2^{nd} Generation Charging Station

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1.0 Introduction

The goal of our project is to improve and complete the 2nd Generation Recharging Bicycle Station started by a capstone team the previous year. In this report, we will talk in depth about the design and individual components of the electrical control system, interactive display screen and the enclosure for this project. All of the designs are not final and will require more research and testing before they can be finalized and approved for final construction.

2.0 Electric Control System

The electric control system's main goal is to turn mechanical energy from the pedaling of the rider into usable electrical energy. This is what will provide power for charging the rider's electronic devices as well as power the interactive display. The system will be made up of three main components: alternator, capacitor, and the inverter. The alternator will convert the mechanical energy and send it to the capacitor. The capacitor will then regulate the power and transfer it to the car usb chargers and the small inverter. The car charger will convert the 12VDC electricity into 5VDC which will then be used to charge the small electric devices. The inverter will convert the electricity to 120VAC current that can then be used to power devices that would normally plug into an average household outlet.

2.1 Car Alternator

The alternator is our proposed component to replace the DC generator which is part of the current design. An alternator is a better choice because it is much lighter, cheaper, rugged and more efficient than a similar DC generator. The current generator has no failsafe to prevent high voltage output which could potentially damage or destroy other components in the system. The alternator does have a failsafe to prevent this from happening. The alternator also runs low amounts of current through its brushes compared to a DC generator which grants it a longer lifespan. The current generator outputs voltage at around 24VDC which is too high for the proposed capacitor. This means an additional DC/DC converter would be needed to step down this voltage which would decrease the overall efficiency of the system while also raising costs.

2.2 Audio Capacitor

The proposed capacitor is a 2.0 Farad Digital Capacitor used to regulate the power input for large audio systems found in automotive vehicles. It can receive input voltage in the range of 12V-16V which works well with the proposed alternator. The works by acting like an extremely simple battery. The power fills up the capacitor and is then outputted to the rest of the system at a stable non-fluctuating rate. It works similar to a run-off reservoir in a water shed system. Its main purposes are to regulate incoming voltage from the alternator and exerting power when the rider stops pedaling momentarily. The capacitor will hold enough energy to power an electronic device for approximately 5 minutes. It is also extremely efficient especially compared to a system that utilizes VRLA (Valve-Regulated-Lead-Acid) batteries to regulate the generator instead. The capacitor also possesses a built in shut-off system that turns of the system when no power is being pulled from the output section of the system.

2.3 Inverter

The inverter will allow the bicycle charging station to charge and power devices requiring AC voltage. This biggest problem implementing the inverter into the system is its low efficiency rating. After simple research on the correlations of efficiencies and power output, we found that at the proposed power outputs of around 400 Watts, the efficiency rating was relatively high, around 80%. This means that it would work well with the charging station without pulling too much power. The inverter will be able to output around 3 amps of power at 120VAC to whichever devices are plugged into it. An extension will be added to make the outlets of the inverter located on the outside of the enclosure for easier access.

3.0 Interactive Display Screen

The interactive display screen will be how the rider views all of the data coming from the sensors on the bike. It will give the rider charts of power output over time, digital gauges displaying the real time voltage, and wattage and current output coming from the charging station. We propose a design where the power outputs at different locations on the bike are measured by sensors and can each be accessed via the interactive display screen. The screen will also be durable and user friendly for the rider so that they can quickly understand how to use it.

3.1 LabVIEW for Android

LabVIEW is a software designed by National Instruments used for data collection, instrument control, and industrial automation. LabVIEW is also available in an application format that is compatible with the Android operating system. The application is called Data Dashboard and can be found on the Google Play store. With this application, we are capable of remotely monitoring the electric control system of the charging station via the internet or Bluetooth for shorter transmissions. We plan to use this Bluetooth capability to transmit all of the sensor data from the Arduino system to the interactive display that would also have Bluetooth capabilities. The display screen on this application is customizable to whatever we would like to show on the display.

3.2 Arduino System

The system that will do all of the monitoring and measuring of the electric control system and transmitting it via Bluetooth to the tablet will consist mainly of the Arduino microcontroller. This component will act as the heart of the monitoring system. It will be capable of measuring voltage, current, and wattage coming from multiple nodes in the electric control system. External components will be connected to the Arduino to expand its capabilities in order to satisfy our requirements. At this time, only two external parts are proposed which are the current sensor and the Bluetooth module used to transmit the data. This section will be the most complex of the entire project and will require additional research and understanding of all the components used in the system.

3.3 Google Nexus 7

For the hardware portion of the interactive display screen, a component was required that was touch screen, durable, had a long battery life, and possessed a popular and easy to use operating system that would make programming easy if not unnecessary. The proposed part that fits all of these components is the Google Nexus 7 tablet made by ASUS. This tablet is reliable, popular and relatively cheap to what we are looking for. It already comes with the Android operating system which has a large community of users and developers who have already designed programs to do exactly what we plan to do. The Nexus tablet also possesses Bluetooth capabilities necessary for communicating with the monitoring system, and has a battery life of approximately 10 hours which is perfect for our needs. The Google Nexus 7 is a perfect choice for a device to fit all our design objectives.

4.0 Enclosure

The enclosure will be the section of the design that houses and protects all of the components in the electric control system. It must be large enough to fit all of the parts inside while also not obstructing the rider from operating the charging station. The enclosure must also have a built in system that keeps the internal temperature of the housing at a low operating temperature. All of these requirements must be met while still maintaining a waterproof structure to prevent the electric components from getting wet.

4.1 Ventillation Fan

The ventilation fan will be the main component of the cooling system and will be located on the front side of the enclosure facing out towards the front wheel. The fan will act as the input location for the cool air and additional holes drilled in another location on the enclosure will act as the output location for the flow of air. All open holes will contain a filtration material such as foam to prevent any humidity or particulate matter from getting into the innards of the housing.

4.2 Material and Dimensions

The material of the enclosure will be made up of pressure-treated plywood. This will help prevent future rotting of the structure as well as bug infestation at a relatively low price. The enclosure will be coated will several layers of epoxy resin in order to make the entire system water tight as well as resistant to small scuffs or scratches. The housing will have to be approximately four inches wide to fit all of the internal components. The enclosure will fit in between the framing of the bicycle, bulging out near the handle bars and ending before reaching the gearing system. It will be designed to efficiently fit all components while still making the ride comfortable for the rider.

5.0 Recommendations

This section demonstrates what steps should be followed in the design process for this project. The following includes tasks that need to be assessed prior to the next milestone.

5.1 Specifications on Car Alternator

Determine if the alternator is suitable for charging the capacitor.

- How much RPM's are required?
- What is the gear ratio on the alternator?

Design a way to mount the alternator to the bike in a reasonable and safe way

- Should the alternator be mounted in between the frame and the second wheel?

5.2 LabVIEW Testing

Use an android device before the client purchases the Nexus 7 in order to see if LabVIEW will provide proper output.

- Thermal couples can be used to test via android and LabVIEW

Communicate Component Needs with Client

- Provide the client with a list of components and where to access each component so that they can be purchased

Component Testing

- As components arrive, begin testing components on an individual basis to determine if they will function with the design

6.0 Conclusion

In conclusion, the electric control system, interactive display screen, and enclosure have all been properly designed. The electric control system was designed for efficiency and simplicity. It will be capable of doing everything that we need without the drawback of large inefficiencies. For the interactive display screen, the LabVIEW software paired with the Google Nexus tablet will be capable of performing all of the tasks desired for the 2nd generation bike charging station. Although the monitoring system will require much more research and analyzing there are pools of information on the internet that we can go to. The enclosure of the entire system will be made of pressure-treated plywood to avoid rotting and will have its own ventilation system to keep the internal temperatures at proper operating conditions for all of the components inside. In total, there is much more to do in analyzing how these components will work with one another and if additional testing and designing will be needed, but we are heading in the right direction and will produce great results in the coming months.