Senior Design: Divide and Conquer 1.0

Motor-Assisted Solar-Charging Cooler

Prepared by:

Group 14

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1. Project Description

1.1 Introduction

Spending time outside is something that every floridian can relate to. The joy of breathing in the fresh air while spending time with family and friends is a priceless experience. There are as many health benefits that can be received by spending time outside as there are social reasons, from football games (go Knights!), to relaxing by the ocean at the local beach. Although it's very beneficial, there are also risks that come with being outside for long periods of time. This is especially true here in Florida, where the temperature can easily rise to over 100 degrees fahrenheit. Staying cool and hydrated is a necessity; which is why, in 1951, the first cooler was invented. The cooler hasn't been improved very much since its inception and we're here to change that. Since Florida is the home of retired people, our product will be more handy and easy to use for them. So they do not need to worry about carrying stuff.

1.2 Motivation

In order to guarantee that our design is innovative, research was conducted on competitive products in the market of battery powered and "smart" cooler systems. There are, in fact, many products currently that have made improvements to the original design. For example, CostWay is selling a portable cooler/refrigerator which does not need ice, the refrigeration can be powered by 120v AC as well as it's 12v DC battery. Homedepot is selling the LiON Cooler which also boasts solar charging capabilities and a mobile app for refrigeration control as well as USB ports for personal device charging. Aside from the cooler itself, there are products designed to make it easier to transport the cooler from place to place. Through teamsportsgift.com, it is possible to buy a RC controlled cooler. There is even a cooler scooter on the market from saferwholesale.com.

The problem with the current products on the market is that none of them combine these features into a single machine. The biggest oversight in these smart coolers are the weight added by the refrigeration systems and battery. The average weight of the products mentioned, not including the motor-powered coolers, is 34 lbs empty. The current products that are motor-powered don't include any of the other, very desirable, features. Aside from the lack of other

features, the controls provided are not intuitive or even very useful. For example, the RC cooler requires the user to operate a controller which needs two hands. A fun toy but doesn't add much value. The second motor-powered example given is a scooter which is ridden by the user. This actually makes the cooler less useful as the user's weight is now added to the cooler and there is no hope of getting through beach sand or any outdoor trail, another fun toy that doesn't add value.

We want to combine the most important features of the previously mentioned smart coolers and add an intuitive motor-assist system that will not only counter the extra weight of the device but will make the entire system feel weightless to the user. This will allow people of all types to bring this cooler to any location they desire.

1.3 Goals and Objectives

This project aims to have a completed prototype of a motor-assisted, solar charging, portable smart cooler by the end of the next semester. There are inherent challenges in designing and completing this project and our goal is to prove that these challenges can be met. The prototype needs to be extremely efficient in order to provide both refrigeration and motor power. An intuitive user control system must be designed that requires no training and feels effortless to the operator. Of course, above all else, the cooler must keep contents below a threshold temperature.

1.4 Project Functionality

There are four main functionalities of this project: motor-assistance, solar charging, powered controlled refrigeration, and powered outlets for personal device charging. With these functionalities the user will be provided with the essentials needed for any outdoor recreational activity.

2. Requirements and Specifications

2.1 Specifications

Housing

Feature	Spec
Internal Volume	13.6” x 7.3” x 9.5”
USB charging ports	2 x USB 3.0
Internal battery charging ports	1 x 120v AC
Mechanical Solar Panel Support	18.1” x 13.8” x 1”

Drive Module

Feature	Spec
Drive Motors	2 x 12 volt DC motors with internal position sensors
Motor-assist Reaction Time	100 milliseconds
Maximum speed	5 mph
PID controller	Texas Instruments MSP430 @ 25 MHz

Battery and Solar Panel

Feature	Spec
Operating Hours	10 hrs
Output Voltage	12v
Solar Panel	12v 10W
LCD	32*2

Current Sensor	0-30A
Voltage Sensor	0-25V
MCU	Microchip or Texas Instruments

Housing Components

- 4 wheels
- Steering mechanism
- 2 USB ports
- Charging port for internal battery
- Mechanical solar panel support
- Powered drive motors

Drive-Module Components

- Drive motors
- MCU for user interface control
- Brushless DC motor controller

Battery

- Lithium-Ion
- 12 volt output
- LCD display

Power Distribution Components

- Route power to all modules with correct power level at each module
- Voltage regulated at multiple levels for different outputs: 5v, 12v, 3.3v

Solar-Charge Module Components

- 12v panel
- Charge controller: Must be correct controller for specific battery

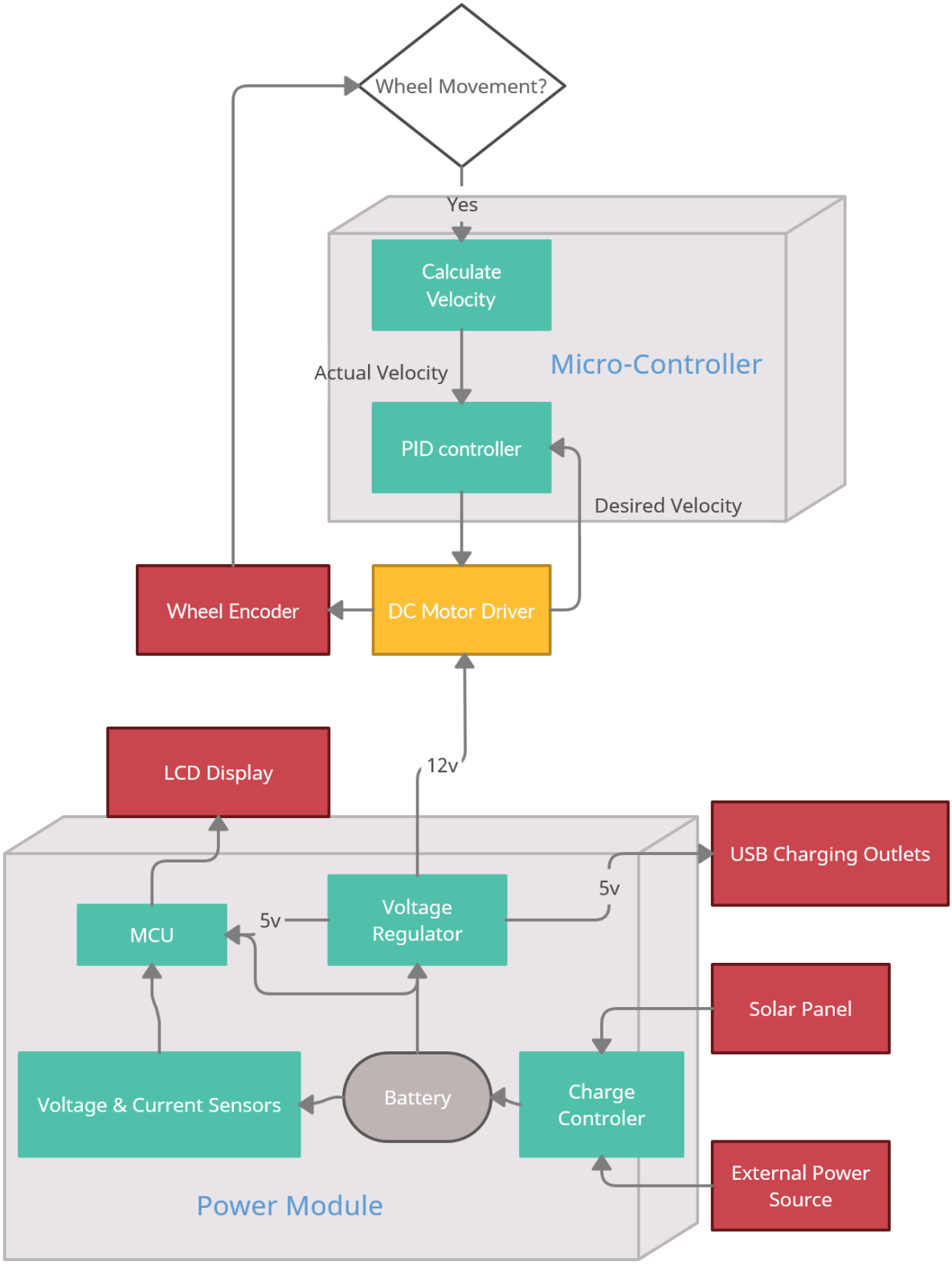
2.2 Requirements

The project combines different areas of study which include control, embedded and energy. The requirements include proper movement of the prototype based on user input, at least two outlets for charging personal devices. In the solar part the goal is to make the solar system smart enough to show the current status of the battery at any given time and as well as current and voltage values on LCD. If time permits then one more feature is also in consideration which will avoid the overloading on the wagon incase if user puts in more load than expected. It is also required to do some arrangements to avoid overcharging of the battery.

2.3 Constraints

There are quite similar products available in the market but none of them include all the features combined together. Our main challenge is to develop a prototype by combining all the features at an affordable cost. The second constraint is to meet all the specifications on time. The main part of the project is to implement a PID controller. It could be tricky as well as frustrating especially when dealing with sensors and finding out a solution with negligible errors. A third constraint will be our budget and financing.

3. Project Block Diagram



4. Project Budget and Financing

Component	Price
DC Battery	100$
Current and Voltage Sensor	30$
Solar Panel	80$
LCD	10$
Electronics Parts	40$
MCU (Controller)	10$
DC Motor	2 x 25$
PID Controller	70$
Wagon	150$
Total	540$

5. Initial Project Milestones

5.1 Senior Design I

Due Date	Deliverable	Steps to complete
5/21/2021	Senior Design Project Ideas	1) Individual's idea submissions for the potential projects 2) Team agrees on one idea
6/11/2021	Divide & Conquer 1.0	1) Independent research 2) Team meetings to collaborate
6/25/2021	Divide & Conquer 2.0	1) Meeting with Dr. Richie to go over v1.0

		2) Team meeting to formulate plan 3) Independent Research 4) Team meetings to collaborate
7/9/2021	60-Page Draft Senior Design Document	1) Team meeting to formulate plan 2) Independent Research 3) Team meetings to collaborate 4) Team meeting to proof-read before submission
7/23/2021	100-Page Report Submission	1) Independent research to elaborate on initial document parts 2) Team meetings to collaborate 3) Team meeting to proof-read before submission
8/3/2021	Final sd1 Document	1) Team meetings to review the 100-page report 2) Independent work to make changes/corrections. 3) Team meeting to proof-read before submission

5.2 Senior design II

Due date	Deliverable	Steps to complete
September/ 2021	Initial PCB design	1) Order parts required 2) Team continues to update documents
October/ 2021	Finalize design for PCB and project prototype	1) Test to ensure all the parts function properly 2) Fabricate, assemble and debug 3) Have the final physical design revised 4) Complete the final physical design

November/ 2021	Final document	1) Work on conference paper and SD2 final document
December/ 2021	Final presentation	1) Team prepares for final presentation 2) Present and conclude project