Autonomous Solar Powered Beach Buggy

Divide and Conquer

Team E

Members

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Sponsor(s)

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1.0 Project Description

The integration of solar-powered electronics into everyday technologies has introduced a new standard to sustainable design since the inception of the photovoltaic cell in 1954. Meanwhile, interest over autonomous features in automobiles has exploded in the past two decades. This project aims to synthesize these two elements within a beach-traversing vehicle, or “beach buggy.” This vehicle will autonomously transport one passenger safely across unpredictable terrain through the addition of path-finding software and proximity sensors. All of the on-board electronics, including the motor, will be powered by a battery that is charged by an attached solar panel during operation.

For the safety of the passenger and the surroundings, the vehicle will be equipped with various modes of operation. The autonomous operation can be initialized by the user and will travel at a low speed to a destination that can be determined by the user through GPS coordinates. The second mode of operation is the low-power mode, which is prompted on a user interface when the battery reaches predetermined levels and can again be initialized by the user. This mode limits the operation of the on-board electronics system to essential operations such as collision avoidance and motor control. The last mode is the manual mode. The manual mode is also limited to a low speed, but it can be steered, accelerated, and stopped by the user. The vehicle should successfully avoid hitting any stationary or moving obstacles in any mode independently of user input.

The passenger should be able to monitor the status of the vehicle through user-friendly displays, which will include the speed, solar irradiance as a percentage of maximum penetration, battery life, and GPS location with navigational directions and topographical information. This interface must be resistant to salt, sand, and water. Moreover, the vehicle frame should be constructed of salt, sand, and water-proof materials to protect the electronics and to extend the lifetime of the vehicle. This vehicle frame should also be lightweight in nature, yet sturdy enough to support the combined load of the solar array, passenger, and personal belongings.

Existing similar technologies include solar powered vehicles, which are commercially limited to golf carts, and autonomous electric vehicles, which are not commercially available for either roads or all-terrain environments. This vehicle will be able to harness both technologies to service two primary beach-related issues, namely transporting disabled visitors and carrying cumbersome items. Both of these issues can lead to injury. In addition, this vehicle must not cause any damage to the environment nor to the people and animals present. This product will thus fulfill a market need for safe, beach-friendly transportation.

2.0 Requirement Specifications

1. Autonomously traverse a 10 mile stretch of beach from Daytona to Ponce Inlet (and return) within an 8-hour time span
2. Capable of transporting one passenger (Max payload: 120 lbs.)
3. Top allowable speed is 3 mph
4. Run completely on solar energy
5. Must do no harm to environment and beachgoers
6. Detect and avoid both stationary and moving obstacles

3.0 CpE/EE Block Diagrams

The full system diagram in Figure 1 below shows all the major components needed to create a Beach Buggy and how they are connected to one another. The name below the block title denotes the team member responsible for the delivery of that object. No parts have been acquired at the time of presenting these block diagrams.

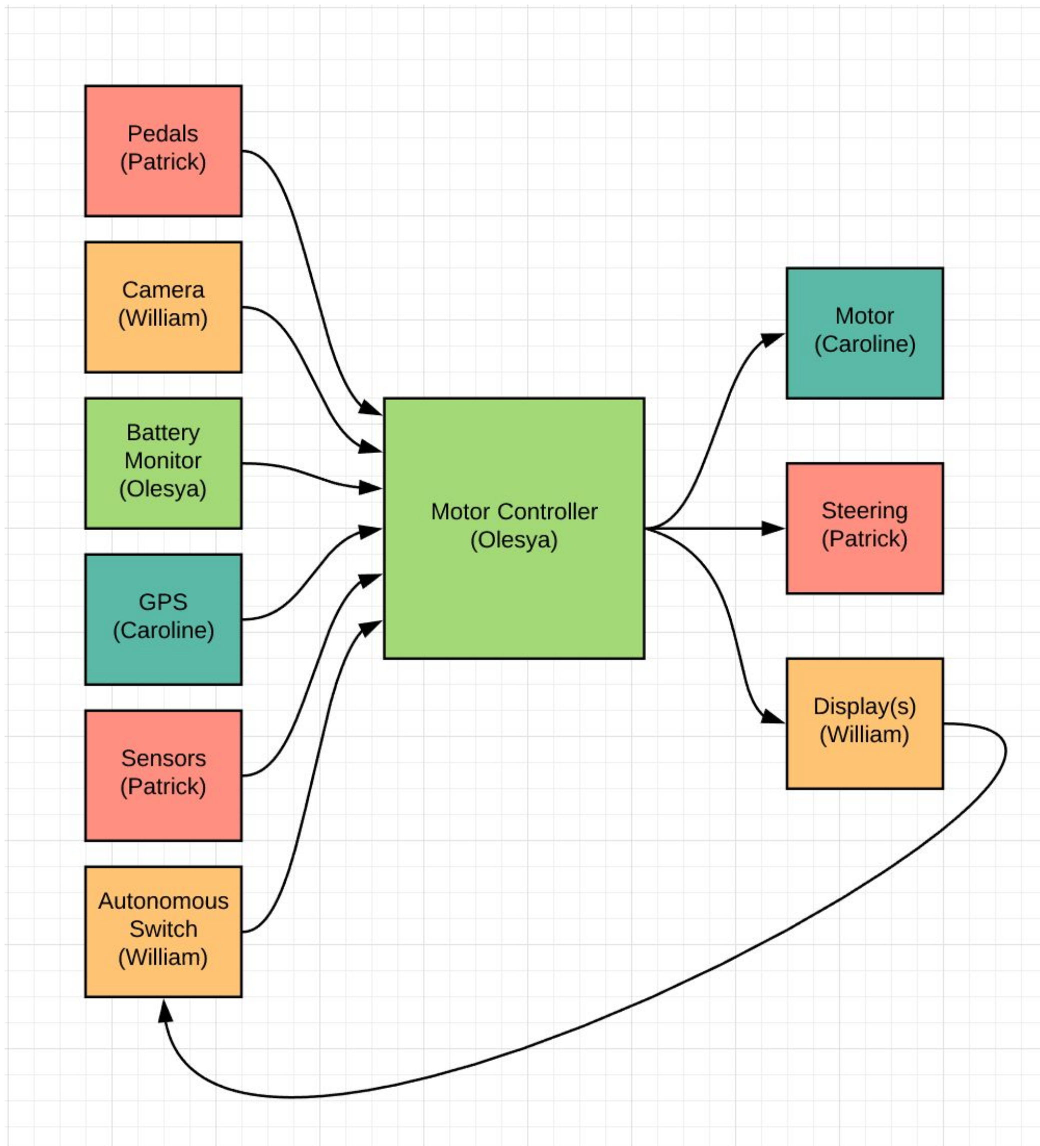

Figure 1. Full system diagram.

The below diagram of Figure 2 is a representation of a more detailed layout of the CpE/EE interface with the sensors and user input available to control the Beach Buggy. The name below the block title denotes the team member responsible for programming the applicable communications to or from that object.

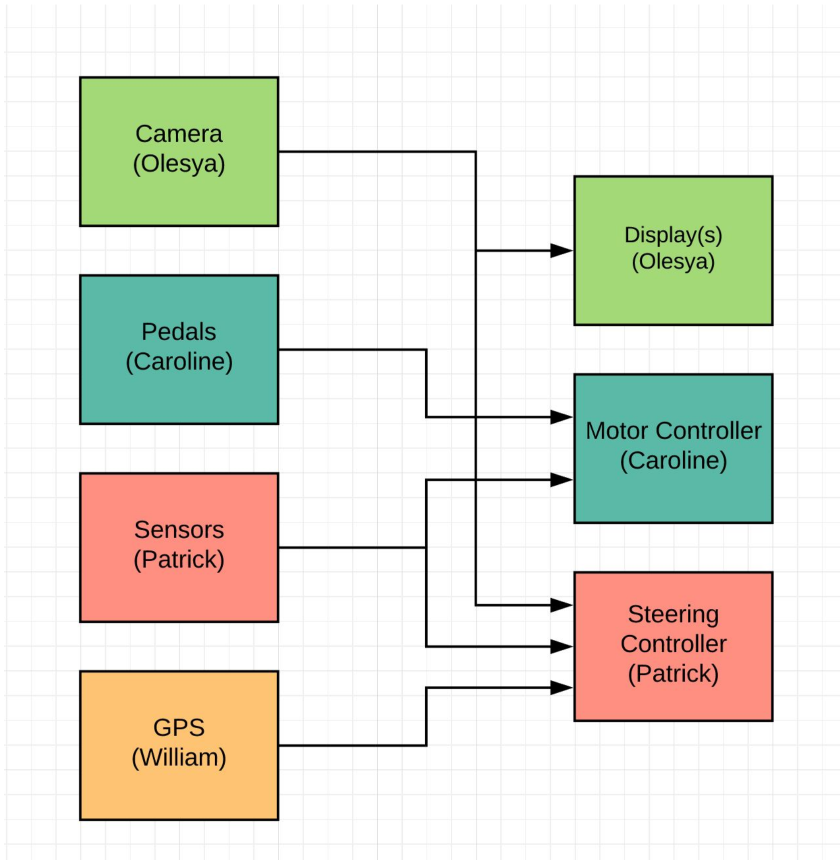

Figure 2. CpE/EE interface diagram.

The next block diagram in Figure 3 shows the representation of the power system for the Beach Buggy. The solar panel will be the primary means of charging the battery while the vehicle is in use, while a wall outlet will provide power to the battery while the vehicle is being stored. A charge controller will regulate the input current to the battery to preserve its lifespan. A converter will deliver energy to the display and to the motor controller, which will enable operation of the motor.

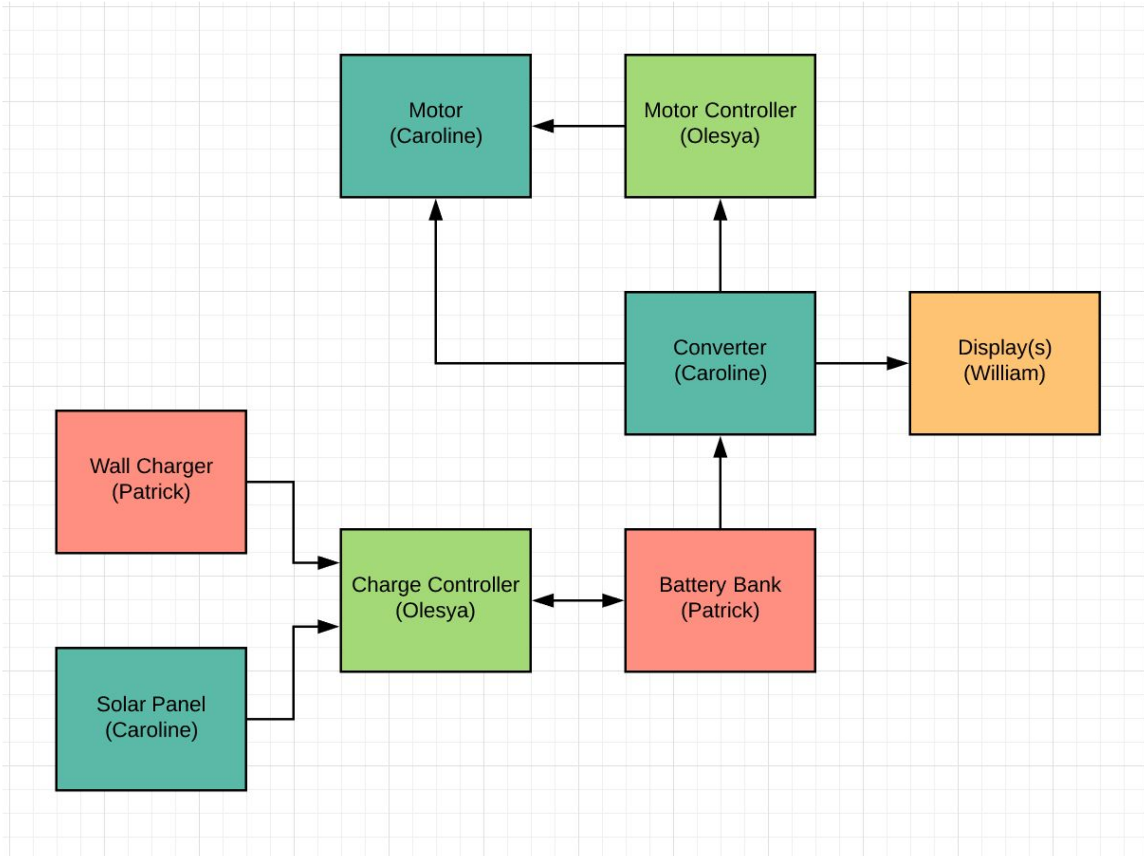

Figure 3. Power system diagram.

4.0 Project Budget

Table 1. Project Budget by Discipline

Team/Subsystem	Part	Estimated cost
EE: **Power System**	Solar panels	$600 (if not donated)
	Batteries	$500 (if not donated)
ECE: **Control system**	Microcontrollers	$150
	Sensors	$200- $300
	Misc.	$100
	LCD Screen (Display)	$100
ME: **Structure**	Cart, Motors, Breaks	$800
CS: **User Interface/Display**	N/A	N/A

		Total Cost: $2450 - $2550

The estimated cost for the control system and the power system will come to $1750 without any donated parts, as shown in Table 1. The team will request to borrow or recycle the solar panels and batteries after evaluating their performance during testing. There will be an investment on the computer vision system and any additional sensors that are needed to make this vehicle autonomous within the given time frame (2 semesters).

Below we have researched the components of the communication/control system that will give us the most likely success in meeting our goals of the level of autonomy desired for our Beach Buggy. This will allow the Buggy to travel from point A to point B without the need of user input. Table 2 incorporates our preliminary research. Meeting with the Software Team to discuss this project's goals will be critical as we identify the steps and components necessary to meet those objectives.

Table 2. Communication and Controls Preliminary Component Selection.

Component	Part Name/ID	Cost
Depth Camera	Creative Labs 3D Camera/BlasterX Senz3D 60FPS	150.99
	Intel® RealSense™ Depth Camera/D415	$149.00
	ZED 2k Stero Camera	$449
Proximity Sensors	TI Inductive Proximity Sensor AFE/LMP91300YZRT	$6.45
	OSEPP IR Proximity Sensors (2) /PROX-01	24.99
LiDAR Camera	Quanergy Solid State LiDar Camera/S3	$250
	LIDAR-Lite Laser Rangefinder/3	~$150

5.0 Milestones

Senior Design I:

- Week of Jan 22 - Decide on Initial Project Idea
- Week of Feb 12 - Research sensors, microcontrollers, motors and other electronic parts.
- Week of Feb 19 - Design protective circuits & power supply
- Week of Feb 26 - Design Beach Buggy Chassis
- Week of March 12 - Design, simulate, & capture schematics
- Week of March 26 - Research and Design Autonomous Algorithms
- Week of April 23 - Final Report
- Week of April 30 - Continue modifying and improving algorithm

Senior Design II:

- Week of August 13 - Purchase hardware components

● Week of August 20 - Build chassis, connect motors
● Week of August 27 - Build PCB and other protective circuits
● Week of Sept 3 - Build protective casing and outer shell components
● Week of Sept 10 - Build power supply
● Week of Sept 17 - Interface components and test for proper connectivity
● Week of Sept 24 - Test sensors, collect and graph data
● Week of Oct 22 - Test and modify algorithm
● Week of Oct 29 - Test the Solar Beach Buggy
● Week of Nov 19 – Improve upon the original design
● Week of Nov 26 - Make sure the project meets expectations and is working as intended
● Week of Dec 5 - Improve and fix any problems or issues before presentation