Position Warning System

**Project Deliverable E- User Manual**

By: Group-7

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**Abstract**

Our customer was associated with such a significant number of physical mishaps, from that point forward he has been wheelchair-bound. He experiences some difficulty knowing precisely what his spatial area is and tends to catch things with his wheelchair. We have structured a position cautioning framework that assists with his spatial mindfulness. In view of our customer's necessities, our framework comprises of four primary parts: ultrasonic sensors, LED's, ESP-8266 Wi-Fi-Module and Vibrator. The principle thought of the framework is once hindrances are recognized by ultrasonic sensors, LED lights will go on to show an obvious action. The vibrator at the backrest of the wheelchair will enact once back obstructions are detected by back-sensors. These two action techniques (LED's and vibrator) work in pair to guarantee that the customer gets feedback from his environmental factors right away.

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# 1. Introduction

The issue to be understood is to structure an attentive and powerful gadget that alarms the customer preceding any impacts, expanding spatial mindfulness and decreasing exertion and time. Position Warning System is a spatial mindfulness gadget that can be introduced on wheelchairs and is intended to give clients sensing module (Ultrasonic sensors) and the feedback module (LED and Vibrator motor respectively) when an obstruction is available near the wheelchair.

## 1.1 So What?

Spatial mindfulness can end up being a lofty expectation to absorb information for most wheelchair clients, particularly to those new to wheelchairs. Clients frequently chance upon individuals, furniture, entryway outlines, and different hindrances which may prompt disappointment and time misfortune, yet in addition wheelchair harm. This issue is considerably more enhanced by electric-controlled wheel seats because of their size and massiveness. This makes a greater test in moving making it increasingly inclined to chance upon anything.

## 1.2 Who Cares?

Collision avoidance technology has the capacity to facilitate safer mobility among older power mobility users with physical, sensory and cognitive impairments, thus enabling independence for more potential users. With increased rates of mobility limitation reported by individuals over age 65, there has been a dramatic rise in wheeled mobility use in this population. Smart or intelligent wheelchairs, which typically combine a conventional power wheelchair with a computer and sensors, have been developed with the aim of enabling people with various disabilities to achieve safe and independent mobility. Anybody with a wheelchair, regardless of whether it is manual or electric controlled, approaches introduce this gadget. This will assist customers with recapturing trust in their portability and give significant serenity to the clients' families demonstrating them increasingly free.

## 1.3 Why Us?

Position Warning System beats every one of its rivals due to its modest, simple to alter structure. It includes an enhanced sensor location structure and moment input framework. The product uses ultrasonic sensors to their fullest hence, reducing maximum blind spots. The prototype has modularity, wider range of sensor coverage, user friendliness and to have minimal wiring. Moreover, the gadget can be introduced and uninstalled with negligible exertion by client or by a companion. The safety of the product and the people is the most vital factor that need be consider while designing our product and thus this lead us to design a quality product. The quality product involves various measurements to ensure its quality is maintained.

# 2. User Manual

## 2.1 How it Works

Position Warning System involves 10 ultrasonic sensors, ESP-8266 Wi-Fi Module, Vibrator, LED’s, Breadboard. The 6 ultrasonic sensors are set on the rear of the wheelchair while 4 in the front on a 3D printed tubular based design. These designs permit the sensor to cover out a 100-degree to distinguish objects at various positions. This entire framework is introduced on a wooden board the size of the wheelchair has returned to give simplicity of establishment. The ESP-8266 is set in a 3D printed box put on the wheelchair to give inclusion and guarantee security of module. The ultrasonic sensors are associated with the ESP-8266 which give the code from wireless transmitter. The sensors send data go back to the wireless receiver without any hindrance. On the working base when the object comes in range of 30 cm the LED illumination is lighter and when the object is less than 15cm the LED indication is very bright to alert the user. The vibrator in the front would alarm the client that there is a barrier in one of their vulnerable sides and that they ought to continue with alert.

Obstacle

Front

ultrasonic sensors

Rear

ultrasonic sensors

Wireless

transmitter

Wireless

transmitter

Wireless

reciever

Wireless

reciever

LED

indication

Vibrator

motor feedback

Figure 1 Basic Flowchart function of the prototype

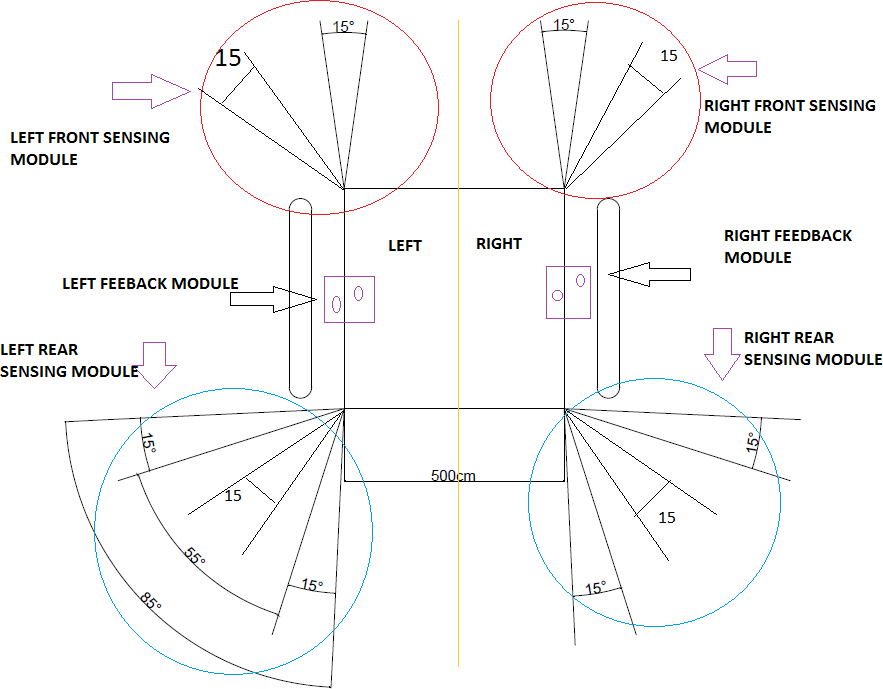


Figure 2 General Prototype Configuration

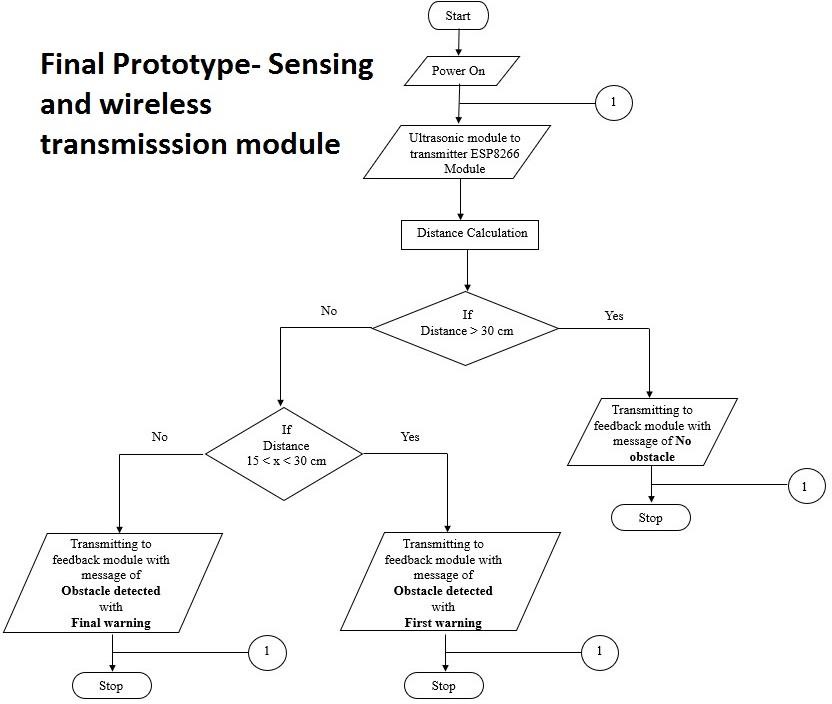


Figure 3 Final prototype- sensing and wireless transmission module

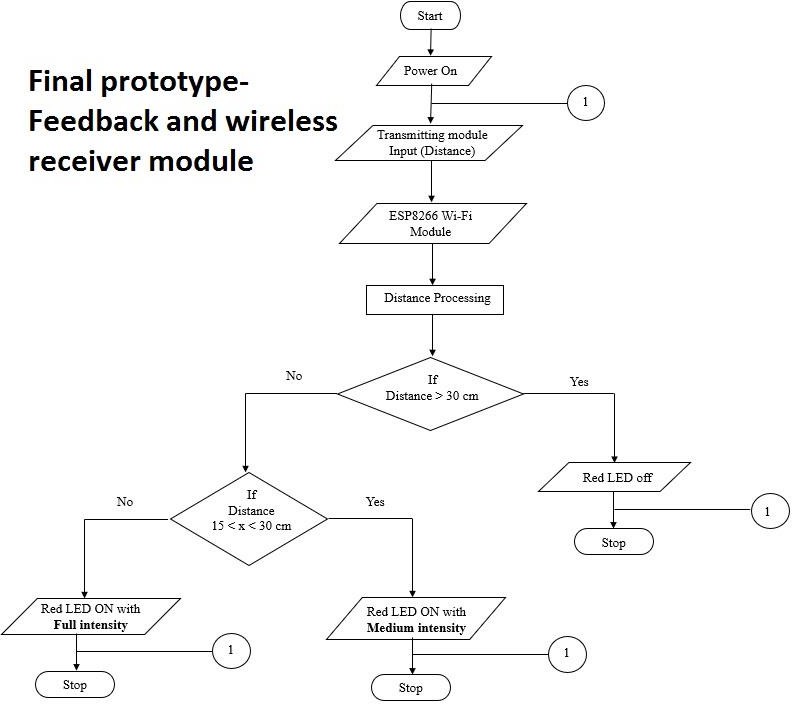


Figure 4 Final prototype- feedback and wireless receiver module

## 2.2 Design Of 3D Printed Components

For this task, various parts must be 3D printed. Most stands, defensive cases, and lodging units were designed for 3D printing to fit careful measurements and decrease cost. The following are a portion of the fundamental 3D printed designs expected to finish this plan:

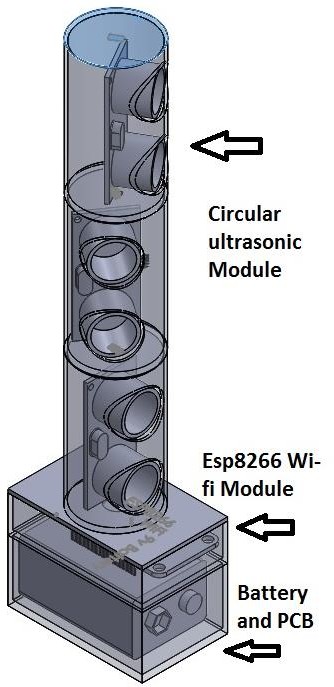
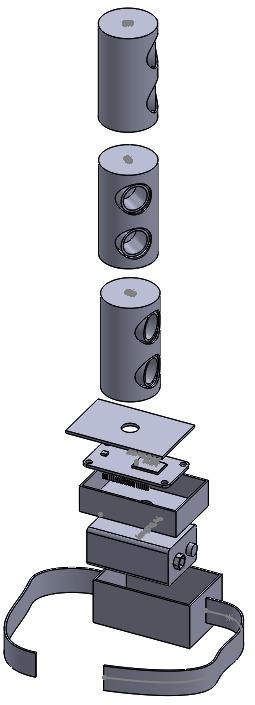


Figure 5 3D model of final prototype sensing

Figure 6 Internal structure of 3D model

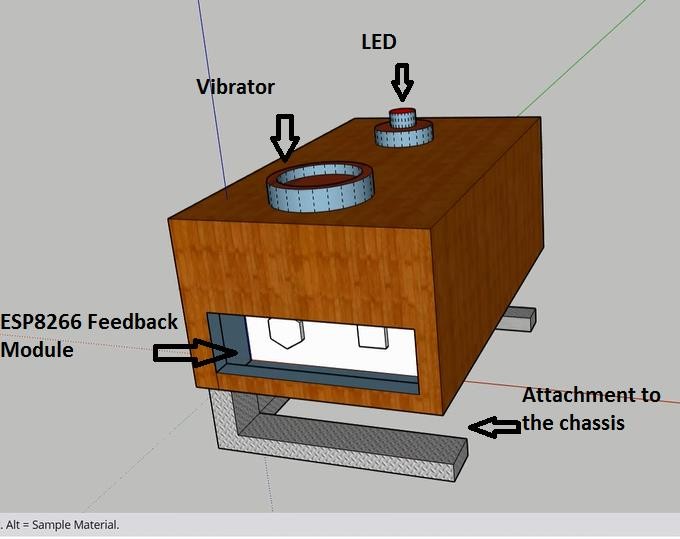


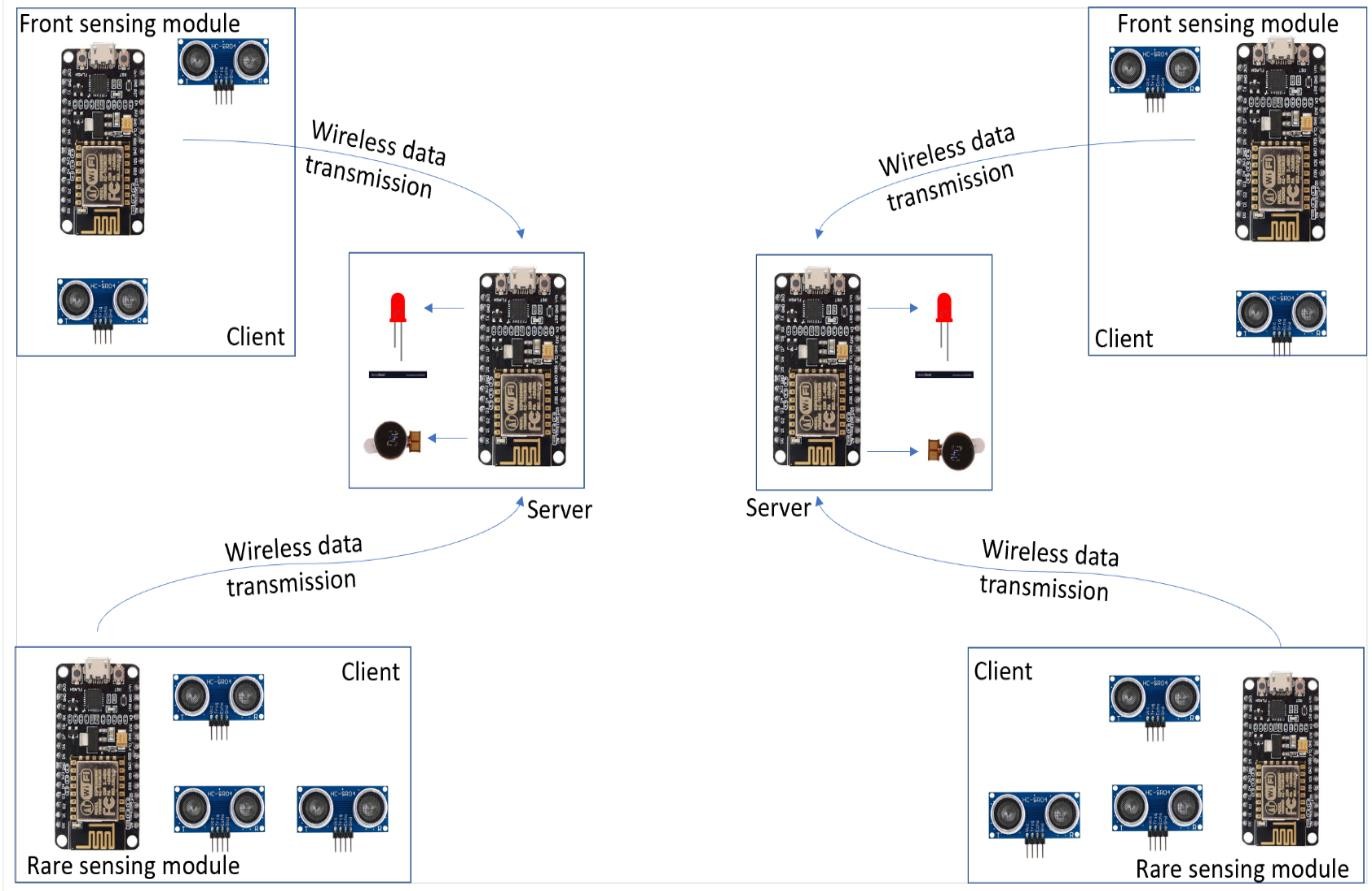
Figure 7 3D model of final prototype- feedback and wireless receiver module

## 2.3 Circuitry

The circuit design of client and server side as mentioned above. All the wires will be soldered according to the schematic diagram.

|  |  |
| --- | --- |
| Client-Side circuit construction | Server-Side circuit construction |

|  |  |
| --- | --- |
|  |  |



|  |  |
| --- | --- |
|  |  |
|  |  |

Figure All circuit connections

Figure 8 All circuit connections

## 2.4 Installation Instructions

The entire structure can be attached to the user’s wheelchair with the help of strap which is available with base box. The entire server structure can be attached in a plug and play manner. It has supporting stand and locking system which directly fits with a wheelchair’s arm rest.

One of the ESP modules are configuring as Master/Server and another one is configured as Slave/Client. LED is attached with Server module and button is attached with Client module. After entering the code in both of them, we would be able to transmit data from client to the server. In this case, we could press the button and send all of the binary data to the server and illuminate the LED.

The sensor circuit will go into the small tube-like structure. The wires would solder to the pins embedded to the ceiling and bottom part of tubes. Every tube gets attached with each other and to the base box with the help of magnets. The ESP module will get attached with the base box and all the wires will be soldered to the pins which are embedded to the ceiling of the box.

## 2.5 Features

The principle highlight of the prototype is the way that it can distinguish protests up to 30 centimeters far. The edge separation of vibrator input is also set to <=30 cm; in any case, this component is flexible to the client's inclinations. Another key element this gadget offers is that not exclusively will it report back the nearness of an object. On the off chance that an article is behind the client and on his right side, at that point the correct side of the vibrator will turn on. It vibrates relying upon which sensor is activated and vibrates in the fitting area.

## 2.6 Safety Guidelines

The prototype uses PLA plastic material which is easily biodegradable. Design is very easy so each and every component can be easily dismantled. Casing and PCB of the product could sustain comparatively longer than battery. Also, the battery that is used in the prototype is dry cell which is better than Li-po batteries form life- cycle analysis perspective. Hence there are very less risk of battery explosion. Below is the website for safety use of battery during transportation.

<https://www.tc.gc.ca/eng/tdg/transporting-batteries.html>

## 2.7 Troubleshooting

In a case of system failure, please follow the following steps to try and solve the issue.

1. Reset the ESP-8266 by pushing its “reset” button or by unplugging and re-plugging the power source.
2. Ensure the wiring is intact and that there are no loose or touching wires. Refer to Figure 6 to compare to proper setup. If problem persists, contact manufacturer for support.
3. If communication between the master and the slave is weakening reset of the module is required.
4. Clean up the ultrasonic sensors net when feedback value is not being updated.

## 2.8 Design Files

For more information on the prototype of position warning system please visit the link below of makerepo:

# 3. Conclusion

## 3.1 Lessons Learned

The challenge of designing a position warning system with a reliable obstacle warning technology, modularity, and the compact design was accomplished by using wireless technology (ESP8266 Wi-Fi module). The ultrasonic technology was used to detect the obstacle using ultrasonic sensor. The variable intensity LED and variable frequency vibrator motor was used to indicate the user regarding obstacle. The functional testing of electrical (Sensors, actuators and Wi-Fi module), software (Ultrasonic sensor distance, Data transmission and receiving through wireless communication, actuating feedback actuators) and mechanical (Software simulation and modeling of casing) sections of the prototype were performed. The software program was completely developed, electrical and mechanical design were completed. The last phase of development was to 3d print the casing and PCB but unfortunately due to uncertain risk (COVID 19 incidence), the team was unable to complete that task and thus assembly testing was incompletely.

Also, creating the prototype, throughout the semester prompted a great deal of exercises learned. Managing the producer lab, figuring out how to 3D print, how circuits work, binding, coding, penetrating and so forth. We took in every one of these things all through the semester which we used to plan and assembling our item. Other than all the aptitudes we gained through this course, there was numerous life exercises learnt all through this whole procedure. Right off the course, we learned time the executives is critical, dealing with a group adequately assigning undertakings and cutoff times assume a gigantic job in a group's capacity to decide achievement and disappointment. Likewise, we learned not all things are ready to be practiced, and an arrangement never works out to how it should be. There are a great deal of factors and factors that will discourage you from arriving at all the assignments you need to have finished. These lone serves to cause dissatisfaction and worry among the group. As a group, we understood this rapidly and relegated needs for all the undertakings we needed to achieve, thusly we can guarantee that our item's principle capacities can be met, and we can stress over littler things, for example, the style as a later date. These exercises will never be overlooked and help us in future cooperation once we are aspiring engineers.

## 3.2 Future Work

The following future works which can be implemented in the prototype is as follows:

1. Improvising battery efficiency by using a battery management system circuit.
2. Constructing dedicated WIFI module circuits that are only designed to interact between

modules. by this power consumption reduces and circuit become more fast and efficient.

1. Adding a feature of mobile application which directly communicate with sensors, for the exchange of commands and data.
2. Design using more efficient sensors like proximity sensor to make system weatherproof.
3. Adding smart control feature that is, the device has the ability to switch on-off the system as per the requirement of the user.
4. Better design of clamps using strong magnets rather than belts, to make it plug and play and user friendly.
5. Fusing those 2 feedback modules into one compact module for reducing power consumption and that makes it easy to maintain.

# Appendix

### 1.0 Need Identification and Product Specification Process

### 1.1 Client Needs and Problem Statement

After meeting with our client several times, the following needs were identified:

* + 1. Help to cover all blind spots of the wheelchair.
    2. Allow client to operate the wheelchair without applying less efforts and skills.
    3. Concerning the wire mess client wanted to have a full wireless module.
    4. Concerning the intensity of the vibrator and its feedback.
    5. There should be no monitor or screen to detect object. Instead he wanted LED light which will change the intensity of the light as per the distance of the object.
    6. Help client to avoid hitting obstacles and having accidents while operating a wheelchair.
    7. A system built around the frame to avoid interference with the structural integrity of the Wheelchair.
    8. The design should easily fit on any type of wheelchair.

**Problem Statement**

Wheelchairs available in the market are robust and reliable machines but the obstacle detection technology available is more complex (like machine vision), and costly. Various attempts were done to reduce the cost and complexity by using basic technology (like sensors, vibration feedback) but lacks modularity. Our aim is to design the position warning system that not only reduces the cost of the system but to improve aesthetics and ergonomics of the system by using modular design and user- friendly interface.

### 1.2 Benchmarking

After a lot of research our team has come to realized that there weren’t too many advancements within this space.

|  |  |  |  |
| --- | --- | --- | --- |
| **DATA** | **QUALITY**  criterion | **DESCRIPTION** | **CORRESPONDING NEED** |
| Sensors position | “EXCELLENT”  proper location of sensor placement | Total 10 sensors used.  **Right Half** -2 sensors used for front and 3 sensors for back  **Left Half-**Same as right half | 1, 6 |
| Sensor Angle | “VERYGOOD”  Appropriate angle/ direction of  the sensor | **Front Side-** 60 Degree  **Back Side-** 90 Degree | 1, 6 |
| Sensor Range | “GOOD”  Selection of range is less with respect to the sensitivity of the  vehicle’s joystick | >30 cm -**No obstacle detection**  >15 cm and <30 cm- **First warning**  <15 cm- **Final Warning** | 1,6 |
| Accuracy of Sensor | “GREAT”  Could work infrequently variable conditions | All 10 sensors accuracy refers to the difference between the output value that is  measured by the ultrasonic sensor and the actual target distance.  **1% to 3%** of accuracy  under temperature from **- 25° C to +70° C** | 2, 5, 7 |
| Accuracy of Feedback | “GOOD”  Obstacle range detection feedback  user- friendly | **Red LED** indication-Front sensor detection  **Yellow LED** indication- Back Vibrator feedback | 1, 2, 4, 5, 6, 7, 8 |
| Wires assembly | “VERY GOOD”  No Wire mesh interference aesthetics of  design | **ESP8266 Wi-Fi module**  Communication between master and slave device | 2, 3, 4, 5, 6, 7, 8 |

Table 1 List of Metrics

### 1.3 Target Specifications

The following table shows the target specifications achieved:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Metric** | **Description** | **Tested**  **Prototype** | **Marginal Value** | **Ideal Value** |
| **Life Span** | How long the product will last before replacement | >5 years | >5 years | >10 years |
| **Object Detection Coverage** | How many angles will the sensor cover | >140  degrees | >180  degrees | >100  Degrees  (Maximum Blind spots were covered) |
| **Structure Mass** | Compact structure with less weight will be easy to attach | <5 Kg | <5 Kg | < 3.5 Kg  (Target has been achieved) |
| **Feedback Intensity** | How is the strength of light and frequency of the vibrator | >50/minute | >50/minute | >70/minute |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Battery Life** | How long the system will function on one full charge | >1 day | >1day | <2 day |
| **Installation Time** | How long it takes to install the product on a  wheelchair | >1  minute | >45  Seconds | Target was not achieved due to **COVID-19 Crisis** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Cost** | The total cost of materials needed to make the  product. | =100 $ | <100 $ | 97 $  (Target has been achieved |
| **Sensing Range** | Distance of sensing | <15 cm | <50 cm | <=30 cm |
| **Maintenance Service** | Low-cost maintenance and easy to maintain | >8 months | >6 months | <12 months |

Table 2 List of Target Specification

### 2.0 Project Planning and Feasibility Study

### 2.1 Gantt Chart

The planning of the whole project is shown in the form of Gantt chart:



Figure 9 Simplified Gantt Chart

### 2.2 TELOS Factors

This section of the Report will include the Feasibility Study, which will include the TELOS factors (Technical, Economic, Legal, Operational, Scheduling).

Technical: Our team comes from a number of different technological backgrounds and thus has a wide range of technical skills. We expect that for attachment bits, our project needs basic programming skills and 3D printing. If more metal or plastic mounts are needed, we can use the resources at CEED center which we are all technically trained to use.

Economic: ESP-8266, LED, ultrasonic sensor are the main aspects of our project. The cost of each of these items is low, so it is not unreasonable to remain within us $100 budget in conjunction with the free resources available to us at the University (3D printing, CEED materials).

Legal: There are no legal issues with releasing our solution to the public. There has never been an attempt at solving this problem in the past, therefore there is no conflict of interest or potential for unoriginal ideas. As long as we give credit to any external company resources, we are using to achieve our project, there will be no issues with releasing this solution for the public to enjoy.

Operational: There should not be any operational constraints that will prevent our success. As long as we stick with our scheduling plan and manage our time effectively, we should have absolutely no issue with achieving our deliverable goals and obtaining the appropriate materials in order to have the best chance at success.

Scheduling: The deadlines revolve around the project deliverable dates which are intended to keep us on track with completing the tasks required to obtain the final product. It is vital to meet the deadlines in order to meet the organizational requirements for the project and to ensure that they are done on time. Most of the tasks we have to do depend on one another, therefore if they are not complete on time, the entire project will fall behind very quickly.