Position Warning System

GNG2101, Group **B4B**

4/12/19

Chris Stevenson - 300050319
Matthew Babineau - 300057485
Calvin Hooton - 300060576
Muztavi Kabir - 300059505
Xinyan Jiang - 300049676

Abstract

Our client was involved in an accident 3 years ago, since then he has been wheelchair bound. He has some trouble knowing exactly what his spatial location is and has a tendency to bump into things with his wheelchair. We have designed a position warning system that helps with his spatial awareness. Based on our clients requirements, our system consists of three main parts: ultrasonic sensors, LED’s and a vibration pad. The main idea of the system is once obstacles are detected by ultrasonic sensors, LED lights will turn on to show a visible warning. The vibration pad at the backrest of the wheelchair will activate once rear obstacles are sensed by back-sensors. These two warning methods (LED’s and vibration pad) work in harmony to ensure that the client receives feedback from his surroundings immediately.

Table of Contents

Introduction

Wheelchair users often face the difficulty of not having a complete view of the area surrounding their chair and this leads to unwanted collisions or injuries. A region which is particularly affected is the user’s knees, since the dimensions of the wheelchair are not, in most situations, optimal enough to prevent the knees bumping into an obstacle. The risk of such accidents, especially in the case of wheelchair patients, are immense, since aggravating an existing injury could lead to further deterioration of physical ability. The user should be able to know if a collision is impending, since this could allow them to either stop or change their direction of movement and prevent said collision. This is where the Position Warning System could be an ideal addition to the user’s wheelchair.

The product described in this document uses a simple combination of components such as sensors, light-emitting diodes (LED’s) and a vibration system in order to alert individuals using wheelchairs to any oncoming obstacles or threats. In general, it allows the user to gain a better sense of position with respect to surroundings. In order to get the best out of what this product has to offer, the user should be able to bring their wheelchair to a complete stop or change direction using a joystick/control mechanism at all times. This is crucial since they may, at times, be required to respond to a sudden warning. The user should also be able to distinguish between different colours, since the light warnings would change colour depending on proximity to an obstacle.

Whereas other projects used sensors to detect obstacles only behind the wheelchair, this system covers four different fields of object/surface detection, with two sensors being placed on both the front and the back of the chair. This allows for increased safety and a better user experience. In addition, it helps prevent injuries to the user’s feet or knees, since the user will receive feedback in the form of a light warning if a collision is impending. The various components of this product are placed in a compact manner within the wheelchair, hence ensuring that it will not interfere with the user’s position on the chair. We have also taken into consideration the fact that users would, under certain situations, be required to transfer from one wheelchair to another. The product would not hinder this movement, since the placement of the sensors and electronics have been idealized following multiple testing procedures. Presence of loose wires has been minimized by placing suitable housings.

Main Body

The position warning system can be decomposed into 5 main components; sensors, displays, vibration pad, housings, and controller board. Their functionalities and capabilities are detailed below.

Sensors:

This system uses six ultrasonic sensors, located across the wheelchair. They are placed on the front frame of the chair (figure 1) and on the rear vertical frame supports (figure 2). These sensors feed information directly to the controller board which then activates warning display lights. By editing the code warning distances can be changed. It must be noted that making slight alterations to the code is the only way to go about changing these distances. As long as power remains supplied by a battery this system will function.

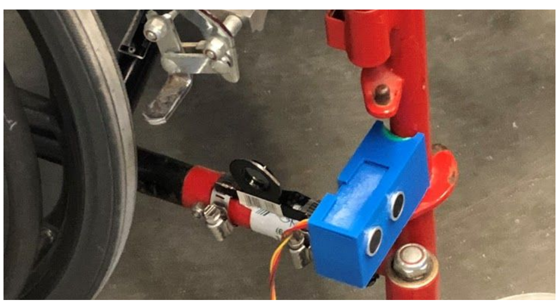

Figure 1. Front sensor

Figure 2. Back sensors

Displays:

Both left and right displays operate as the warning devices for both the front and angled rear facing sensors. They relay an obstacle's proximity by queuing a yellow light for a nearing threat and a red light for an immediate threat (Figure 3). This system function by relying on the data inputted from the sensors if the user focuses on maintaining these sensors, their wiring and the power supply this system will function.

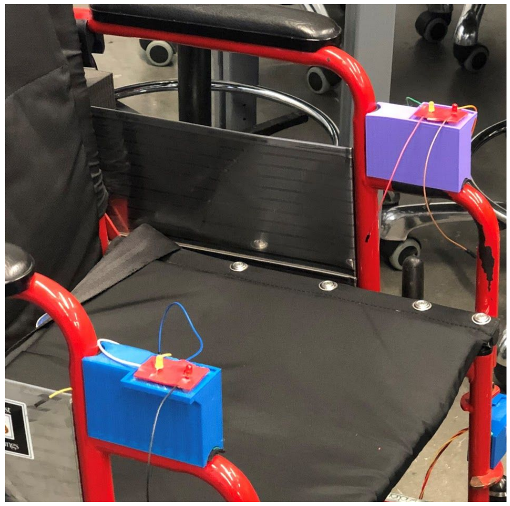

Figure 3.

Vibration Pad:

The vibration pad acts as a warning for the user when an obstacle approaches the rear of the wheelchair. It is fed information **only** from the two rear facing sensors. It operates in the same fashion as the display LEDs but instead of a visual output it is a physical one. It is located on the backrest of the wheelchair. For the maintenance of this system providing wiring is undisturbed and no abnormal force is imposed this system will remain function with an appropriate power supply.

Housing Design and Installation:

There are 6 housing components in the design: 2 front sensors, 2 back sensors, and 2 LED housings. They are placed on the left and right sides of the chair as can be seen in Figures 1, 2, and 3.

These housings were created using Solidworks 2019 and printed using the Cura Ultimaker 2+. They have 20-30% infill and have rubber backing to provide stability and so as to not damage the wheelchair. The ultrasonic sensors can slide directly into the housing, providing a tight fit.

<u>Front housing (Figure 5):</u> Designed with a lid to protect the top from any debris. Mounted only using the frame of the wheelchair and friction between the rounded surface and the frame
<u>Back housing (Figure 6):</u> Designed to house the 2 back sensors. Attached using 3 magnets each, and screws (not into the frame, just hanging on the frame).
<u>LED housing (Figure 4):</u> Designed to house the LEDs. LED PCB is hot glued onto the housing and the housing is attached using the frame for support as well as U-clamps that are bolted on.

Controller Board (Uno Board):

This controller acts as the brains directing the system. Located aft of the user, all input and output wires are run directly to the Uno board. This board is placed inside the back pouch, along with the PCB and the power supply. At this location a port exists so that in the event that the code must be changed a computer can connect an upload modified instructions to the system. This code is attached within the makerRepo link below. To maintain this section of the system the user may inspect surrounding wiring for disconnection or damage. The power supply is also located along with the board so in the natural event that the battery must be replaced the user shall look to the location of the bored.

Troubleshooting:

Code:

If there are problems when using the code provided, see the following solutions:

- Ensure Arduino is connected to the correct port
- Ensure the global variables for the echo pins correspond to the sensors in the diagram
- Ensure the global variables for the lights and vibration pad correspond to the correct digital pins in the diagram
- Ensure logic statements are indicative of the required digital outputs
- Input the distances at the beginning of the loop function in ‘cm’

Wiring:

If there are problems when creating the circuit in the diagram see the following solutions:

- Ensure wires stretching from the ultrasonic sensors are going the correct pins, trig, gnd, echo and vcc.
- Ensure the LED +/- pins go the power and ground respectively
- Ensure the solder on the PCB connects all of the pins together and has no incontinuities
- Ensure wires and solder on Arduino is connected and secured
- If a wire becomes disconnected, follow the wire to the sensor to determine which pin it needs to go to and then reconnect it to the Arduino/PCB

Link to MakerRepo:

https://makerepo.com/Stevenson/gng2101b4b2019

Conclusions and Recommendations for Future Work

There are many key takeaways that come from this project. First of all, when using a large amount of wires, the organization and layout of those wires needs to always be considered, as many wires can create a mess very easily. Having many different sensors and displays on our system required us to use many wires, and we did not plan enough for how they would be arranged. This led to the wires and the Arduino board hanging at the back of the chair with nowhere to store them, as there were too many wires to fit in any of the possible storage locations on the chair. Another lesson learned is that the agile wiring method is not the most useful wiring technique, and that using long wires would have helped us avoid many of the problems that we encountered on Design Day. We initially had thought that using the agile wiring technique would allow for easy assembly/disassembly, because we knew that we would have to remove our system form the chair and place it back on multiple times. This technique hindered us more than it helped us however, as many of the wires would disconnect, and it is quite difficult to reconnect them. Had we used long wires instead of many shorter wires, we could have avoided many of these issues.

For anyone that chooses to work on this project in the future, they must always keep in mind how they will wire their system, and how they will run those wires along the chair. It is essential to be familiar with the entirety of the wheelchair, so that the wires can be as organized as possible, and as protected as possible. Not planning for how the wires will be run along the chair will only lead to issues in the future, and those issues will not be easy to fix.

Appendices

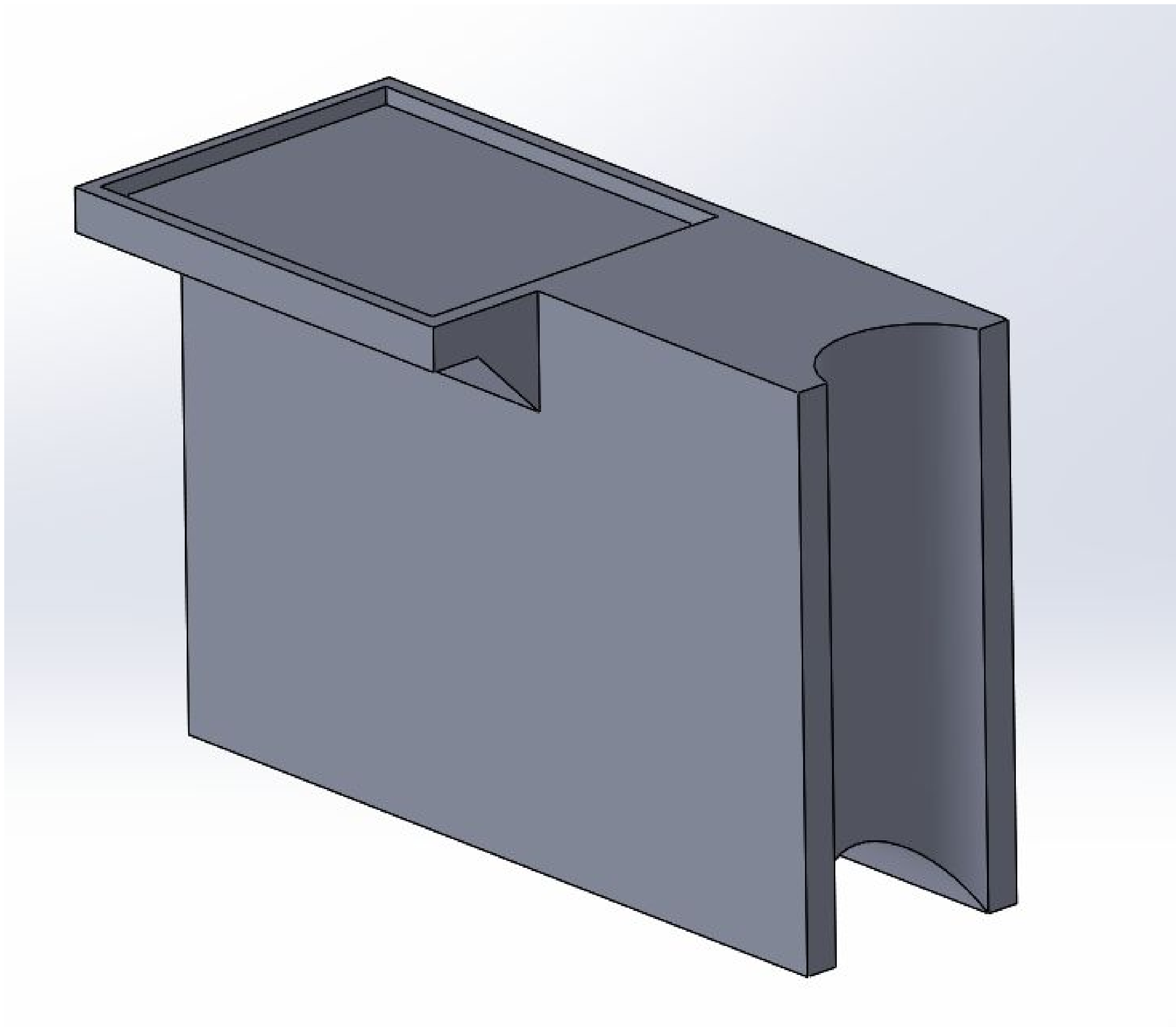

Figure 4. Frame of LED’s display

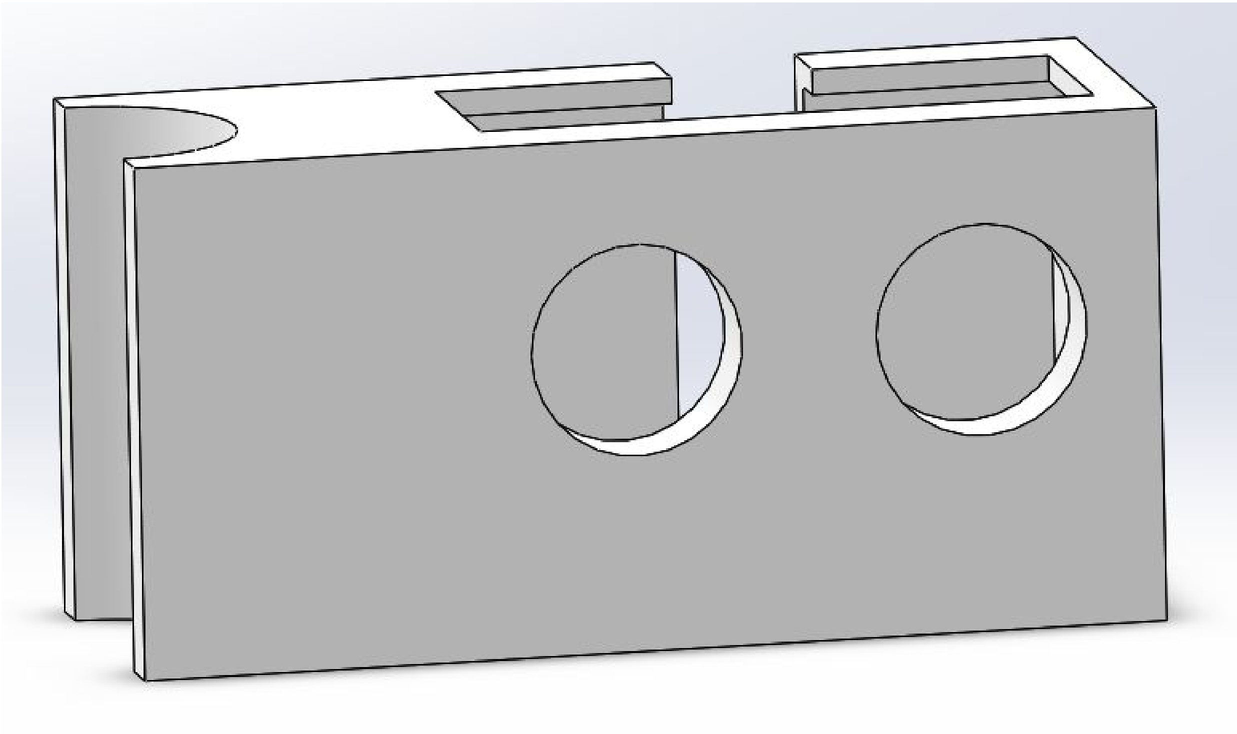

Figure 5. Housing of front sensor

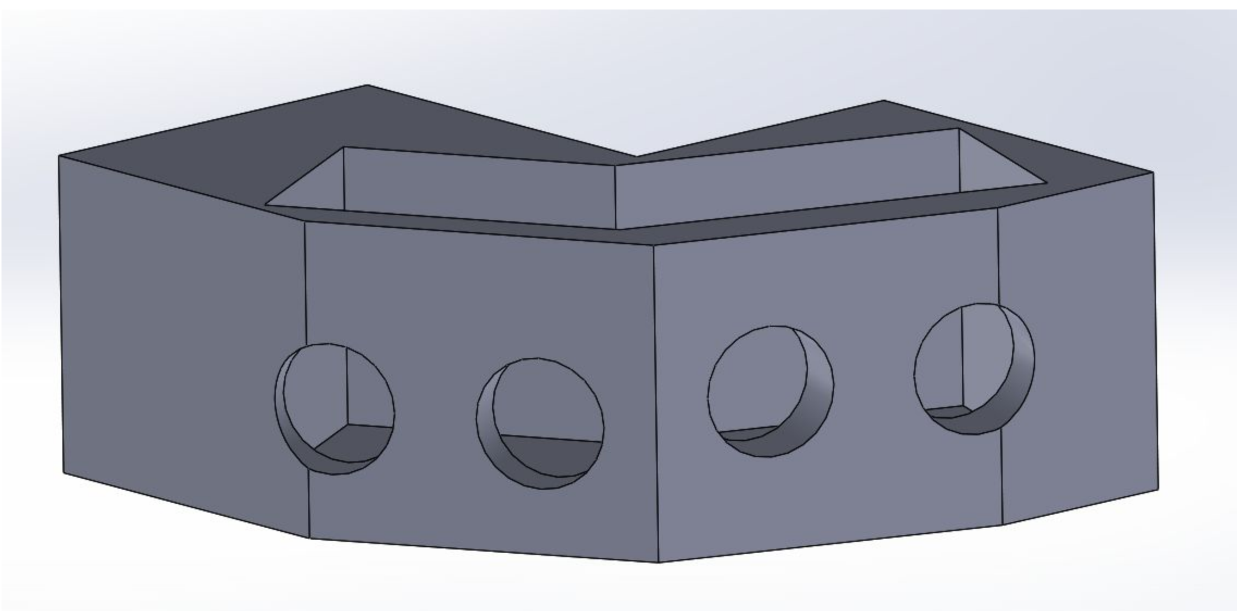

Figure 6. Housing of back sensors

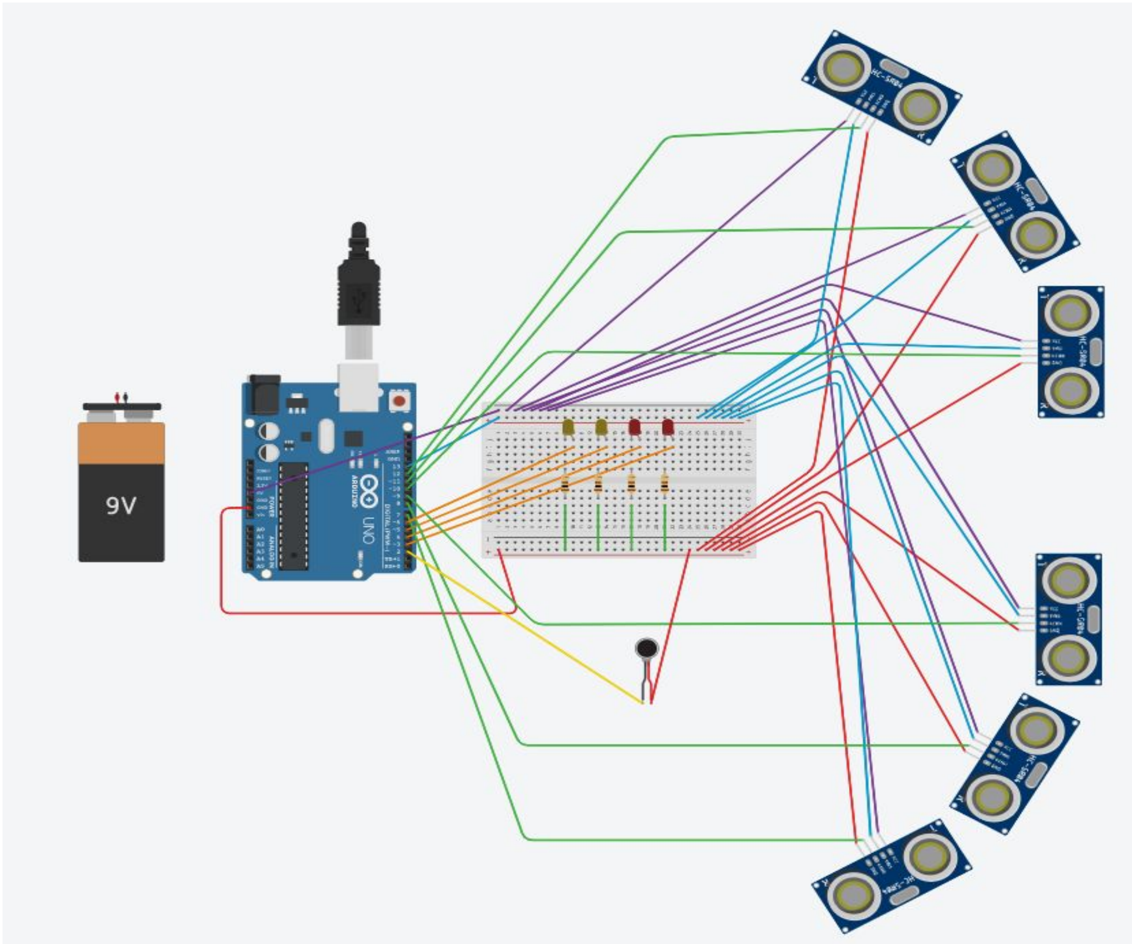

Figure 7. Schematic graph

For code, see attached file within makerRepo.