Charging Bicycle Station Second Generation

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Design Progress

Document

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1 TABLE OF CONTENTS

2 OVERVIEW

During Winter break, the team practiced on some of the programming languages that are compatible with the Raspberry Pi chipset that will be used in this project. The team also did some search on the components of the projects in order to start working on the charging bicycle station. Modifications to the components and the work roles were made and will be discussed in detail in the coming sections of this report.

3 BACKGROUND

The details of how the generator will work begin with the magnetic field. According to the Biot–Savart law, Ampère's circuital law, and Gauss's law for magnetism; a generator works with the idea of electromagnetism. Within any magnetic field in a wire, it's calculated with the permeability of free space (4*pi*10^-7) multiplied with the current and divided by the coils wire length, which is 2*pi* ***r***, with ***r*** standing for the radius. The strength of the magnetic field depends on the current ***I*** in the wire and ***r***, the distance from the wire. The other calculation is finding the magnetic field of the axis contained within the generator. As the coil is wrapped around the axis (armature) the number of loops will determine the strength of the magnetic field, which in turn will create a higher output voltage. Since magnetic fields are a major part of the generator, a solenoid can be a potential component within the generator. The solenoid is simply an iron core with an enameled coil around it. This creates a very strong magnetic field as it acts an electromagnet. Since a strong magnetic field is essential for a generator, the magnetic flux becomes equally as important. The magnetic flux is the magnetic

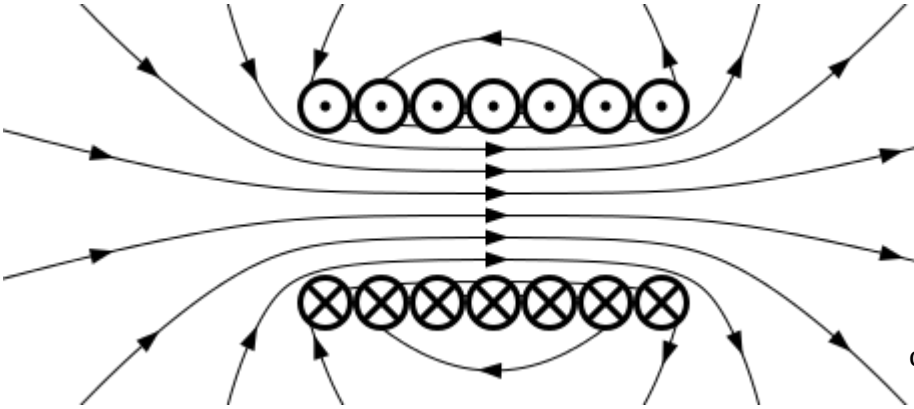

Figure 1: Faraday's Law

field multiplied by the surface area of the magnetic field. All of these technical aspects of the magnetic field and the magnetic flux create the generator, which is probably the biggest component to this project. After the generator is established and working, the team will then be able to test and run programs to display on the touchscreen. The idea is to make this system as user friendly as possible. Users should be able to interact with the touchscreen and get feedback when pedaling the charging bicycle station.

4 GENERATOR (300 WATTS/DC)

A purchased generator is built to maximize efficiency and minimize cost. Purchased Generators are designed to use machined parts that fit together with minimal wasted space. By minimizing gap space, the generator achieves a higher flux density and a higher number of turns with the same materials. According to Faraday's Law, higher flux density increases the induced electro-motive force on the wire causing a larger current. The more turns of wire used in a generator multiplies the current generated due to Ampere's Law. From these two aspects we can see that a machined generator is very efficient.

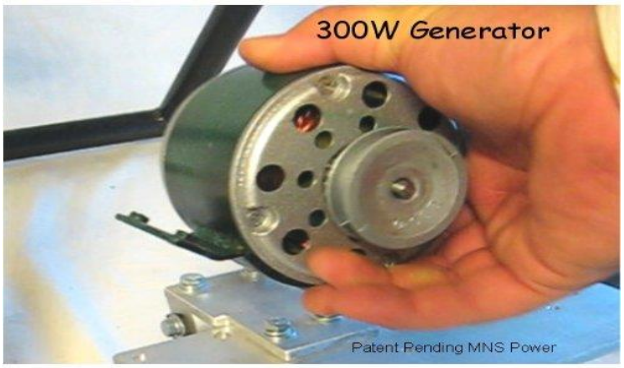

Figure 2: Purchased Generator

The output power of the bicycle is expected to be no more than 160 Watts, which means that the chosen generator will be more than enough to overcome this amount of power. Figure 3 to the right shows the amount of power generated using a similar bicycle generating technique as our project.

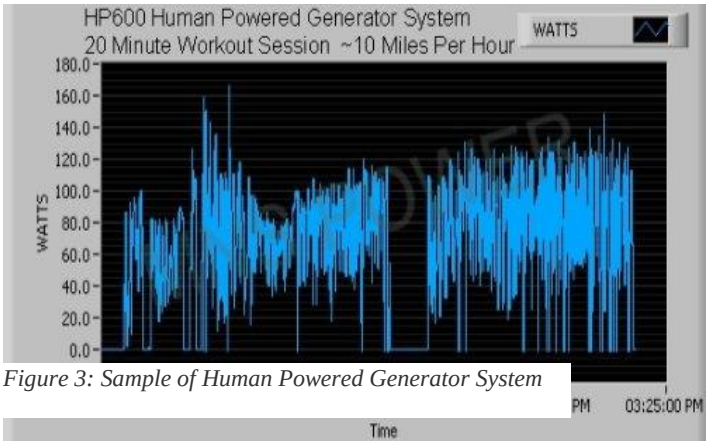

Figure 3: Sample of Human Powered Generator System

Initially, the team's plan was to purchase an AC generator that will use a rectifier and an inverter to convert the AC to DC to charge the devices and have into consideration that the Laptops will be charged using the AC power. However, the plan has been changed so that the generator will be a DC generator that will use a DC-AC inverter to charge the Laptops. This generator will have the

following features which also could help the mechanical team when considering the size and the weight:

Table 1: Specifications of the Generator

Wattage	300 watts
Power Source	Rotation of stator
Weight	8 pounds
Dimensions	10 x 5 x 7 in

5 RASPBERRY PIE CHIPSET (MODEL B)

Raspberry pie chipset is the team's first choice. These kinds of chipsets have the ability of displaying an HD output due to their HDMI built in ports. Furthermore, Raspberry pie chipsets have expandable memory and can store very large amounts of data and build in a Linux operating system. Also, its programs can run on top of existing architecture and can have multiple expansion ports that keep track of multiple sensors at once.

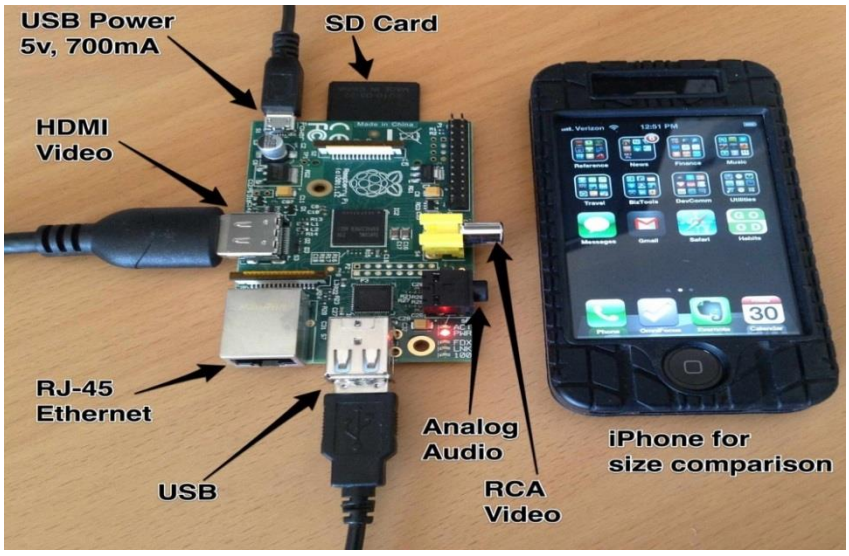

Figure 4: Raspberry Pie Chipset

Detailed specifications of the Raspberry Pie chipset will be included in the table below:

Table 2: Raspberry Pie Specifications

Weight	0.126 pounds
Length	4.75 in
Width	3 in
Height	1 in
Power	3.5 Watts
Memory	512 MB
Storage	SD Card Slot
Graphics	Broadcom Video Core

6 DISPLAY (7" TOUCH SCREEN)

For the display purposes, the choice of a display touch screen will be used since the team is using the Raspberry Pie chipset which is compatible with variety of display monitors. However, as required by our client, the screen should have some specifications that will narrow the search of screens. Therefore, a choice of a 7" touch screen was agreed by the team which will have the following specifications to be displayed:

Figure 5: 7" Touch Screen

- Power generated
  - Instantaneously as a number (in watts)
  - Graphically as a scrolling line graph
  - Illustrated using light bulbs or refrigerators or flat screen TVs or iPhones
- Energy produced when the user finishes their session (Wh)
- Power used to charge the user's device
  - Instantaneously as a number - it will likely be best to have this number next to the number of watts being generated so users have a comparison
- Energy produced
  - Total energy produced over the lifetime of the charging station (kWh)
- Carbon offset (probably in pounds)

- This can be shown for each user and cumulatively over the lifetime of the charging station
- Total number of users

Nevertheless, these specifications will be modified and added to as the team progresses with the project. The choice of the screen that will be used to display the above parameters will have the following features:

Table 3: Display Screen Features

Type	HDMI+VGA+2AV Controller Board
Size	7 in
Resolution	800 x 480 LCD with Touch Screen

7 POWER LOGGER (E-LOGGER)

The idea of the power logger is to find out how much power will be coming into the raspberry pi and how we can program in response to that. For example: If power = 60watts, then

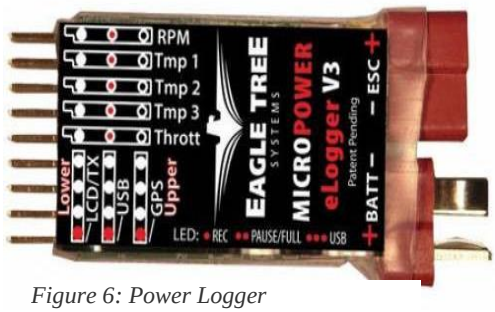

Figure 6: Power Logger

the touchscreen will display "You are powering one light bulb!" The power logger will be compatible with the raspberry pi and is essential for the programming operation of this project.

8 DC TO AC INVERTER

Since the output power from the generator will be in DC, a device to convert DC to AC is needed. The purpose of this inverter is to convert the generated power to AC so it can charge devices like Laptops. The inverter chosen will be able to take 11-15 V of DC power and will have a maximum current of 20 Amps which is more than enough for project. Moreover, the inverter will be able to output as much as 200 watts.

Figure 7: DC to AC inverter

9 CABLES

For the cables, the team will provide all of the kinds of cables needed for smartphones and tablets along with three and two prong cables for charging Laptops. Below is a list of the various cables the team is planning to provide by the end of the design.

- iPhone Charger (New & Old)
- Three Prong Cable
- Two Prong Cable
- USB to USB
- USB to Micro

However, a table that includes all of the prices for the above cables is on the next page.

Table 4: Cables Prices

Cable	Price($)
iPhone Charger (New & Old)	**4.03 (Total)**
Two-Three Prong Cable	**3.00**
USB to USB	**2.78**
USB to Micro	**5.99**
Total	**15.8**

10 CAPACITORS

For the purpose of overcome the fluctuation that occurred when the generator outputs it power, a capacitor will be used. These 2200 micro farad capacitors will be used during the tests of the functionality of our charging station. If needed, more capacitors from the IEEE will be used.

Figure 8: Capacitors

11 FINAL BUDGET

Our estimated budget from last semester is $363.48 more than our current estimated budget. Below will be two tables that show the two different budgets.

Table 5: Last Semester's Budget

Components	Price($)
Purchased Generator	**500**
Raspberry pie	**35**
Display	**200**
Capacitors	**30**
Cables	**42**
Total Budget	**807**

Table 6: New Budget

Components	Price ($)
Generator	**199.00**
Display	**89.00**
Power Inverter	**21.00**
Raspberry Pi	**35.00**
Raspberry Pi Case	**7.89**
SD Card	**4.99**

Capacitor Pack	**7.00**
Cables	**24.66**
Power Logger	**69.99**
Total	**458.53**

12 CONCLUSIONS

The programming has begun, the materials have been defined. As of now the team is waiting on materials to be purchased, so the team can finalize the programming and begin to get all electrical components working together.

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