Initial Project Document Divide and Conquer

Solar Picnic Table

Group D:
Amos Luo - Computer Engineering
Azzan Al Busaidi - Electrical Engineering
Faisal Al Ghafri - Electrical Engineering
Thach Vo - Computer Engineering

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I. Project Narrative

Motivation:

Life is advancing at an extraordinary pace, this evolution in life is accompanied by stressful jobs and lifestyles, and what way is better to relieve that stress than going out for a picnic in nature. However, because of the lack that we still have in our modern technologies like batteries running out and the absence of portability in other technologies, a lot of people bypass the idea of taking a picnic because they will be far from some essential amenities they enjoy at home. In this project, we are aiming to solve this problem, and since preserving earth is our duty, we are powering our project using renewable energy. Looking at the geographical aspects of our area, the optimum form of renewable energy to use will be solar energy. We will utilize the power generated by the solar panel to power our picnic table. This table will contain the most crucial amenities people are looking for when heading out for a picnic, like a power outlet paired with USB outlets, LED lights, a battery to store excess energy, and an app that will ease accessing these facilities through the user's smartphone.

Objectives and Goals:

For this project, we have two primary goals: creating a smart picnic table and making it environment friendly. To accomplish these two goals, we have set up different objectives. First, we will add many different functionalities to the smart table so that it can interact with electronic devices such as bluetooth, lighting, and charging. On top of this, we plan to implement an app that allows users to control these functionalities. To make it environment friendly, the smart picnic table will be powered through solar power and a lithium ion battery.

Functionality:

Our goal is for the table to function during all day times, and to be safe to use under all weather conditions, whether rainy, windy, or cloudy, if the battery is charged with sufficient energy that is. Battery energy level can be checked through an app, in which it will be paired to. This app will allow the user to check for energy in the battery, manually turn LED lights on/off and check the temperature, all using bluetooth to connect through the cell phone. Another requirement of making this happen is protecting the battery and power distributing wires from water, dust, and insects, this will be done through a waterproof box that will keep the battery and wires protected at all times. The table will also contain an AC power outlet, and two USB ports, for charging and powering other devices.

II. Specifications and Requirements

- Table Dimensions

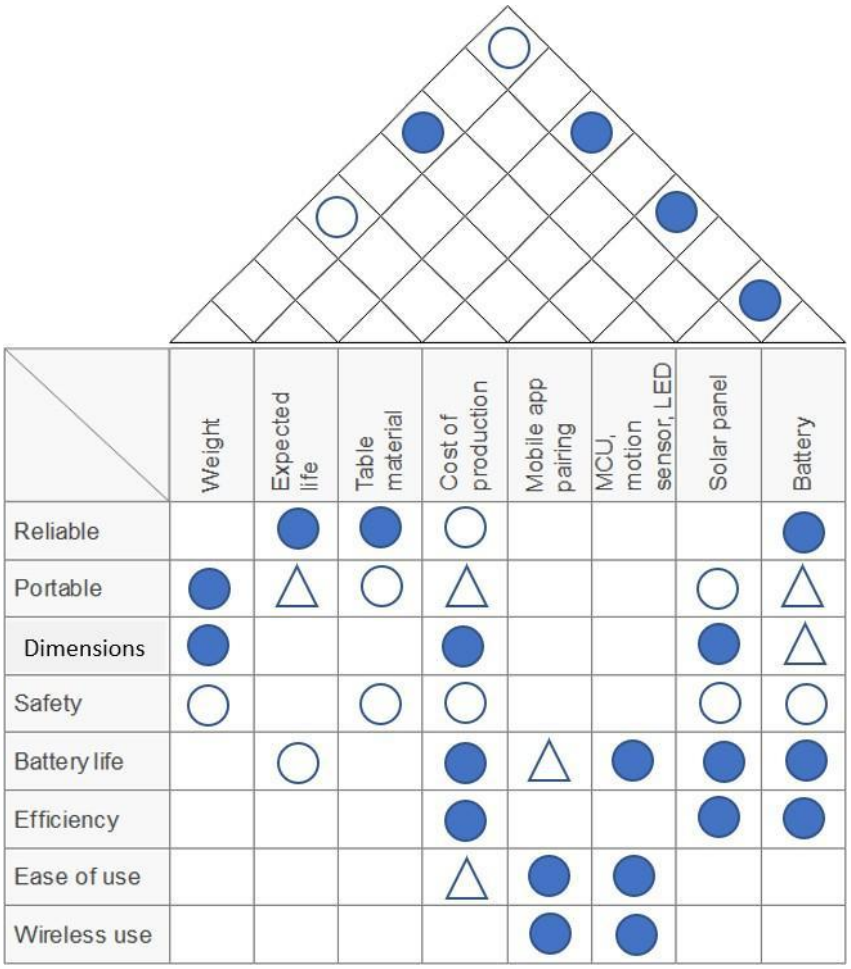
Length	3ft - 5ft
Width	3ft - 5ft
Height	2ft - 4ft
Pole Height	4ft - 5ft
Material	Wood/Plastic/Steel
Shade	Enough to cover table area

- Waterproof box
    - Waterproof box to enclose arduino and modules
    - Waterproof outlet box and cover to protect electronics
- Solar panels
- Solar charger controller
- DC to AC inverter 150W-250W capacity
- Solar Racking
- Power Storage
    - Lithium ion battery, enough storage to hold excess power from solar panel
- Arduino + Arduino hardware
    - Arduino Mega 2560 Rev3, main controller where a lot of the functionality/monitoring is centered around
    - HC-05 Bluetooth module, allows for users to wirelessly connect, monitor, and control functions on the table
    - PIR Motion Sensor, turns on LED Lights when user is close to the table (feature only works at night using internal timer)
    - Voltage & Current sensors, used to monitor output generated from solar panel and to monitor how much power is left in the battery
    - Temperature monitor, monitors the temperature around the table to give the users accurate temperature readings
- Power outlets and USB ports
    - Standard type B power plug
    - Standard type A USB plug
- LED lights
    - LED Strips, 6-7 feet
- Temperature Sensor

Power Distribution Table:

Item	Voltage (V)	Current (A)	Power (W)
Solar Panel	12 - 24	Up to 4.3	100
Battery	~12	10Ah	~120
MCU	3.3 or 5 (TBD)	Up to 0.2	<=1
LED	5	<2	<10
Motion sensor	TBD	TBD	Up to 5
Temperature sensor	3.3 - 5.5	0.001	Up to 0.0055
Type B Power Outlet	110 - 120 AC	Depends on device being plugged	Depends on device being plugged

III. Quality House Diagram

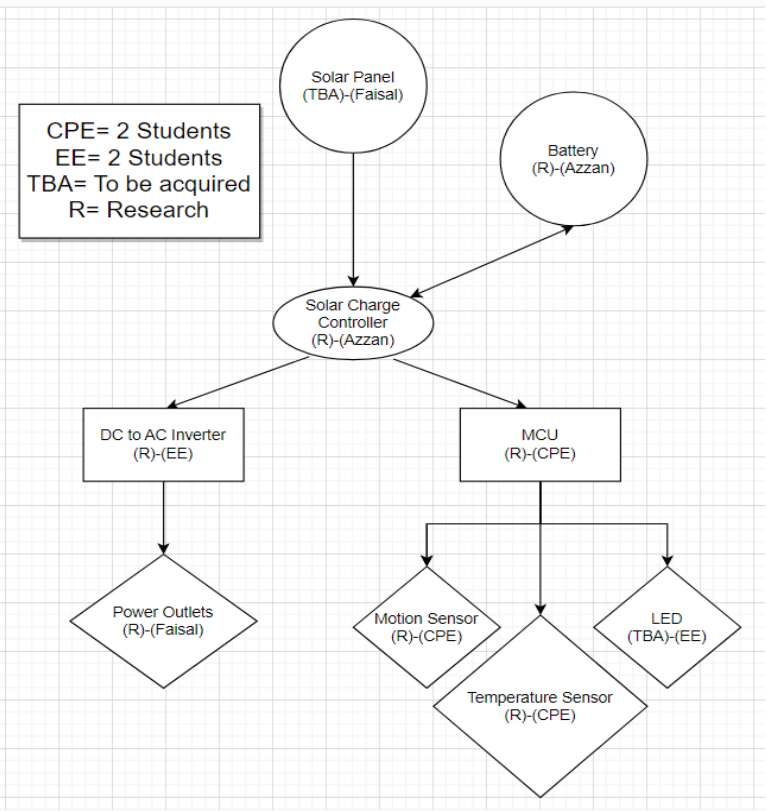


Relationship between customer requirements and technical descriptors		
●	Strong	+9
○	Medium	+3
△	Weak	+1

Interrelation between technical requirements (correlation matrix)		
●	Positive	+3
○	Weak Positive	+1
△	Weak Negative	-1
▲	Negative	-3

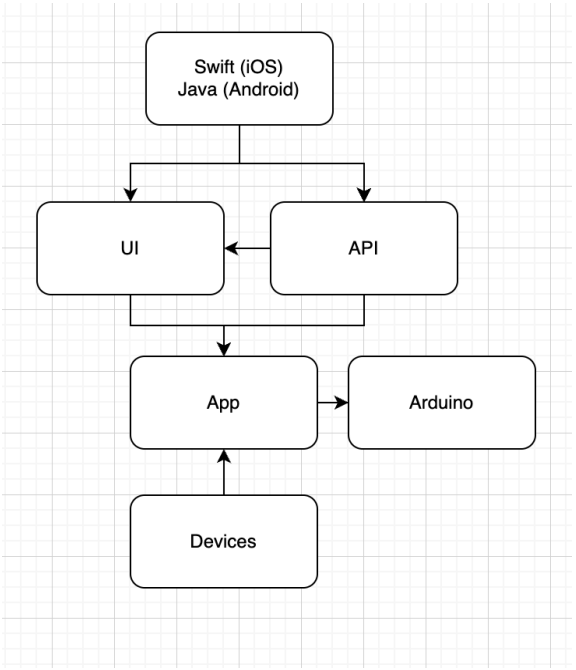
IV. Block Diagrams

Power Distribution:



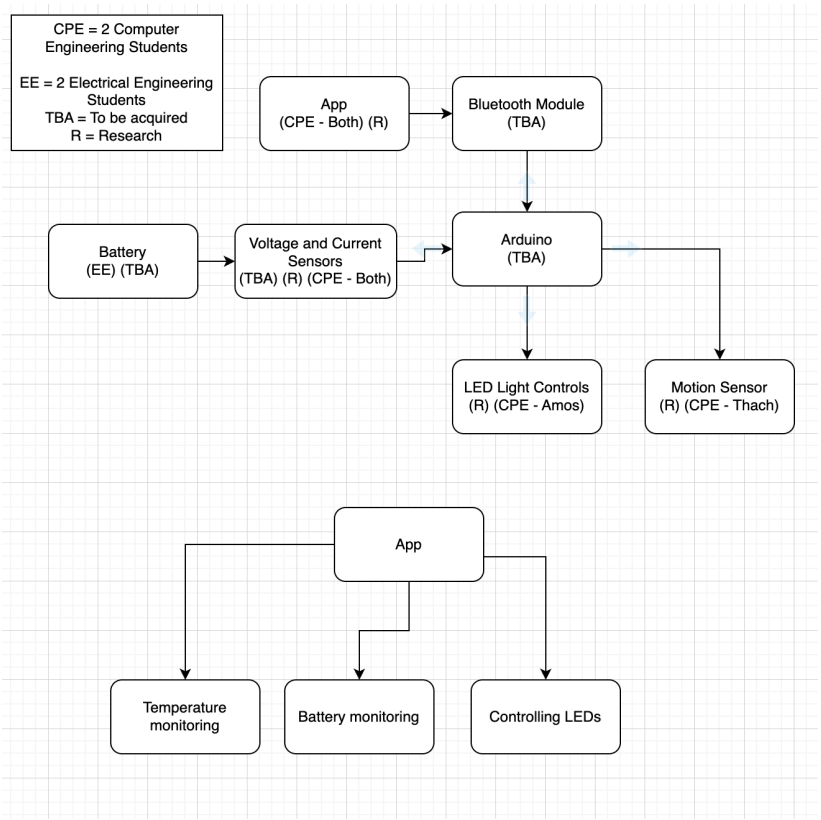
The block diagram above depicts the different components needed for the power distribution. As you can see, the solar panel and battery will be connected with the solar charge controller which will then power the MCU and the power outlets. This is an important aspect as we want there to be enough power for all of the electrical components.

App:



This is the block diagram of the mobile app that we will be developing. This shows the general overview of all the elements of the application and how they will interact with the app.

Microcontroller



Finally, we have the microcontroller diagram. We can see all of the different components that will come into play when implementing this feature. As you can see it is responsible for a majority of the software functionalities. The arduino mcu is simply a placeholder as we have not determined what to use yet.

IV. Constraints

For a project of this scale, there are many possible constraints and limitations that might have an effect on the final outcome of this project. It is very important that we thoroughly investigate, research, and plan ahead. These constraints could be either from the financial aspect, power generation and distribution, power storage capacity, or even software implementations. Below we have listed these possible issues and provided a detailed explanation on how they might affect the final product.

Financial:

The biggest constraint financially would be the table itself. If our group isn't able to use one of the tables provided by UCF, then we would have to build our own table. This could prove to be an obstacle financially as it can get expensive acquiring the materials and equipment for this task.

Power Generation and Distribution:

Since we are planning to power the whole table using solar energy, the main concern is having a solar panel that is able to generate enough energy to power all the electrical components in our system. Some of these components in our system would require AC current while others will require DC. Having one solar panel with a limited budget may provide challenges in providing the various types of currents at different voltages each without any power shortage.

Power storage capacity:

The main constraint regarding the storage capacity is ensuring that the battery storage is able to store enough power that would last the whole night when sunlight is no longer available. Under ideal circumstances a fully charged battery storage should be able to last at least 6 hours (6 hours is the average "peak sun") while powering all components at once.

Weather:

While the weather in Orlando is a great place to utilize solar energy, there are some days of the week where it is going to be hard to generate electrical energy from solar. The table's design will be able to withstand any rains without any damage, but won't be able to generate sufficient energy to last through the night.

V. Microcontroller/software implementations

Microcontroller:

The way we are going to control features such as lighting, battery monitoring, temperature and motion sensing is by utilizing an Arduino Mega 2560. To make sure the Arduino is capable of measuring these things, we need to buy and connect multiple modules to enable these capabilities. Voltage and current sensors are needed to read the outputting voltages/currents from both the solar panel and the battery. A temperature sensor is used to measure the temperature around the table. Lighting is controlled by plugging in the programmable LED lights into the Arduino and programming is based on the pins it's plugged into. For the motion sensor, we will use a PIR motion sensor that will detect whether someone is nearby and turn the LEDs on/off depending on the situation. All these functionalities will be programmed using C/C++ to create our own functions to read and display readings.

Software:

To allow the user to read all the measurements and controls from the Arduino, we will implement a bluetooth module allowing connections from bluetooth devices such as phones. Our goal is to create an app that is available on any devices that allows the user to connect to the microcontroller through bluetooth. This app will provide the user with necessary information such as, displaying battery percentage, the temperature, controlling the LED lighting, and how much power the solar panel is generating. The main focus is to learn and research about both iOS and Android app development to create an application for any type of user. Both versions of the applications are going to be tested using built-in emulators in both Android Studio and XCode. Real world testing will be done using different phones provided by team members.

VI. Budget

Item	Quantity	Price ($)
Arduino mega 2560	1	45
LED light strips (65 ft)	1	20
PIR motion sensor	1	7
HC-05 Bluetooth module	1	10
Lithium-ion battery	1	50
Solar Panel	1	85
Solar charge controller	1	10
DC to AC Inverter	1	15
Power Outlet/USB Ports	1	13
Voltage/Current Sensors	2	10
Waterproof box outlet box	1	35
Temperature Sensor	1	5
Table	1	TBA
Pole Stand	1	TBA
Estimated Total	-	315

VII. Project Milestones

Tasks	Start	End
Senior Design 1		
Project Selection	1/13	1/24
Divide & Conquer I	1/24	2/2
Group Meeting	2/6	2/8
60 page draft	2/8	3/24
Group meeting	3/27	3/29
120 page final	3/29	4/25

Tasks	Start	End
Senior Design 2		
Design	TBD	TBD
Ordering parts	TBD	TBD
Prototype	TBD	TBD
Testing	TBD	TBD
Finalizing prototype	TBD	TBD
Present project	TBD	TBD