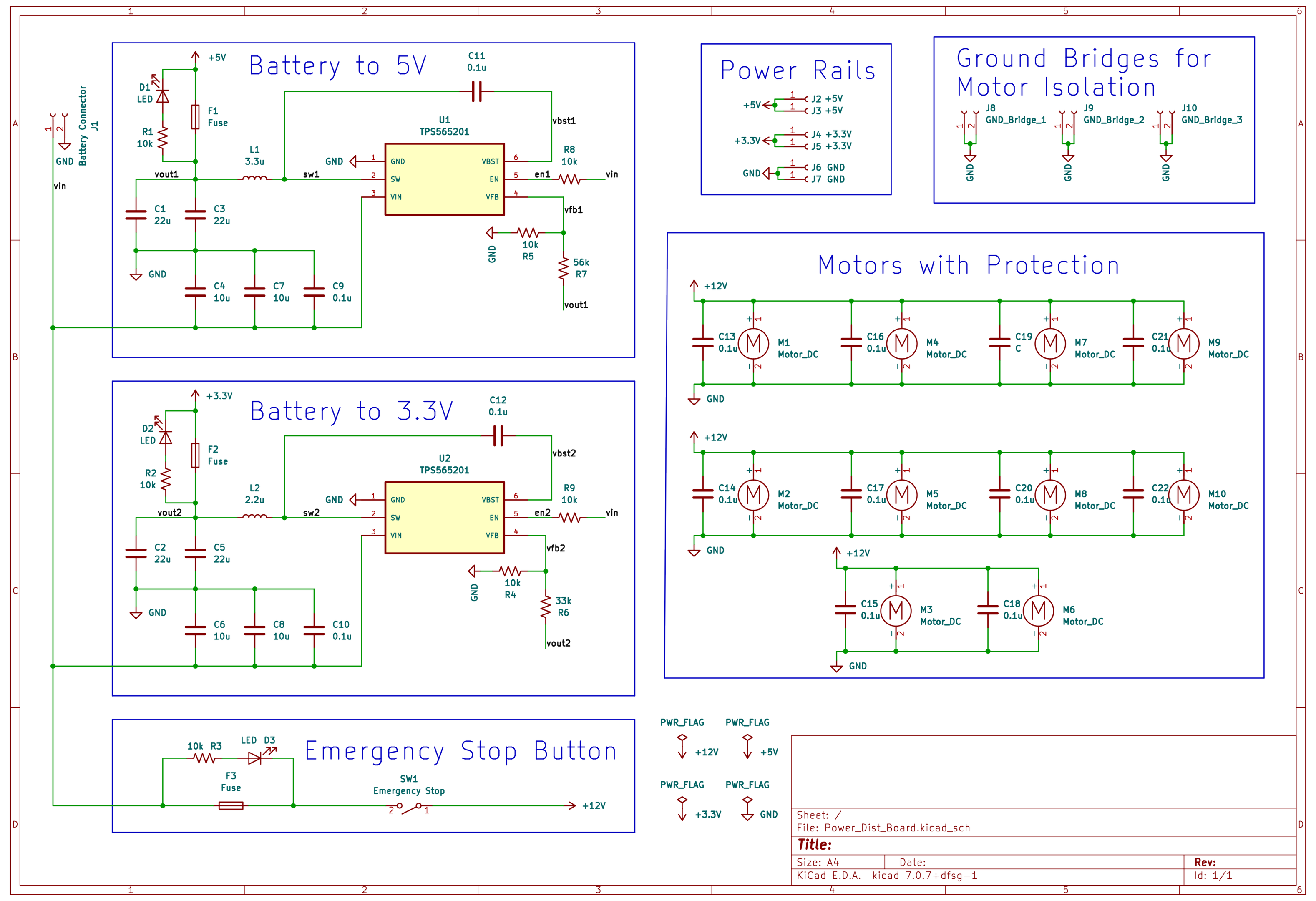

Figure 3. Power Distribution PCB Schematic

Experimentation

Capabilities

- The robot can autonomously navigate upon starting while moving 360 degrees, forwards, backward, and on inclines and declines up to 25 degrees.
- The robot contains modules that are plug-and-play and are adaptable for different applications.
- The robot has a robust, centralized power system that allows the robot to be used while the battery is being charged.
- Wireless charging was used to power an LED on the robot.

Figure 4. Location Error of Different Sensors

ROS2

The robot utilizes ROS2 and Slam toolbox for simultaneous localization and mapping (SLAM), and Navigation 2 was used for autonomous navigation development and written for maintainability.

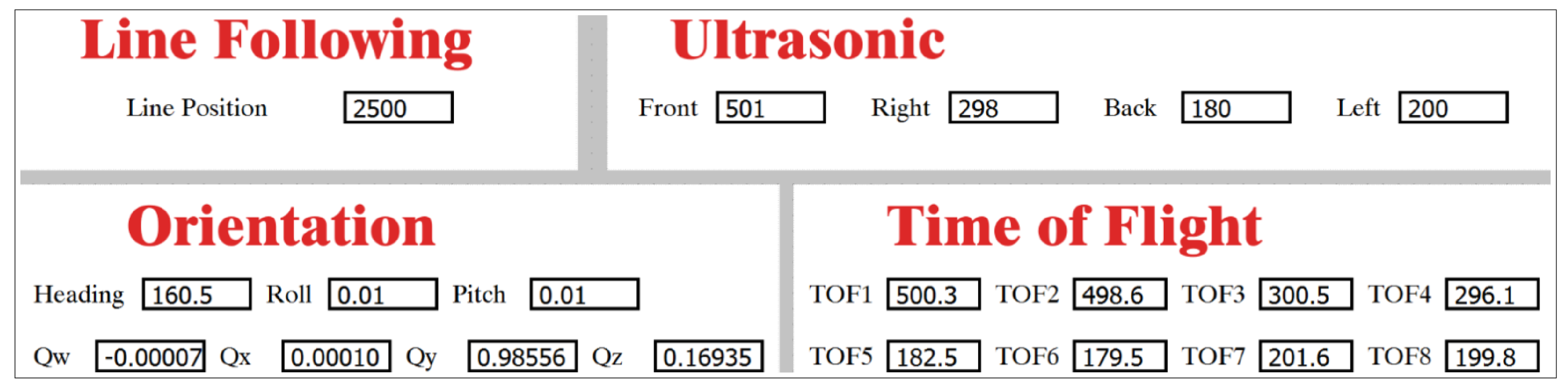

Figure 5. Real-time autonomous sensor readings

Conclusion

The team has successfully created a modular robot base. A foundation for a LIDAR-based robot has been laid, but it must be designed by future teams to fit the competition's needs. Wireless charging may also be explored further using capacitive wireless power transfer as detailed in the design documentation.

Proposed Budget	
Subsystem	Cost
Chassis	$245.00
Power	$730.00
Master Control	$150.00
Motor Control	$363.00
Navigation	$314.00
Wireless Charging	$0.00
Miscellaneous	$200.00
Total Cost	$2,002.00

Final Budget	
Subsystem	Cost
Chassis	$145.01
Power	$428.80
Master Control	$196.44
Motor Control	$318.73
Navigation	$424.23
Wireless Charging	$134.06
Miscellaneous	$0.00
Total Cost	$1,647.27

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GitHub: https://github.com/lchapman42/Control-Sensing-Wireless-Charging-Robot