



Transcend Performance, Beyond Excellence

Centauri Motorsports: Autonomo

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Background

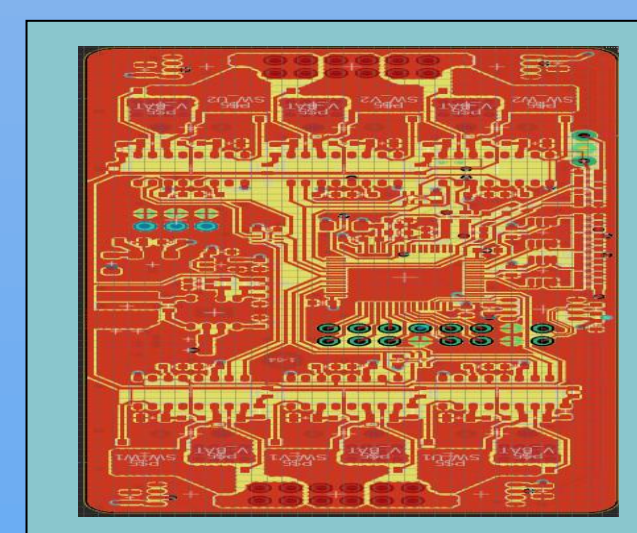
F1Tenth is a small-scale autonomous racing competition where teams build and program driverless race cars to complete a track as fast as possible. The event is a time-attack challenge: performance is measured by the total time to complete a set number of laps, so teams must balance speed, stability, sensing, steering, and throttle control.

Overview

Our design uses two vehicle concepts to separate low-speed autonomy validation from high-performance time-attack development.

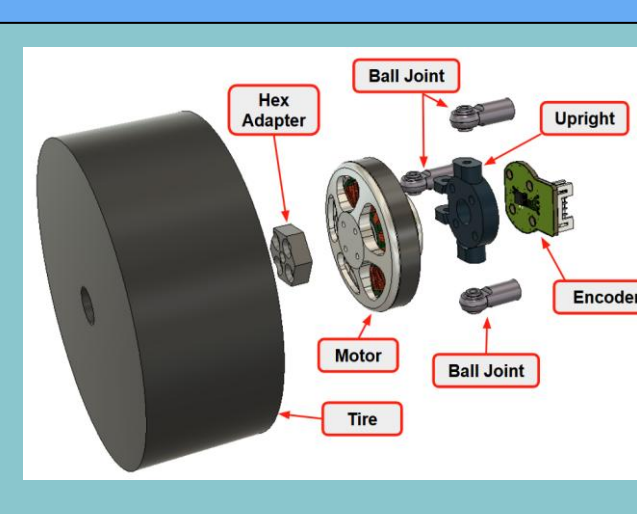
- Concept 1 proves the baseline pipeline: LiDAR sensing, Jetson compute, motor control, steering control, and Follow-the-Gap navigation.
- Concept 2 extends the platform with a lightweight chassis, lower center of gravity, stronger powertrain, encoder feedback, real-time datalogging, and advanced control strategies.

Hardware Components



miniFOCer Custom Inverter

Drives the brushless motors using compact, efficient, sensored field-oriented control. It receives commands from the vehicle electronics and converts them into motor phase power.



Brushless Motor

Integrated into the wheel assembly with an encoder so the system can measure wheel motion and support closed-loop motor control.



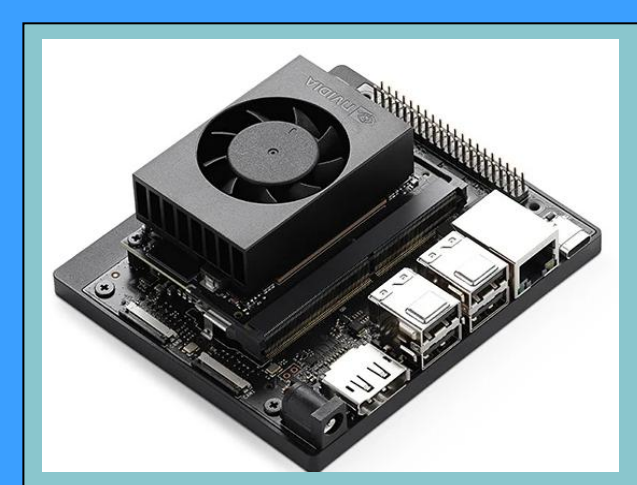
Servo

The servos receive PWM commands from the low-level control system and convert them into physical wheel-angle changes for cornering control.



Teensy

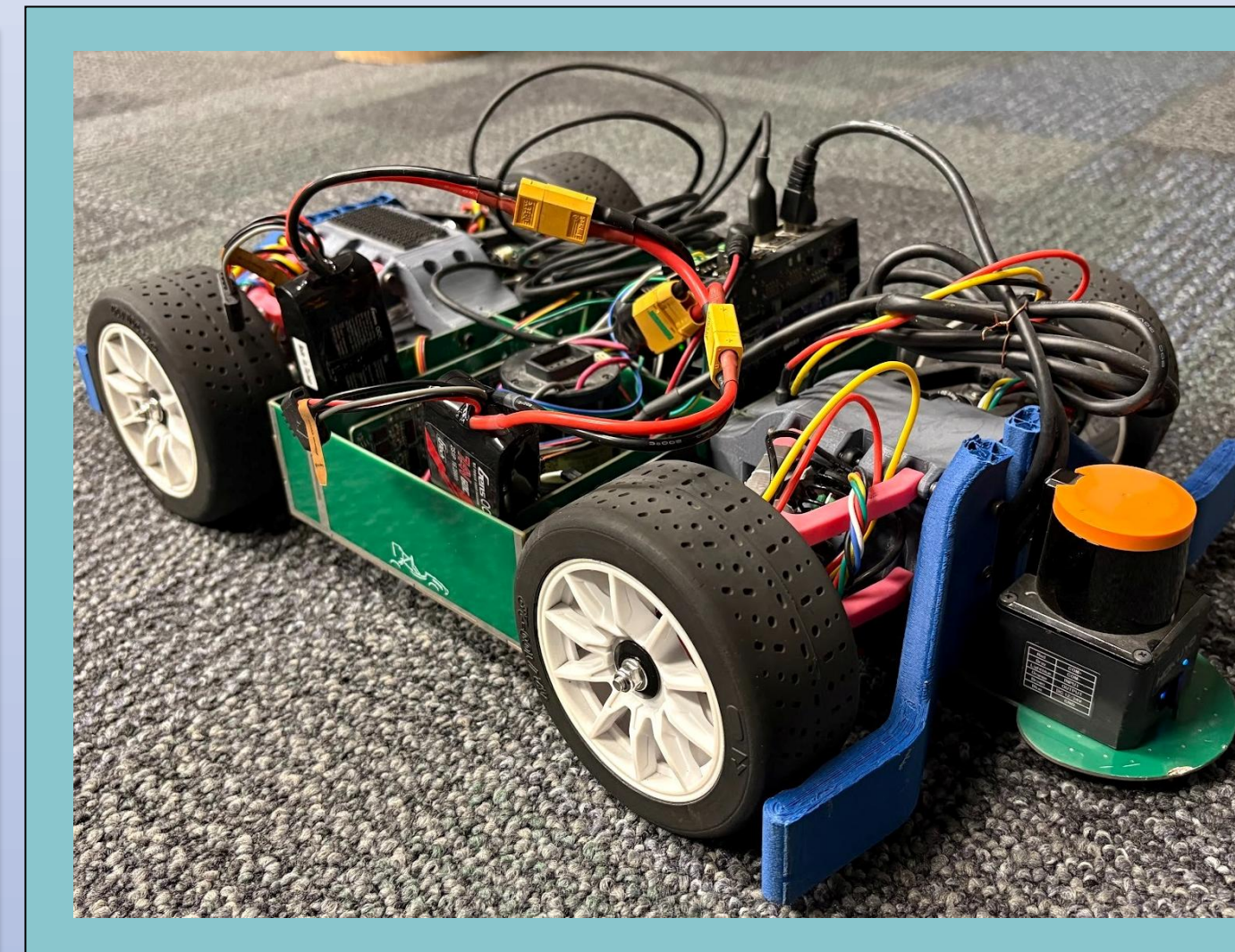
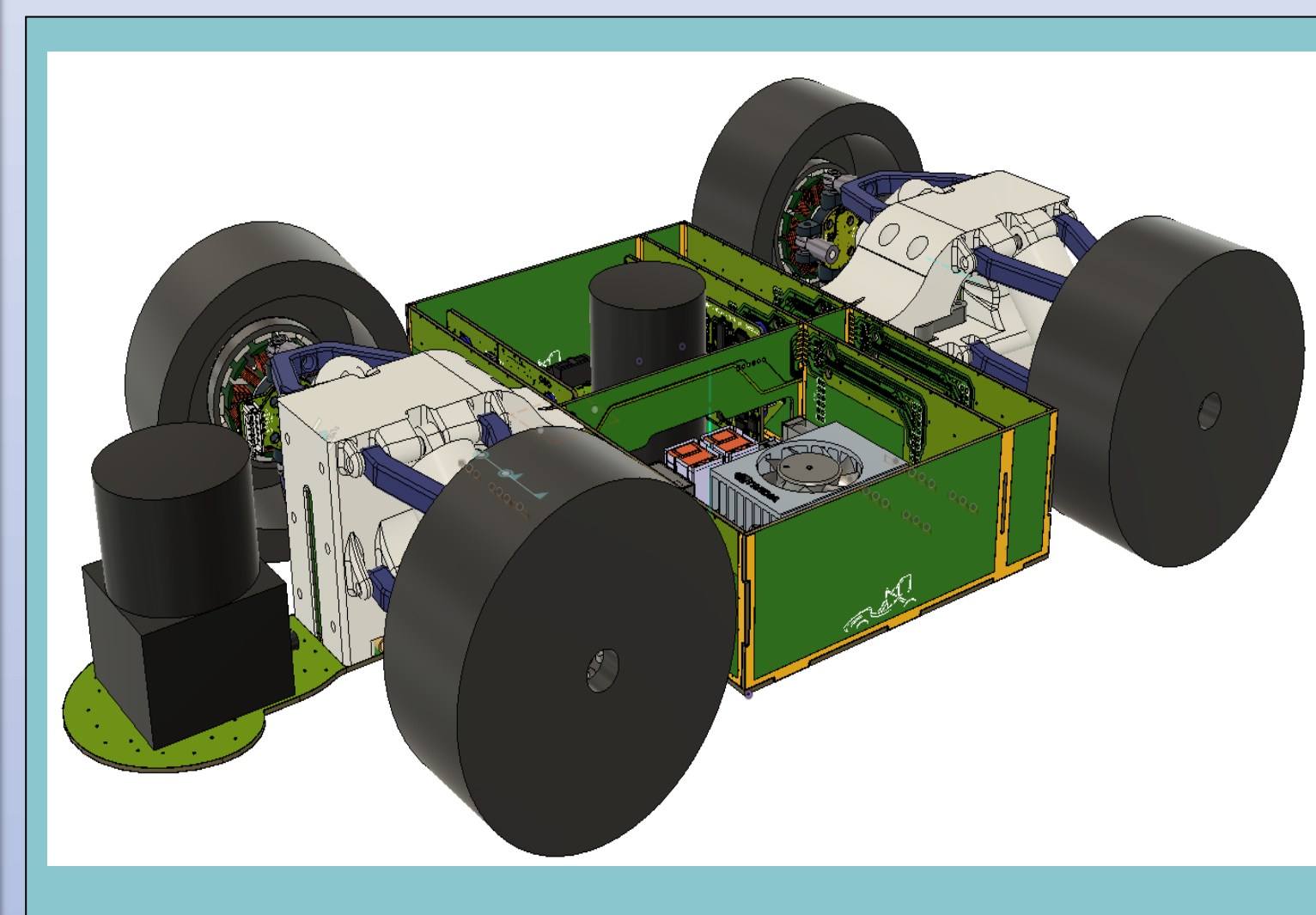
Low-level control interface between the Jetson and vehicle hardware. It converts high-level steering/throttle commands into actuator signals and handles communication with vehicle electronics.



Jetson

Processes LiDAR data, runs the autonomous driving algorithms, logs data, and sends steering and throttle commands to the low-level control system.

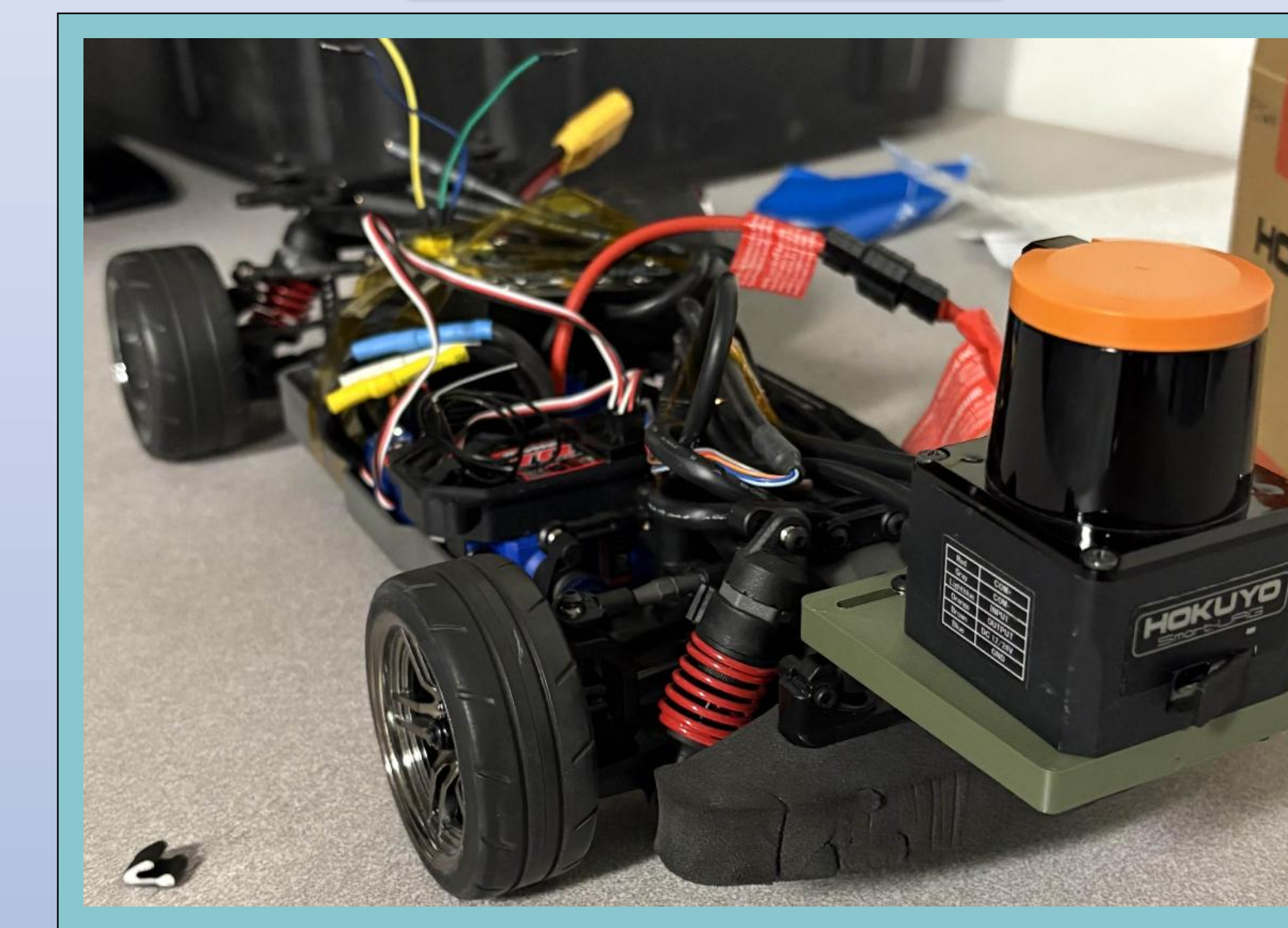
Concept 2



Goal: high-performance race-car platform for time-attack development.

- The vehicle uses a fiberglass chassis and custom suspension to reduce mass and lower the center of gravity.
- A stronger powertrain with miniFOCer inverters, quad motors, four-wheel steering, and torque vectoring supports higher acceleration and cornering authority.
- LiDAR, wheel encoders, and real-time datalogging provide feedback for tuning steering, throttle, and future advanced control algorithms.
- The target architecture supports higher speed, lower latency, and tighter vehicle-state feedback than the baseline car.

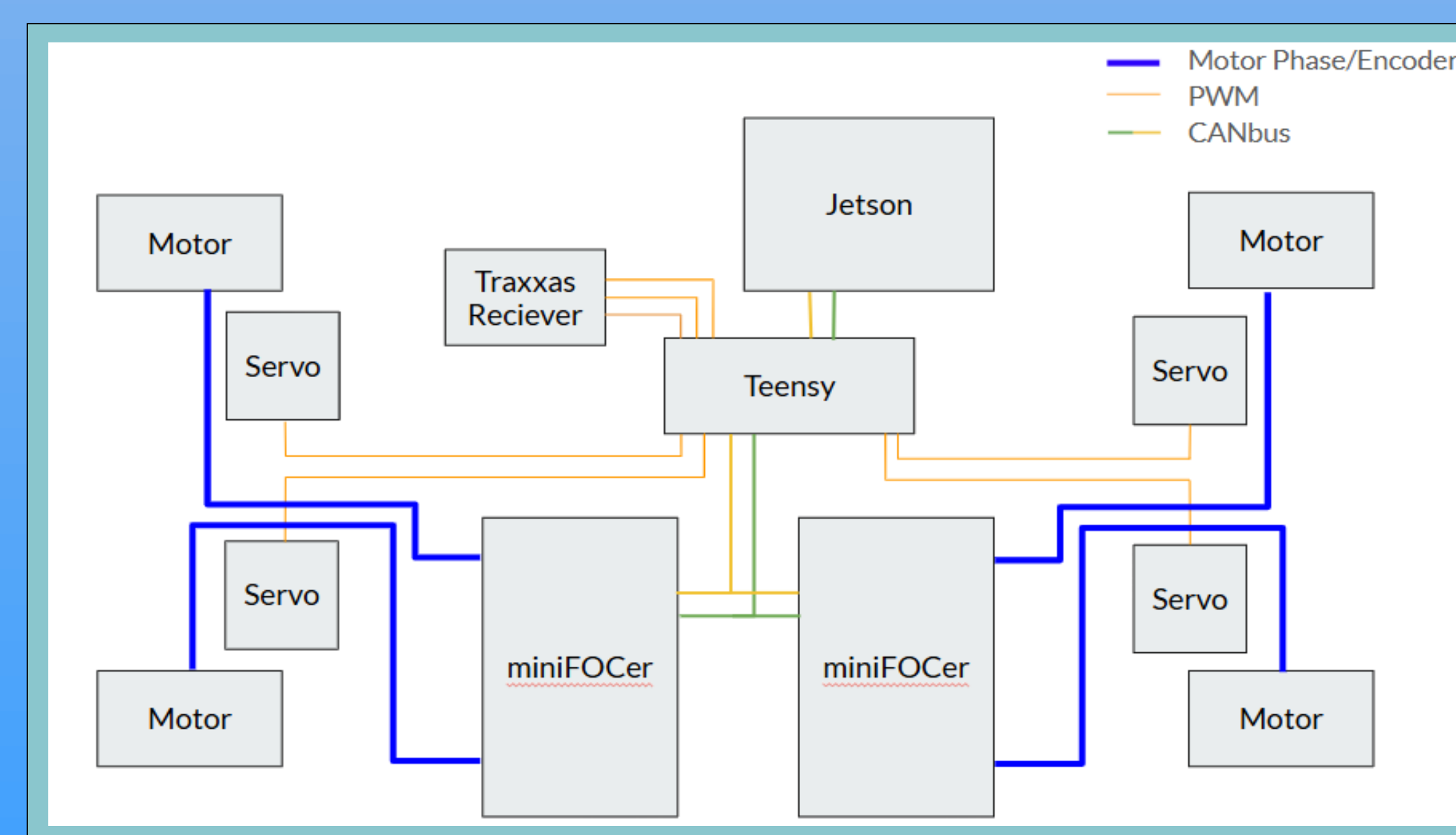
Concept 1



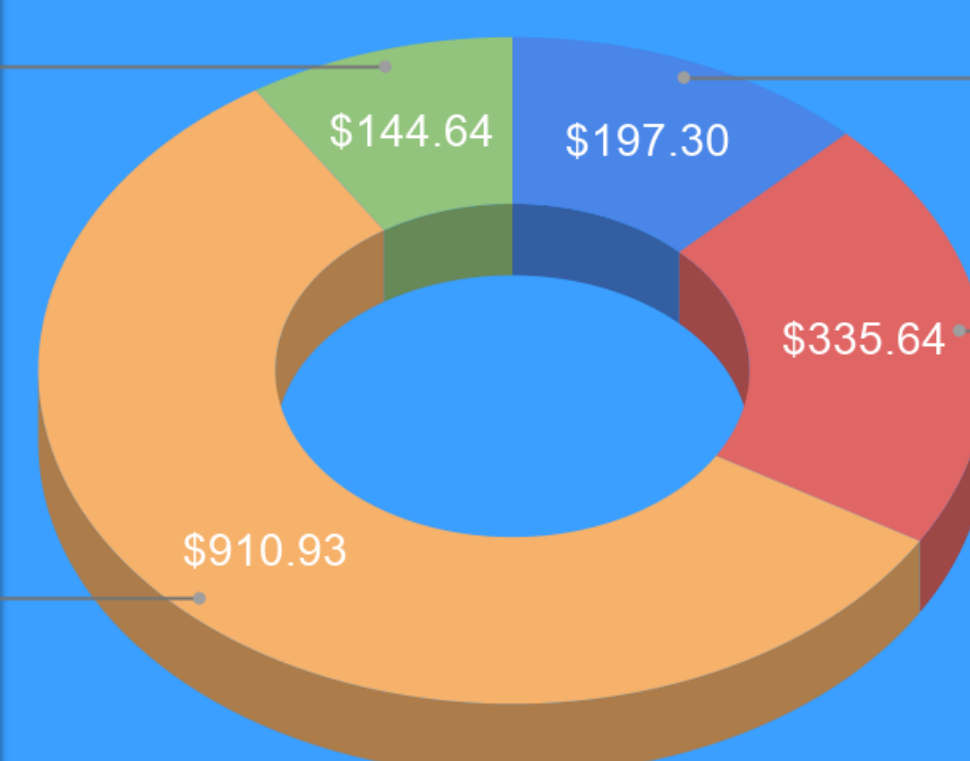
Goal: Build a simple baseline autonomous vehicle for early testing.

- Target speed of approximately 5 mph.
- Use LiDAR as the primary sensing method.
- Run a 30 Hz control loop.
- Test communication between the Jetson, motor controller, servo, and sensors.
- Use Follow-the-Gap as the initial low-speed autonomy algorithm.

Functional Flow Diagram



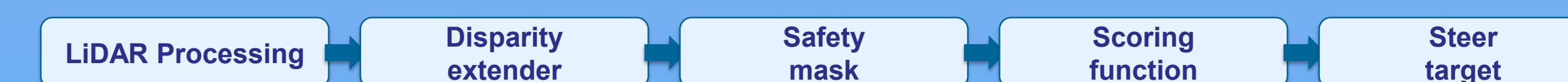
Finances



Budget: \$1,588 / \$3,500
\$855 / \$1,588 per product

Consumables (Green): Filament, tape, glue
Assorted Hardware (Blue): Tires, nuts, bolts
Control Electronics (Red): SSD, servos, connectors
Powertrain Electronics (Orange): Motors, inverter, PCBs

Autonomous Control Algorithm (FTG Disparity Extender)



The FTG algorithm uses LiDAR data to select a safe driving direction. The disparity extender detects sudden range jumps between adjacent beams, treats them as wall or obstacle edges, and blocks neighboring beams by a safety margin so the vehicle body does not clip obstacles.

$$\text{Score} = W_r \text{ range_norm} + W_c \text{ forward_pref} - W_a \text{ angle_norm} - W_s \text{ smooth_norm}$$

Here, *range_norm* rewards open space; *forward_pref* = $\cos(\text{angle})$ favors straight-ahead motion; *angle_norm* penalizes sharp steering; and *smooth_norm* penalizes sudden target changes. The highest-scoring beam becomes the steering target.

Acknowledgements:

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