Semi-Autonomous Multi-Terrain Buggy

Group 12
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1 Project Narrative

The exploration of hazardous and unsafe environments is an ongoing obstacle mankind is constantly trying to overcome. Whether it's the deepest trenches in the ocean, the peak of a mountain, or even into the furthest depths of space, we do our best to conquer the next frontier. In order to reach these goals, technology has been our greatest ally in assisting to achieve them. Vehicles, in particular, are one of the greatest technologies we have made to date. They're capable of transporting us through many terrains, such as: land, sea, air, space, and underwater.

The focus of this project will be on land based transportation. Being able to move across the ground faster than on foot is an important part of today's society. In fact, without modern vehicles, it would be impossible to live as we do. As our technology progresses, so do our vehicles. All modern transportation vehicles contain micro-controllers. These computers control all of the electrical components of the vehicle. Many higher end models have multiple computers that control different parts of the vehicle. Along with transportation vehicles, we've developed vehicles that were made to journey through inhospitable areas.

The most famous of these vehicles is undoubtedly Curiosity, the Mars rover created by NASA. Curiosity is a rover capable of semi-autonomous operation, which allows it to travel the harsh Mars landscape through limited autonomy, while also getting orders from a ground control team on Earth. Tesla is also creating semi-autonomous vehicles that are capable of navigating traffic, driving within road markings, and to some degree self driving without an operator in the vehicle. Closer to our project scope is an autonomous buggy made by Infosys, an Indian technology company. This buggy was retrofitted from an existing buggy, and adapted it to be able to drive autonomously using a "Drive-by-Wire" system developed by the company. Yamaha, a Japanese vehicle manufacturer, is also producing a driver-less buggy used for public transport and cargo transport.

The concept for our project is in the scope of all the vehicles mentioned in the previous paragraph. We aim to design a buggy capable of semi-autonomous driving and navigation with a feature rich web portal for statistics and control. This buggy will have an abundance of sensors on it to gather data about the surrounding environment. These sensors include: temperature sensors, humidity sensors, oxygen sensors, carbon dioxide sensors, ultraviolet sensors, particulate matter sensors, volatile organic compound sensors, ozone sensors, light sensors, ultrasonic (proximity) sensors, and multiple cameras. This data will aid in the study of the condition of the environment, and also give us insight to the habitability of the areas the buggy traversed. The buggy is being designed to comfortably transport 2 people while having storage for more equipment. The total payload goal for the vehicle is 400lbs, including occupants.

2 Requirement Specifications

- Must run a minimum of 3 hours.
- Must charge in a maximum of 8 hours.
- Must be able to maintain a manual driving speed of 32km/h.
- Must be able to maintain an autonomous driving speed of 8km/h.
- Must display correct GPS coordinates within 2m.
- Must be Wifi/GSM connected at 5Mb/s for live data transmission.
- Must be able to plan and execute routing within 10s.
- Screen must give feedback within 100ms.
- 2 seats for occupants with a 175lb limit each.
- Must be able to hold a maximum of 400lbs.
- Must detect external objects within 1000ms at 10m.

2.1 House of Quality Diagram

Marketing Requirements		Engineering Requirements: Price	Data Transmission Rate	Response Time	Weight Capacity	Low Power Consumption
		-	+	-	+	-
Long Runtime	+	↑↑	↓	↓	↓↓	↑↑
Quick Recharge Time	-	↑	X	X	X	X
Accessible/Easy to Use GUI	+	X	X	X	X	X
Reliability	+	↑↑	↑	↑	X	↓
Safety	+	↑↑	↑↑	↑↑	↓	↓↓
High Accuracy	+	↑↑	↑↑	↑↑	X	↓↓
Target		$7,500	5 Mb/s up-down	1 s	500 lbs	1.3 kWH

Legend
↑↑ Strong Positive Correlation
↑ Positive Correlation
X No Correlation
↓ Negative Correlation
↓↓ Strong Negative Correlation

Figure 1: House of Quality Diagram

3 Block Diagram

The block diagram shown below is all the current information we've been able to gather and compile so far. The group member's individual responsibilities are color coded. Some nodes have a border color, and this is used to represent if another group member will be assisting with the node, in which case the border will have the corresponding color of the group member assisting.

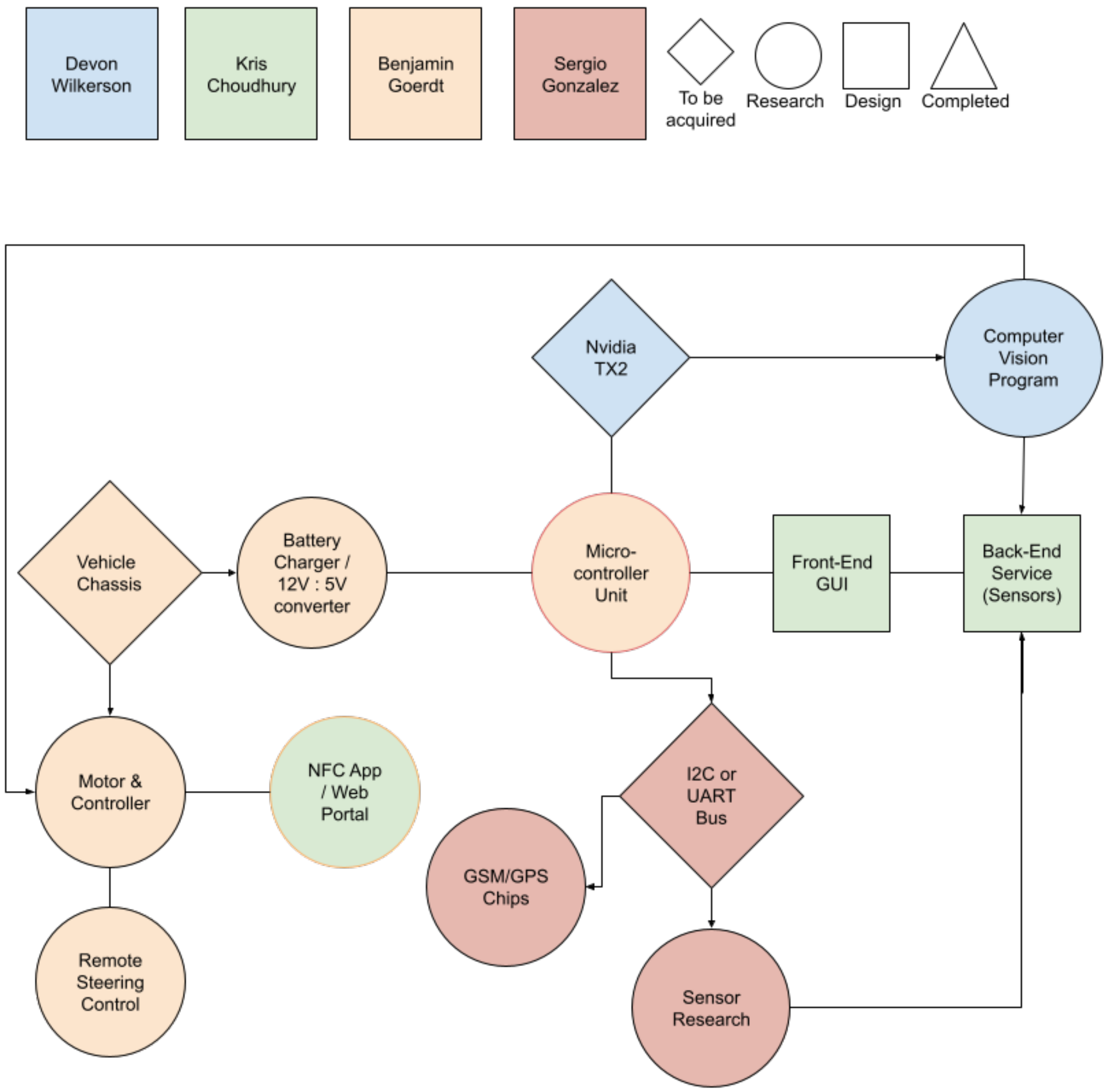

Figure 2: Block Diagram

4 Budget

The following parts list shows the components required for our project. Although all components are essential to the design, the most important components are the vehicle chassis and the Nvidia TX2. The chassis is the main component that we are building around, as it provides us with a rigid frame to add smart features too. The Nvidia TX2 will act as the brains of our buggy as it will be primarily used for computer vision. Machine vision will assist with with obstacle recognition.

The cost of our design has not been fully decided yet, mainly due to the fact that parts like the chassis do not have set prices and are entirely dependent on the seller and condition of the component. Alternatively we have the option to build the chassis ourselves which may prove to be cheaper in the long run. We are also still in the process of finding sensors that fit our performance needs, and getting a complete bill of materials. With that being said, the goal is to minimize overall costs but ensure quality components that meet our specifications.

As an estimate, our group has found golf-cart/go-kart chassis to be around $500 - $1200, while a hand made frame could be built for around $500 using wood, or metal. Sensors range from a couple dollars to multiple hundreds of dollars. As our design cycle progresses we'll be able to figure out which sensors to prioritize and spend more money on, and which ones we can afford to replace with a budget oriented option.

Item	Quantity	Price (Ea)
Chassis	1	$500-1000
Batteries	4	$100
Motor/Controller	1	$500
Solar Panel	Quantity	Price

Touchscreen Display	1	$150
Nvidia TX2 NX	1	$200
NFC Sensor	1	Price
UART/I2C Bus	1	Price
GPS chip	1	Price
GSM chip	1	Price
Temperature Sensor	1	Price
Humidity Sensor	1	Price
Oxygen Sensor	1	Price
Carbon Dioxide Sensor	1	Price
Ultraviolet Sensor	1	Price
Particulate Matter Sensor	1	Price
Stoplight Switch	1	$5
Volatile Organic Compounds and Ozone Sensor	1	Price
Light sensor	1	Price

Ultrasonic Proximity sensor	4	Price
Kinect Camera	1	$0
LED Headlight	2	$20
LED Taillight	2	$20
12V Relays	15	$2
12V - 5V Converter	3	$5
		Total (Unknown)

5 Project Milestones

The major milestones have been noted in the table below. As the design cycle progresses a more detailed timeline will be possible.

SENIOR DESIGN 1

Task:	Assigned to:	Start Date:	End Date:	Status:
Assign Group Roles	Group	05/27/2021	06/15/2021	Complete
Component Research	Group	05/27/2021	06/15/2021	Working
Initial Project Document	Group	05/27/2021	06/15/2021	Working

Start buying components	Group	06/15/2021	08/03/2021	Working
Micro-controller Design	Ben	06/15/2021	08/03/2021	Future
Computer Vision Design	Devon	06/15/2021	08/03/2021	Future
Sensor Implementation	Sergio	06/15/2021	08/03/2021	Future
GUI interface	Kris	06/15/2021	08/03/2021	Future
NFC App	Kris	05/27/2021	08/03/2021	Future
60 Page Draft Document	Group	05/27/2021	07/09/2021	Future
100 Page Final Document	Group	05/27/2021	08/03/2021	Future
Task	Person	Date	Date	Status

SENIOR DESIGN 2

Task:	Assigned to:	Start Date:	End Date:	Status:
Prototype	Group	TBD	TBD	Future
Testing	Group	TBD	TBD	Future
Final Build	Group	TBD	TBD	Future

Final Report	Group	TBD	TBD	Future
Final Presentation	Group	TBD	TBD	Future
Task	Person	Date	Date	Status