Self Sustainable Electric Golf Bag

Project Proposal

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Introduction

1.1 Project Statement

This project was chosen because we feel there is a need to be able to keep beverages cool while enjoying a round of golf without the hassle of walking back and forth between the clubhouse. Currently, there are no similar items on the market that can complete this goal while also providing the added features proposed within our golf bag. Our group has had experience with golfing, and each member is excited about the idea of a golf bag that does more than simply hold your clubs. This is also a great opportunity to learn new concepts while also applying those we have learned throughout our academic careers.

1.2 Objectives:

Goals:

- Create a solar rack that can be easily attached to a golf bag
- Design a cooling system that has variable temperatures
- Create a digital scorecard used to keep score
- Enable charging of battery via home outlet
- Allow charging of USB devices from on-bag battery

Functions:

- Solar Panel or AC input acts as source of power, charging battery
- Microcontroller used to regulate temperature as well as keep score
- Thermoelectric modules used to heat/cool insulated pouch
- Power electronics used to ramp up/step down voltages as needed
- LCD with keyboard to display temperature and score

Benefits:

- Allows golfers to have cold beverages in warm weather and vice versa
- Can now enjoy a round of golf without worrying about phone charge
- Can power any USB device
- Keep score in an easy to read format
- Have the most advanced golf bag on the course

Features:

- Heating and cooling pouch
- Temperature control via keyboard control
- Digital Scorecard displayed via LCD
- USB power
- Solar power
- AC outlet charging capabilities

Design

2.1 Block Diagram

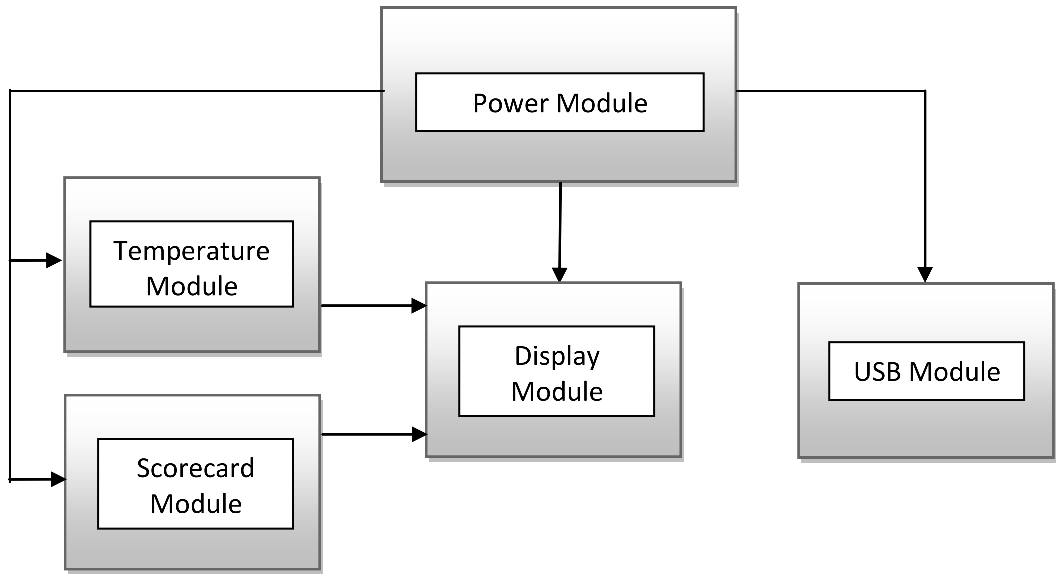

Figure 1: Top Level System Layout

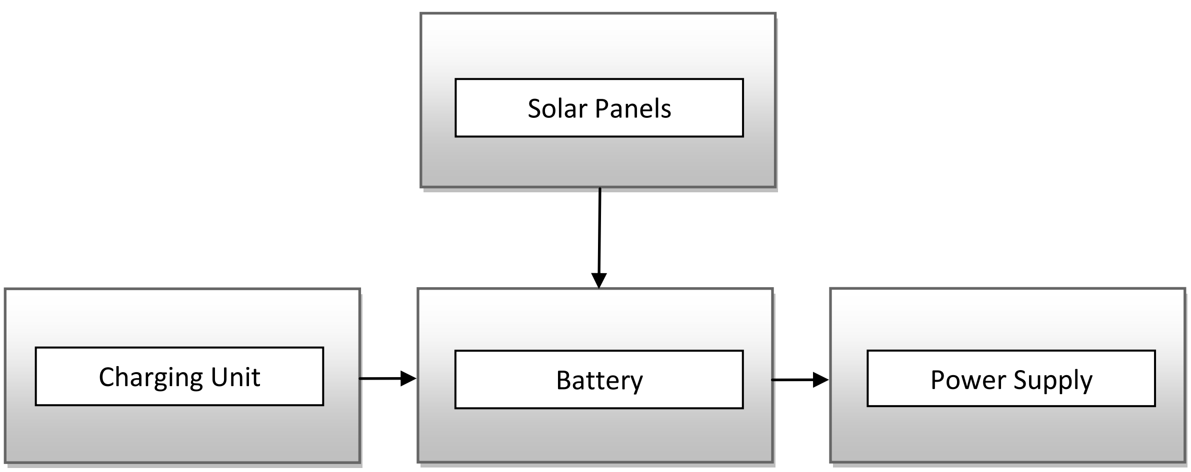

Figure 2: Power Module Block Diagram

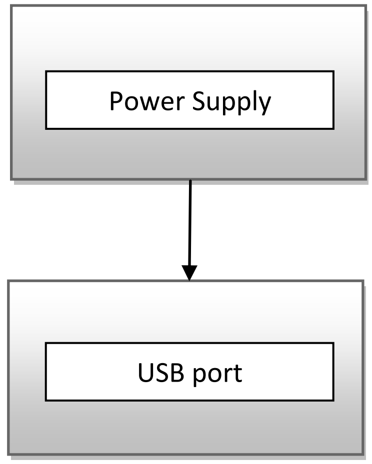

Figure 3: USB Module Block Diagram

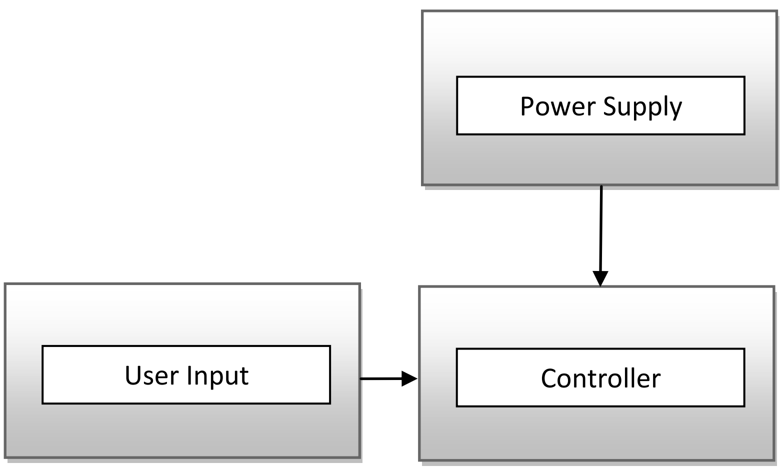

Figure 4: Scorecard Module Block Diagram

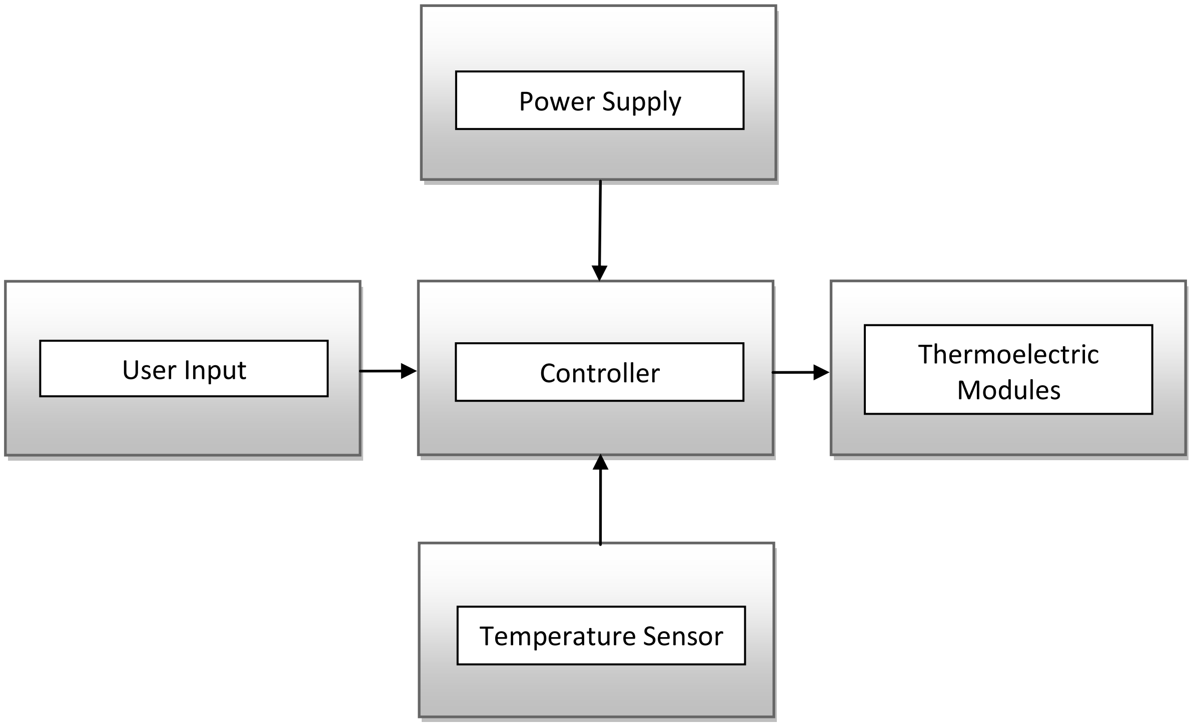

Figure 5: Temperature Module Block Diagram

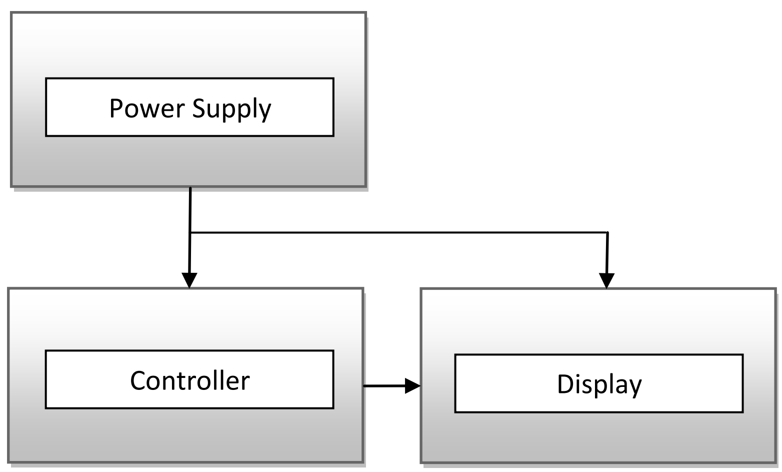

Figure 6: Display Module Block Diagram

2.2 Block Descriptions

Power Module

Overall, the Power Modules acts as a power supply for the entire system by generating, storing, and distributing appropriate power to each component.

Solar Panels

Solar panels will be the primary power generation component of the power module. Under ideal conditions, the solar panels will generate all of the power used by the entire system. A power budget calculation estimates 25W as the maximum power consumed by the system. Therefore, panels rated at a total of 30W will be used. Power from the solar panels would not be consistent enough to directly power all of the components. Instead, the panels will recharge a battery.

Charging Unit

The charging unit allows the battery to be charged by a wall outlet for when solar panels cannot be used. An AC-DC converter will modulate the power which will be scaled into a usable source for the battery.

Battery

The battery is responsible for storing power generated by the solar panels. In addition to being recharged by solar power, the battery will also be capable of being charged through an ordinary wall outlet (in case the weather does not favor solar power.) The battery will output the approximated 25W to a power supply sub-block.

Power Supply

The power supply takes the 25W power from the battery and converts it into usable voltages for every other component in the system (USB, Scorecard, Display, and Temperature Modules.) k

USB Module

The USB Module is a very simple component that takes power distributed from the power supply and sends it to a USB port. The power will already be scaled by the Power Module to our desired 2.2W for the USB port, so there will be very little circuitry.

Scorecard Module

The Scorecard Module will be an electronic version of the scorecards received at any golf course. It will generate a grid for multiple players to enter in the par and their score after each hole. A running counter will keep a total for each player as well as their +/- from par.

Power Supply

The power supply comes from the Power Module. It is a source of power (two lines) for both the display and microcontroller in the Scorecard Module. Because the display and microcontroller are used in other modules, this power supply component is shared between the Temperature and Display Modules.

User Input

The user input for the Scorecard Module is a group of buttons used to navigate the scorecard and enter in numbers. Signals from the buttons are sent to the controller to be processed. Depending on the type of controller we choose to use, buttons may already be part of the board.

Controller

The controller is a device responsible for processing our coded scorecard, powered by the power supply and driven by user input. We will code a GUI for the scorecard, load it on to the controller, and send it to the Display Module.

Temperature Module

The Temperature Module is a feedback control system that will allow the user to set a desired temperature for an insulated pocket in the bag, and maintain that temperature through the use of thermoelectric modules.

Power Supply

The power supply is a source of power from the Power Module, used by the microcontroller in the Temperature Module. This power will already be regulated to the microcontroller's specifications as it enters the Temperature Module. These specifications will be determined once an appropriate controller is selected.

User Input

The user input for the Temperature Module will be two buttons to set the desired temperature of the pocket (one to increase the temperature and another to decrease it.) Signals from the buttons are sent to the controller to be processed.

Temperature Sensor

A simple temperature sensor (most likely a thermistor) will be used to provide feedback into the control system. Its resistance will vary with temperature, allowing the controller to calculate the temperature based on the Steinhart-Hart equation (with a, b, and c values determined by the sensor's data sheet.)

Thermoelectric Modules

Thermoelectric modules (Peltier coolers) will be used to change the temperature of the pocket. They are solid-state devices that convert an electric voltage into a temperature difference. When our controller determines that there is an error between the user-selected reference value and the temperature of the pocket, a voltage will be applied to these modules to create a temperature differential.

Controller

The controller will use the user-selected temperature as well as feedback from a temperature sensor to determine if the Peltier cooling devices need to be running. It will operate based on a closed-loop transfer function in which the output of the system is fed back through the sensor measurement to a reference value. The controller will take the error between these values and correct accordingly by enabling/disabling the Peltier devices to cooler/heat the bag.

Display Module

The Display Module consists of an LED screen and controller that will display the electronic scorecard GUI and temperature information sent by the Scorecard and Temperature Module.

Power Supply

The power supply is a source of power (2 lines) from the Power Module, used by the controller and display. The appropriate power values will have already been determined by the Power Module and sent directly to these components.

Controller

The controller sub-block in the Display Module represents the controller in the Scorecard and Temperature Module. All information that needs to be displayed will have already been processed by each respective block. Therefore, the information will be ready to be displayed on screen.

Display

A low resolution LED screen will be used to display the electronic scorecard and temperature information. This information will come from the controller. The display will be mounted on the bag in a location that is easy for the user to access. Similarly, the screen will need to be low-glare so that it is easy to use outside.

Requirements and Verification

3.1 Requirements

Top Level System Layout

Power Module – Must be able to supply the appropriate power values to all modular components

Temperature Module – Must be able to regulate the desired temperature selected by the user

Display Module – Must be able to clearly display the appropriate images under all conditions

Scorecard Module – Must correctly process input through an easy to use interface

USB Module – Must consistently output the appropriate power

Power Module

Solar Panels – Must not interfere with the functionality of the bag

Battery – Must be able to store enough power to last a full round of golf

Charging Unit – Must safely convert wall outlet power to charge the battery

Power Supply – Must efficiently distribute consistently regulated voltages to each component

USB Module

Power Supply – Must safely send appropriate power to the USB connector

USB Port – Must be easily accessible

Scorecard Module

Power Supply – Must safely send appropriate power to the controller

Controller – Must send the correct data to the display module without errors

User Input – Must be user friendly

Temperature Module

Power Supply – Must safely send the appropriate power to the controller

Controller – Must accurately interpret input and feedback data and act accordingly

Thermoelectric Modules – Must work properly while safely dissipating heat

Temperature Sensor – Must be appropriately placed to accurately monitor the pocket's temperature

User Input – Must be user friendly

Display Module

Power Supply – Must safely send appropriate power to the controller and display

Controller – Must send the correct data to the display without errors

Display – Must clearly display the appropriate images under direct sunlight

3.2 Verification

Top Level System Layout
Power Module – Test that an appropriate voltage is being constantly supplied by the battery. Check with Voltmeter
Temperature Module – Set a temperature and use a temperature probe to test inside the refrigerated pouch. Should be around 50 degrees
Display Module – Input a score and see if the image is displayed. Test the pins on the micro-controller for activity.
Scorecard Module – Input data into the micro-controller. Check the pins to the display for activity
USB Module – Check if 5v is supplied by the port. See if cell phone charges

Power Module
Solar Panels – Use a wattmeter to test that 30 watts is being supplied.
Battery – Use a voltmeter to test the 12V battery. Check its voltage after being charged by both the Solar Panels and the Charging Unit
Charging Unit – Plug in the charging unit into the wall. Test the output voltage to see if it is indeed 12V DC
Power Supply – Use a multimeter to confirm each component's power lines are sending appropriate values

USB Module
Power Supply – Use Voltmeter to test 5v is running to USB connector
USB Port – Use a voltmeter to test 5V is running from the USB connector

Scorecard Module
Power Supply – Use voltmeter to test 5v is going to Controller
Controller – Input data into the controller, and see if the correct value is displayed on the LCD. Test output pins for activity
User Input – Run a continuity check on the output of the keyboard

Temperature Module
Power Supply – Use Voltmeter to test 5v is going to Controller
Controller – Allow the refrigerated pouch to reach room temperature. Set temperature to 50 degrees using controller. Use temperature probe to test the pouch. Test the output pins on micro-controller for activity
Thermoelectric Modules – Use Voltmeter to test 3.9V. Also use temperature probe to test 50 degrees
Temperature Sensor – Use an Ammeter to test resistance with changing temperature
User Input – Run a continuity check on the output of the keyboard

Display Module
Power Supply – Use voltmeter to test 5v is going to Controller and 3v is going to Display
Controller – Input a score see if the displayed value corresponds to the input. Test output pins for activity

Display – Witness the value of the score set by the controller

3.3 Tolerance Analysis

There are two components that are critical to the overall system; the first being the solar cell panel. This panel needs to produce at least as much power that will be consumed, about 25W. The planned panel is capable of 30W generation. To test how consistent the power generation is, a wattmeter can be used to measure the power generated under varying conditions of light. The entire device must be tested when receiving less than desired power to observe possible effects to the system.

The second crucial component is the thermistor. This thermistor must produce resistances values within 5% of the expected value at any given temperature. If this thermistor is not accurate enough, the microcontroller and Peltier modules will not be able to control the temperature as desired. To test these values, a simple ohmmeter will suffice. The thermistor can be placed in environments that will simulate the extremes expected during a typical golf game.

Cost and Schedule

4.1 Cost Analysis

Name	Hourly Rate	Total Hours Invested	Total = Hourly Rate x 2.5 x Total Hours Invested
Cory Edwards	$30.00	170	$12,750
Jon Kinney	$30.00	170	$12,750
Harrison Kantner	$30.00	170	$12,750
Total		510	$38,250

Item	Quantity	Unit Cost ($)	Cost ($)
Micro-Controller	1	30.00	30.00
LCD	1	10.00	10.00
USB	1	5.00	5.00
Peltier Module	4	15.00	60.00
Solar Panel	1	130.00	130.00
Metal Rack	1	100.00	100.00
Thermal Bag	1	20.00	20.00
Transformer	1	15.00	15.00
1N4005 Diode	5	0.20	1.00
Golf Bag	1	100.00	100.00
Resistors, Capacitors, and Inductors		40.00	40.00
PCB	1	40.00	40.00
Temperature Sensors	5	1.00	5.00
2 Prong Electrical Cord	1	5.00	5.00
Alligator Clamp	2	1.50	3.00

Battery	1	20.00	20.00

Section	**Total**
Labor	$38,250
Parts	$584.00
Total	**$38,834**

4.2 Schedule

Week	**Task**	**Responsibility**
2/4	Finalize and hand in proposal	Jon
	Mock DR sign-up	Cory
	Power Design Schematic	Harrison
2/11	Parts List	Cory
	Prepare Mock DR	Jon
	Circuit Simulation PSpice	Harrison
2/18	Finalize Electrical Design	Harrison
	Finalize Power Simulation	Cory
	Begin Controller Design	Jon
2/25	Obtain Golf Bag and Create Refrigerated Pouch	Jon
	Consult Machine Shop About Solar Power Rack	Cory
	Design Power Converters	Harrison
3/4	Test Peltier Modules	Jon
	LabVIEW Simulation of Temperature Control	
	Lay Out PCB Design	Harrison
	Design Digital Scorecard	Cory
3/11	Assemble and Test Solar Panels and Battery	Harrison
	Individual Progress Reports	Jon
	Program Control	Cory
3/18	**Spring Break**	**All**
3/25	Assemble Cooling System and Display and Test Control	Cory
	Integrate Outlet Power Conversion Component	Harrison
	USB Charger	Jon
	Prepare Mock-Up Presentation and Demo	
4/1	Overall Testing	Harrison
	Final Assembly	Jon
	Tolerance Analysis and Verification	Cory
4/8	**Ensure Completion**	**All**
4/15	Prepare Paper	Jon
	Prepare Demo	Cory
	Prepare Presentation	Harrison
4/22	Paper	Jon
	Demo	Cory

	Presentation	Harrison
4/29	**Return Supplies**	**All**