# Formula 1/10th Racecar

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Electrical and Computer Engineering

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## Introduction:

Autonomous vehicle technology is slowly gaining attention on today's roads around the world. Without the need for a driver or human input, autonomous vehicles (AV's) or commonly referred to as self-driving vehicles require various input sensors and computational power to extract raw data from its environment and process this data for a programmable action. LiDAR (light detection & ranging) is the newest to the hierarchy of mapping technology. LiDAR uses pulsed laser signals to determine ranges by targeting an object or surface and measuring the time for the signal to return. The result of this is the ability to collect data and to map a three-dimensional model of the environment in which is being analyzed. Our design utilizes these technological concepts to map a given indoor environment and use this map with further implementation. The F1/10th racecar's low cost and easy setup allow for implementation in both consumer and manufacturing environments, thus providing easy access to local and global mapping capabilities.

## Testing:

Several tests were conducted to test both individual components as well as the AV system fully assembled. All initial individual testing was performed to analyze each components parameters and then factored into the full system. While a preferred operational speed was not outlined, test were conducted on the brushless motor individually to set a max rpm speed of the motor. To avoid draining our battery, we set our max motor rpm to 5,000 (<5 mph) to allow for the minimum 30 minutes of operation and to allow for the most accurate map representation as possible.

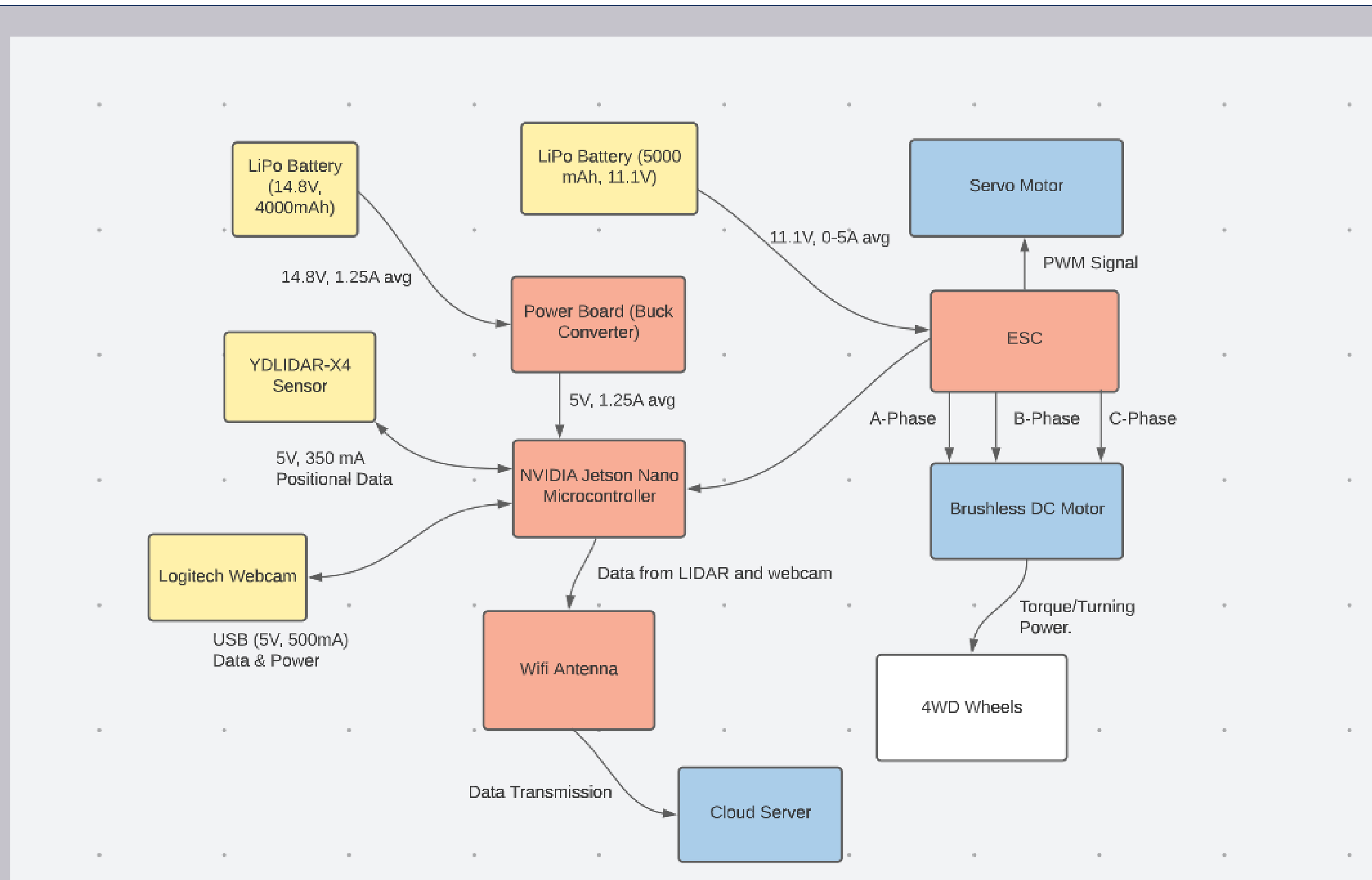


**Figure 1:** Illustrates the overall F1/10th autonomous vehicle system block diagram. One- way arrows describe the signal going one direction, and two-way arrows describe the signal going both directions.

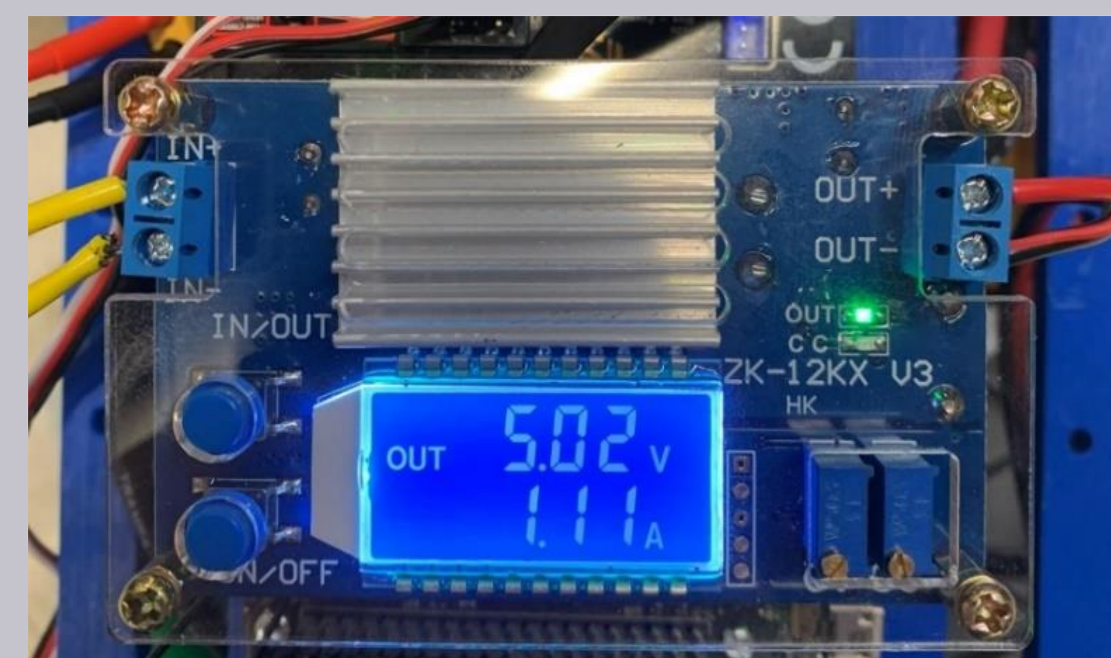

**Figure 3:** The power board's actual output current. Given the device's connected to the Jetson, we were expecting it to draw roughly 4A. The output current was much less than we anticipated drawing average 1.25A DC.

## Components and Design:

- For the power supply of the system, a 5000mAh 11.1V 3S battery was utilized to supply power to the electronic speed controller. A 14.8 V 4S battery was used to supply power to the microcontroller.
- We used a NVIDIA Jetson Nano Microcomputer as the center brains of the project, controlling the signals that operate the speed, turning direction, and braking capabilities.
- A DC-DC Buck Converter was used to step down the initial battery voltage of 11.1V to 5V to supply power to the microcontroller.
- A Logitech gaming controller was programmed to allow easy access controls of the system including a master throttle, emergency brake, and manual steering controls.
- An upgraded brushless 3-phase motor was used to drive the vehicle as it allowed for a higher torque/rpm output while considering the added drag weight of the electrical components.
- With the assistance of DET Alumni, Luke Mikesell, we were able to design a mounting board that mounts all major electrical components of the vehicle to the vehicle's main chassis.
- Finally, the primary mapping platform that was used, Rviz (Robot Operating System) allowed for simplistic illustrations of the mapped environment as well as live feedback of the vehicle in operation.

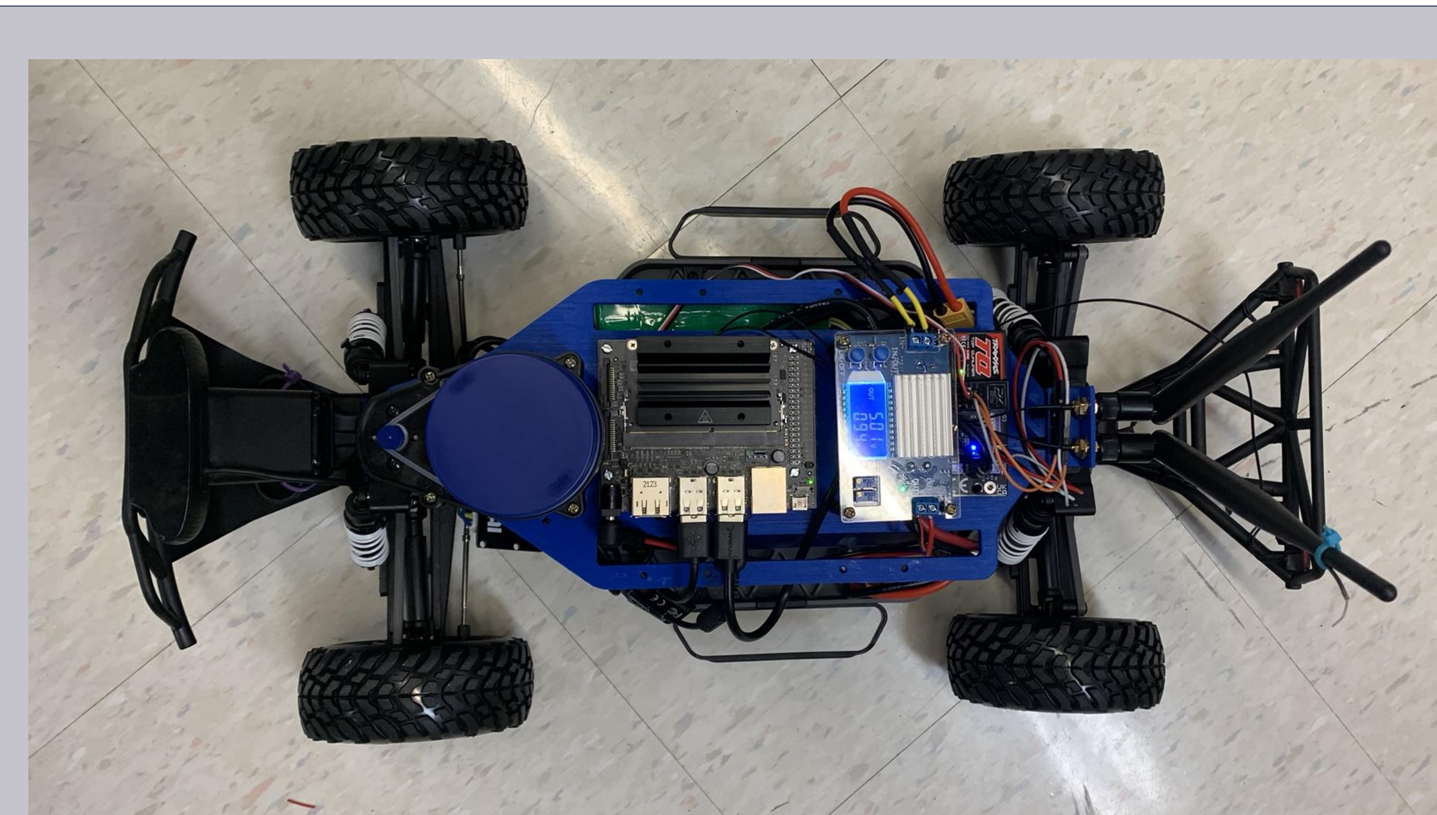

**Figure 3:** Shows the F1/10th autonomous vehicle fully assembled

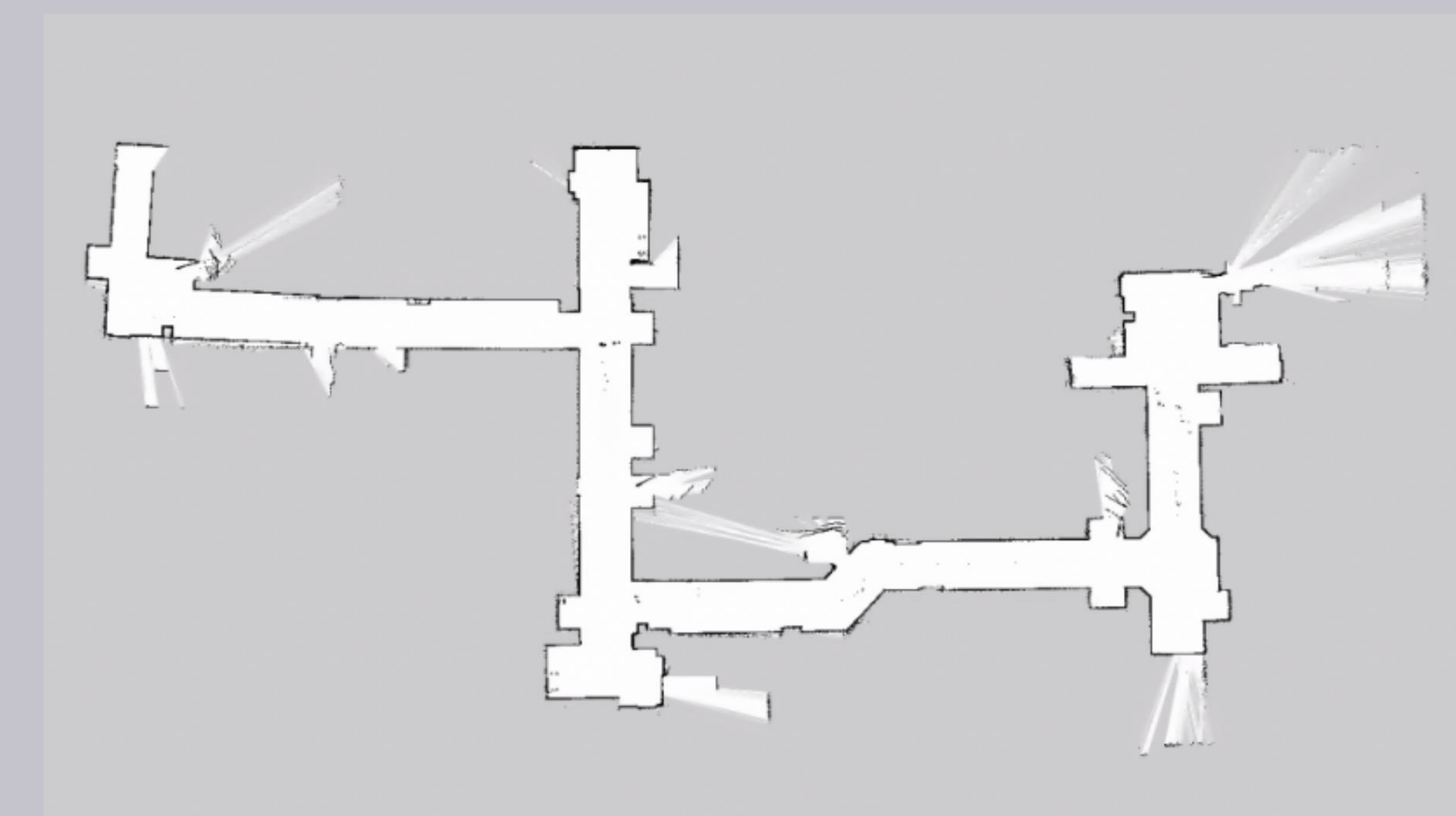

**Figure 5:** Illustrates the initial map rendering of the 2nd floor of Fawick Hall. A slow, steady speed and one full lap around the building yielded the best results during our testing phases of environmental mapping.

## Conclusion:

Our team created a mapping vehicle to provide rough estimate mapping and the ability of autonomous driving. A wall-following algorithm was used depending on the application of the mapping and autonomous behavior. The end-product is a system capable of drafting an environment in a visual form that can be used to survey an environment or in RC car racing competitions. The F1/10th racecar is also able to send the raw data collected from the LiDAR sensor to a cloud-based storage directory where algorithms can be fine-tuned for more efficient performance and accurate mapping output. Furthermore, the onboard webcam can record the drive time for a 1st person POV during operation.

## Future Work:

The following are ideas to further improve the Formula 1/10th Autonomous Vehicle:

- Constructing an enclosure to house the electrical components
- Consolidating all launch files into one compact launch file
- Creating a more in depth and user-friendly control interface
- Properly designing a buck converter for the microcontroller
- Including a more expensive, higher quality LiDAR sensor to provide more detailed 3-D environment maps

## Acknowledgements:

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