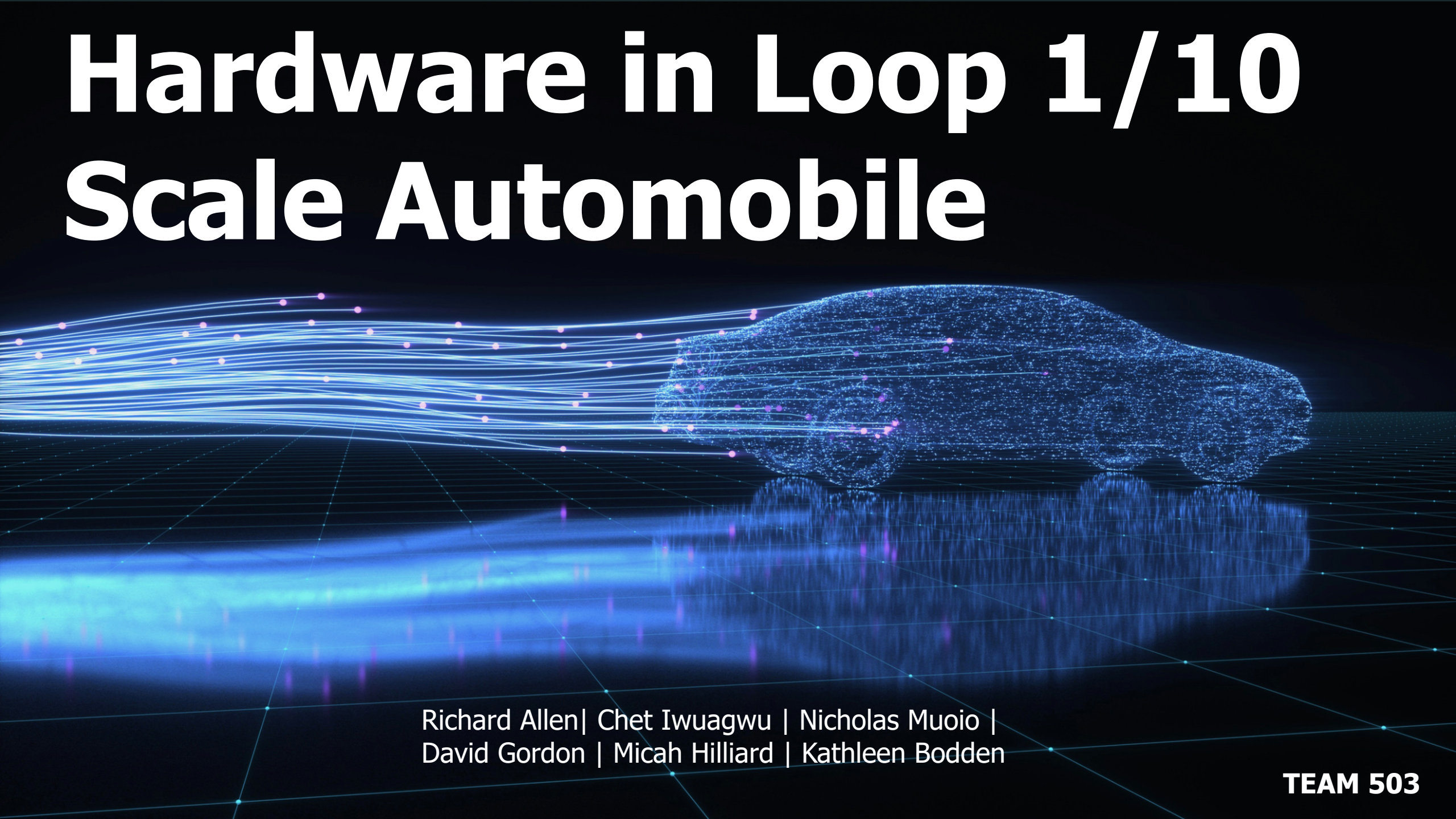
Hardware in Loop 1/10 Scale Automobile



Richard Allen| Chet Iwuagwu | Nicholas Muoio |
David Gordon | Micah Hilliard | Kathleen Bodden

TEAM 503

Meet Team 503

Richard Allen

Design Engineer

Micah Hilliard

Structural Engineer

Nicholas Muoio

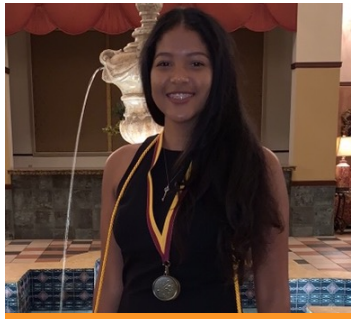
Controls Engineer

David Gordon

Hardware Engineer

Chet Iwuagwu

Software Engineer

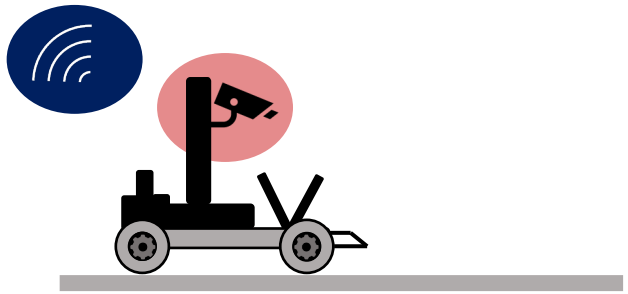


Kathleen Bodden

Research/Test Engineer

Project Objective

The objective of this project is to minimize inertial forces during propulsion and support object location software to keep up with chosen targets with autonomous features for object detection.



End Goal

End Goal

Sponsor & Advisor

Joann-Rochelle

Central Intelligence Agency

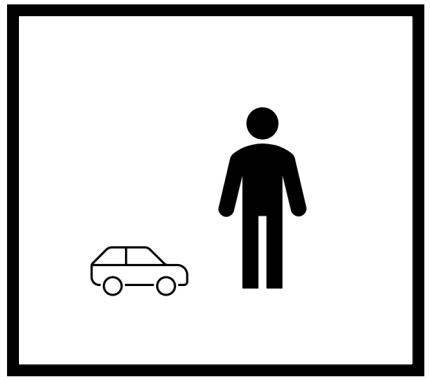
Dr. Camilo Ordoñez

FAMU-FSU
College of Engineering

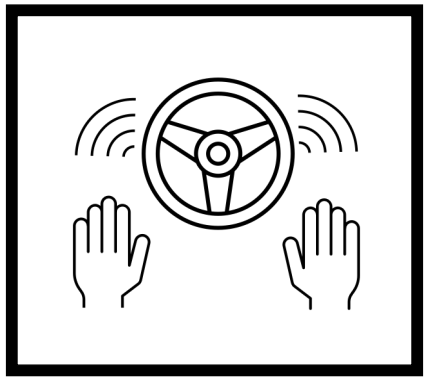
Stakeholders

TEAM 504

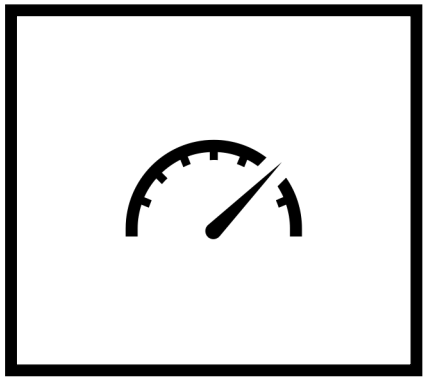
Key Goals



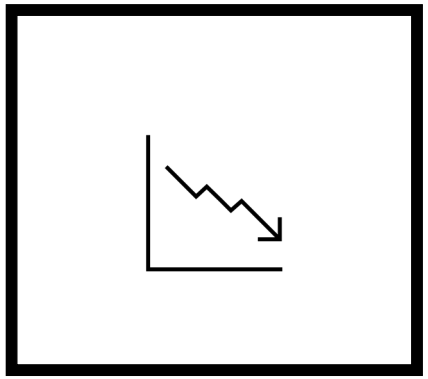
Small Scale Vehicle



Autonomous



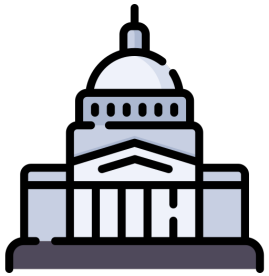
Maintain velocity



Minimize inertial losses

Markets

Primary
- Private and public government agencies
- CIA, FBI, etc.



Secondary
- Original Equipment Manufacturers (OEMs)
- Spyware enthusiasts
- Private search teams

Customer Needs

Question/Prompt	Customer Statement	Interpreted Need
What is the estimated weight of the design?	Must be able to carry a payload without impacting maneuverability.	Focus primarily on a lightweight design to compensate for the extra weight that will be added.
Is the design based on the F1tenth competition requirements?	Yes, but improve on the design to gear towards the CIA requirements.	Follow F1tenth specifications but optimize being able to keep up with a tracked target.
What is the estimated cost of the design?	F1tenth bill of materials approximates $3500.	Work adjacent with team 504 to combine budgets and determine which team is financially capable of buying what items.
What is the general design of the obstacles?	min: 12x12x30cm max: 35x32x30cm LiDAR perceivable material	Design the obstacle out of cardboard to be detectable by LiDAR, starting at one of the size extremes.

Question/Prompt	Customer Statement	Interpreted Need
Are the obstacles static or dynamic?	Both	Design for static obstacles first, then make the design more complex.
Define failure to avoid an obstacle?	The goal is to keep up with a target being tracked so, ideally, the design should not crash.	LiDAR specifications: detection range = 10 m scanning frequency = 40 Hz angular resolution = 0.25°
What speed is the vehicle operating at?	The average speed on a track is 35mph while the vehicle can go upwards of 70mph. Cornering and maneuverability affect speed.	Determine an optimal speed that does not sacrifice maneuverability. An even weight distribution can achieve an infinite critical velocity; however, acceleration will compromise weight distribution.

Assumptions

- Follows the requirements of the F1TENTH competition
- Operates on a Tarmac surface
- Detects and avoid obstacles
- Complete design in a year with monthly updates

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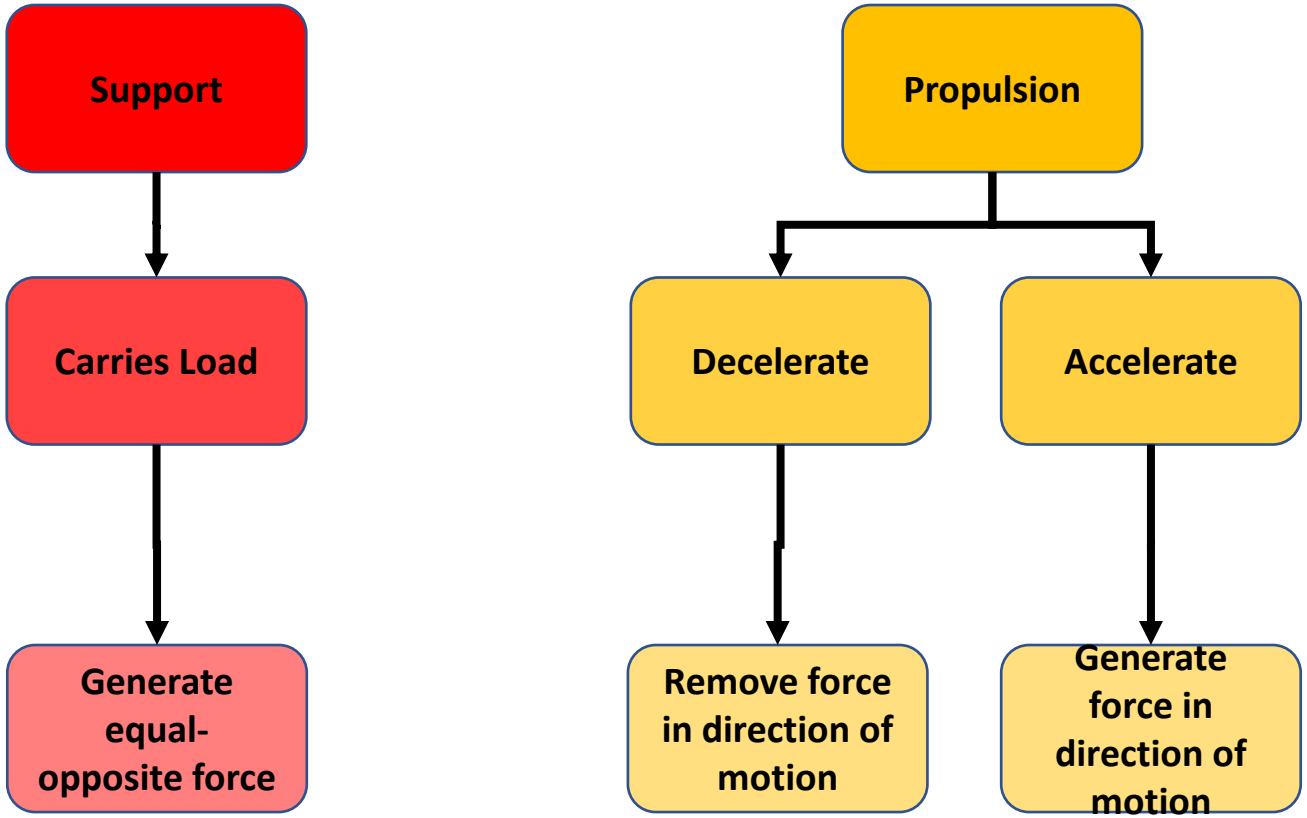
Functional Decomposition

Cross Reference Table

	Propulsion	Support	Signal	Navigation	Total
Generate force in direction of motion	X				1
Remove force in direction of motion	X				1
Generate Equal & Opposite Force		X			1
Generate Weight Distribution	X	X		X	3
Generate tire lateral forces				X	1
Generate tire longitudinal forces				X	1
Generate aerodynamic forces	X			X	2
Measure light Reflection from object			X	X	2
Measure tire speed and heading angle data			X		1
Measure and update position data			X		1
Total	4	2	3	5	

Functional Decomposition

Hierarchy Flow Chart



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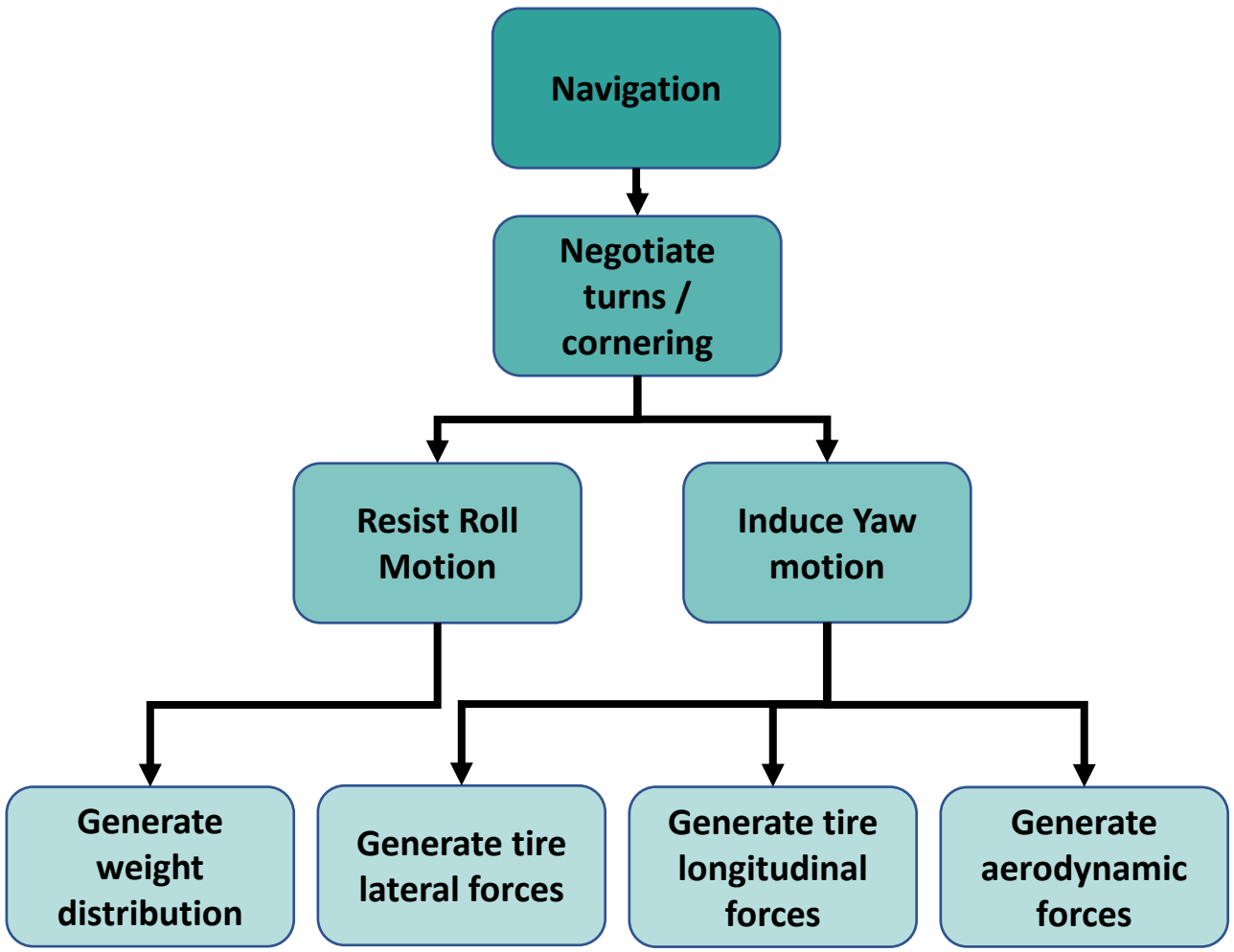
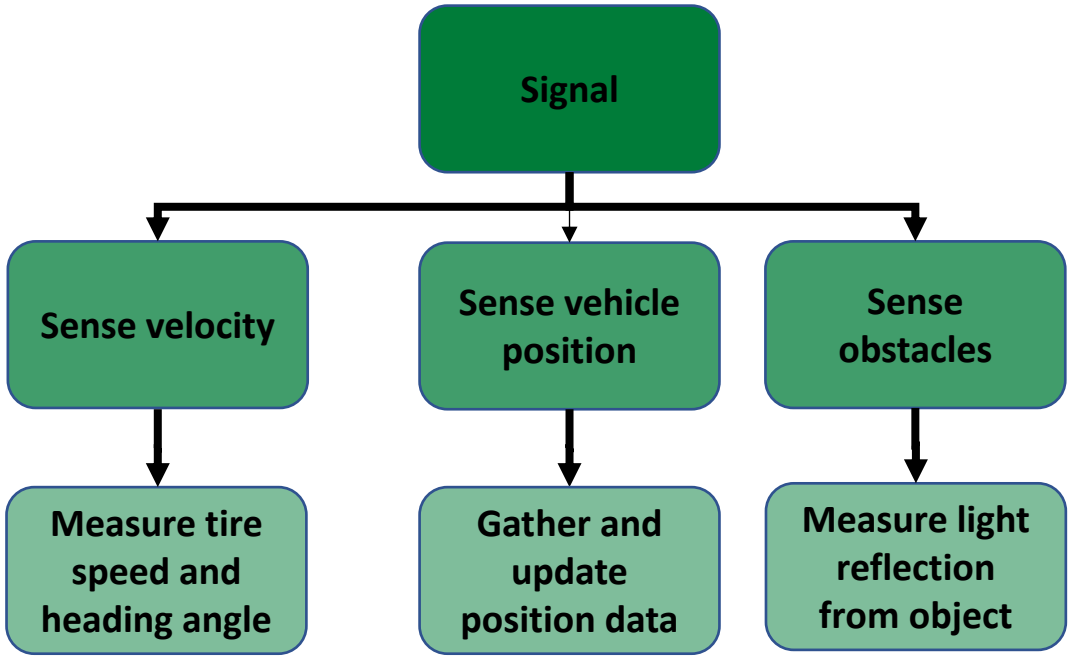
Hierarchy Flow Chart





TEAM 503

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Hardware in Loop 1/10 Scale Automobile

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F1Tenth Requirements

Restricted Class allows only cars that meet the following constraints:

1. The vehicle is constructed according to the official bill of materials. The teams are allowed to use components of similar or lower specifications.
2. Each vehicle will be inspected as a part of qualification whether it meets the criteria. In case the criteria are not met, the vehicle is moved to the Open Class.
3. **F1TENTH Competition is a battle of algorithms. Any hardware that should turn the odds in your favor is not allowed**.
4. *Chassis*: Any chassis listed as *1:10 scale* car is allowed. Preferably **1:10 Traxxas** (e.g., TRA74054, TRA6804R, TRA68086), but generally, any chassis with similar dimensions is allowed. Both 4WD and 2WD are permitted.
5. *Main Computation Unit*: **Nvidia Jetson Xavier NX**, Equivalents to the Nvidia Jetson NX (e.g. Nvidia Jetson TX2, Nvidia Jetson Nano), or anything of equal or lower GPU and CPU specification is allowed. Examples of possible computation units could be: Raspberry Pi, Arduino, Beaglebone.
6. *LiDAR*: **Hokuyo UST-10LX**, its equivalent, or anything of lower specifications is allowed. The main observed characteristics are: detection range (10 m), scanning frequency (40 Hz), and angular resolution (0.25°).
7. *Camera*: Both *monocamera* (e.g. Logitech C270, Logitech C920, Raspberry Pi Camera Module V2, Arducam) and *stereokameras* (e.g. Intel Realsense, ZED) are allowed.
8. *Engine*: Only brushless DC motors are allowed. The **Velineon 3500 kV**, its equivalent, or anything of lower specifications regarding power and torque are allowed.
9. *Other sensors*: Other sensors (IMUs, encoders, custom electronic speed controllers) are not restricted. Indoor GPS sensors (e.g. Marvelmind) are not allowed. In addition, in the spirit of the competition, components with significant internal computation power are prohibited.

Nicholas