Vibrational GPS

Project Proposal

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1 Introduction

1.1 Objective

For our project, the final objective is for our team to create an arm guard that can be worn on either arm and can assist people in getting to a desired destination. In the arm guard itself, we aim to have two motors positioned on the left and right sides that will vibrate according to the direction the user needs to travel to. We also aim to have an app developed to complement the arm guard in an intuitive fashion. When the user launches this app, it will prompt them to select which arm they will wear this arm guard on to properly calibrate it. After this, the app will act like a normal GPS and ask the user where they would want to go. After selecting start, the user can now put their phone away and the arm guard will start working. Whenever a left or right turn is needed, the arm guard will vibrate the corresponding left or right motor to tell the user which direction they need to turn or walk towards. It will also vary the intensity of this vibration corresponding to how close they are to the turn. For example, there will be a slight vibration when the destination is 100 metres away, two vibrations for 75 metres, three vibrations for 50 metres, four vibrations for 25 metres, and at 5 metres away, it will start vibrating intensely. Once the user gets to the location they want to get to, both vibration motors on the arm guard will vibrate simultaneously for 3 seconds as well to let the user know they have arrived.

1.2 Background

When people bike, skateboard, or walk, it is not always convenient for them to take out their phones. However, when it comes to getting to a new destination, many people have no choice but to use the GPS on their phones to get directions. Looking at their phone, however, means that they must take their eyes off of the sidewalk or path which could cause an accident. Also, using headphones to hear means that they would not be able to hear other noise on the path such as other people trying to pass them. In addition, not everyone is able to hear so they wouldn't be able to hear directions that were spoken. Therefore, a method to be able to get directions without audio or visual feedback would be optimal.

1.3 Physical Design

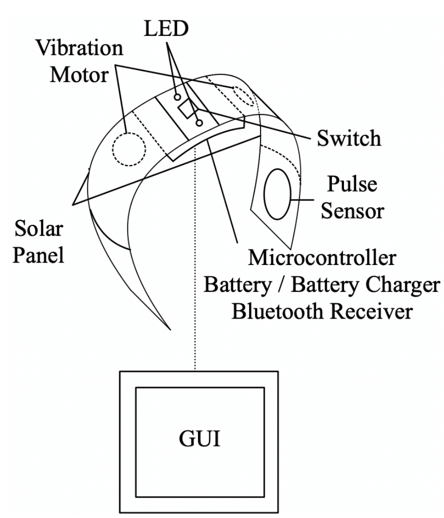

Figure 1: Physical Design of the Vibrational GPS

1.4 High-Level Requirements

- Micro-controller will be used to control when and how long each vibration motor will be active.
- App-based GUI that allows the user to enter a destination and receive turn by turn directions there.
- Arm-mounted solar panel is used for changing a battery. This battery will then be used to power the entire system.

2 Design

2.1 Block Diagram

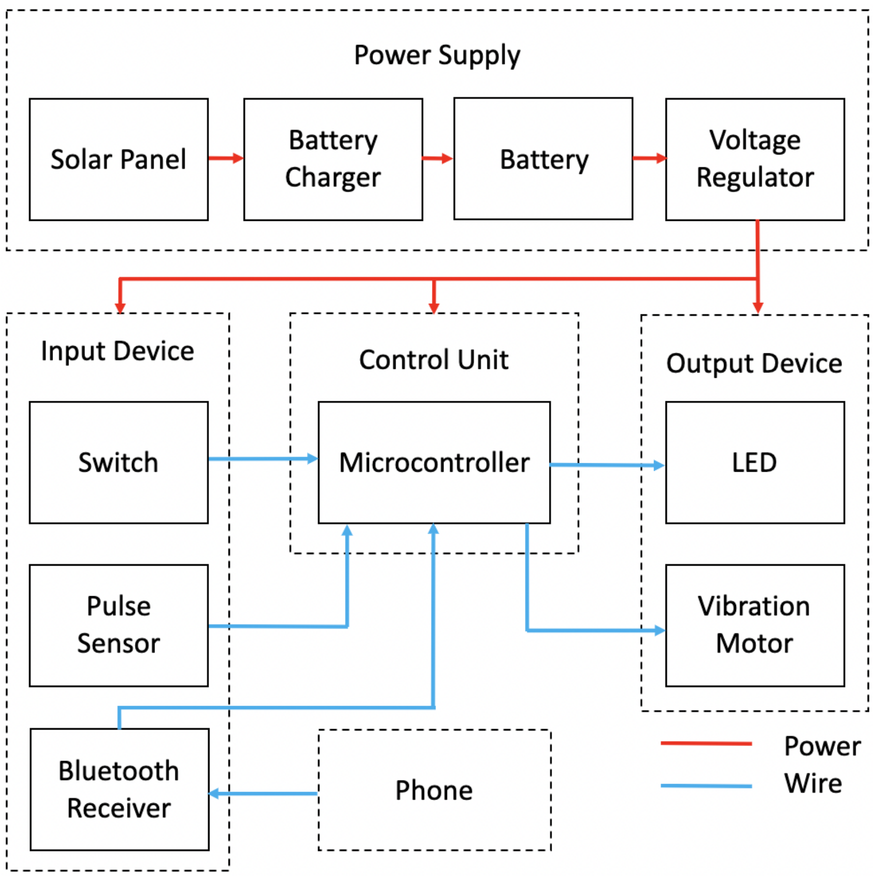

Figure 2: Block Diagram of the Vibrational GPS

The device will be operated based on five different subsystems: phone power supply, control unit, input device, and output device. The micro-controller, the LED and the pulse sensor will be powered when the user presses the switch. If the pulse is detected after the user puts on, the micro-controller will turn on the Bluetooth receiver. The phone will send the signal to the Bluetooth receiver whenever turns should be made, which will then utilise either side of the vibration motors. Entire power supply will be from the solar panel, when the user uses the device outside. Energy will be stored in the battery. Then the voltage supplied will be regulated to ensure that the right voltage can be supplied to all other systems.

2.2 Functional Overview and Requirements

2.2.1 Phone

The phone will be a core component of our design as it will house all of the back-end and front-end for our GPS through a custom built app. Our app will be developed for Android and utilize the Mapbox API for location tracking and navigation [1]. Using this API as well as a variety of custom features, the app will communicate back and forth with our microcontroller in order to send the proper signals needed for the hardware. All of this data transfer will be done utilizing the Bluetooth feature on the phone as well as the microcontroller.

2.2.2 Power Supply

The power supply block will be responsible for powering the device as it is mounted on the user's arm. The solar panel will be used to charge the battery [2]. The voltage regulator in this block will need to be able to regulate the voltage from the battery to the required voltages for all the devices connected. This will also need to be able to handle the current flowing through the regulator at peak draw. The power supply will be controlled by the PCB, or the control unit.

• **Solar Panel** should be flexible to adjust to the arm guard. To supply enough power to all the components, it should generate more than 3.7 V. Ideally, 6 V - 500 mA solar panel will satisfy. However, this is assuming regular sunny days. A thorough testing of electricity generation under cloudy days is required.

• **Battery Charger** will charge the Li-ion battery using the energy obtained from the solar panel. Battery charger can receive up to 10 V and charge rate varies depending on the charger.

• **Battery** will supply the power to the device. If it is charged through the solar panel during the day, the device can be used at night as well. For Li-ion batteries that will be used, the output would be around 3.7 V with 150 mA to 1000 mA depending on the batteries.

• **Voltage Regulator** allows to change the input voltage to the voltage that should be used for the device. It is important to control the voltage supply as the components require different voltages and if the voltage is too high, the components may get damaged.

2.2.3 Control Unit

The control unit will consist of a microcontroller. This microcontroller will be responsible for receiving all signals from the input devices. The microcontroller will decide what to do based on the received signals.

• **Microcontroller** will be in charge of deciding which components to use. The data from the Bluetooth receiver should be updated regularly, so the cycle of the microcontroller should be adjusted such that retrieving data can occur without errors. ESP 32 is a microcontroller with Bluetooth module [3], which can process up to 4 MB of data. Since the device only needs some simple instructions, the space will be enough.

2.2.4 Input Device

The input device will contain a switch, a pulse sensor, and a Bluetooth receiver. The switch will be used to turn on the microcontroller, which will then turn on the pulse sensor. The pulse sensor will be used to detect when the user is wearing the device. When a pulse has detected, the remainder of the device will power on. This will allow us to save on energy usage by not turning things on until they are required. Finally, there will be a Bluetooth module. This module will be used to enable communications between the device and a phone-based app.

• **Pulse Sensor** does not require the accuracy. As far as it can detect some pulses, it should run other components. Supplying voltages between 3 V to 5 V will operate the sensor.

• **Bluetooth Receiver** is the component that probably will consume most of the energy, other than microcontroller, since it should continuously communicate with the phone. The data should be pulled out every second to ensure the correct navigating. The input voltage should be between 3.6 V and 5 V to operate.

2.2.5 Output Device

The output device will contain an LED along with several vibration motors. LED will be used to indicate to the user when the device is turned on. Anytime the switch is pressed to turn the device on, the LED will turn on and stay on until the button is pressed again turning the device off. Vibration motors will be used to communicate to the user when to turn left or right.

• **LED** will have different voltage drop for different colours. Since it is necessary to reduce the unnecessary voltage loss, either lower frequency LED will be preferred. Red to green LED's require around 2 V - 20 mA.

• **Vibration Motor** should be strong enough such that the user can notice the vibration. The minimum requirement is 3 V - 85 mA for one vibration motor. If changing the intensity by changing the voltage of the vibration motor is trivial, then it is possible to use multiple vibration motors to change the intensity.

2.3 Risk Analysis

The block that poses the greatest risk to our project working in the success of the microcontroller. The reason for this is that the microcontroller is used in every part of our project. Everything in our design runs through the microcontroller at some point. Without this block functioning properly, we will be unable to deliver a working solution for the problem. The verification of voltages that each component requires will also be taken in depth since high voltages can cause malfunction of teh device or permanently harm the components.

3 Ethics and Safety

In order to maintain the highest standards of integrity, responsible behaviour, and ethical conduct in professional activities during the development of this project, we will always keep the safety of our user and the public as our number one priority. We will strive to research the social implications that our product might bring to the table, and also to always accept criticism and correct any errors we encounter along the way. Lastly, we will treat all of our members and testers with respect and never engage in any harassment or discrimination of others. For safety, we will use good research practices and our skills as engineers to produce a safe design. We are confident that we are able to make this product safe and easy to use. We will make certain that nothing in our design has huge potential to fail or be dangerous to lower the probability of a potential safety malfunction [4].

References

[1] Mapbox. (2013). “Maps and Location for Developers,” [Online]. Available: https://docs.mapbox.com/. [Accessed: 16-Feb-2021].

[2] D. Mohankumar. (2014). “Solar Charger Circuit for 6 V Battery,” [Online]. Available: https://www.electroschematics.com/solar-charger-circuit/. [Accessed: 17-Feb-2021].

[3] E. Systems. (2021). “Esp32 Wi-Fi and Bluetooth MCU,” [Online]. Available: https://www.espressif.com/en/products/socs/esp32. [Accessed: 16-Feb-2021].

[4] IEEE. (2020). “Ieee Code of Ethics,” [Online]. Available: http://www.ieee.org/about/corporate/governance/p7-8. [Accessed: 15-Feb-2021].