

Smart Walker Device
Trevor Dirheimer
Customer Evaluation to Determine Components
ECE 480 Application Note
Team 4
April 3rd, 2015

Table of Contents

Executive Summary	2
Introduction.....	2
Physical Characteristics.....	2
Environment.....	3
Response Time.....	4
Walker Dimensions.....	4
Duration of Device Usage.....	5
Choosing a Sensor.....	6
Choosing a Power Supply.....	8
Conclusion and Device Expectations.....	9
References.....	11

Executive Summary

Devices for the disabled have the ability to help individuals overcome hardships and obstacles that many others take for granted. The challenge begins immediately at the design process because depending on the disability and other characteristics of the individual the design must fit their needs specifically. In the case of designing a Smart Walker Device that detects drop offs, many considerations need to be made in determining components. This article will discuss an example of steps for the evaluation process of determining the components of a Smart Walker design for a specific individual to meet their needs.

Introduction

To determine the components of a Smart Walker Device many considerations about the individual and their walker need to be tested, measured and determined. This article will describe what to evaluate and test when designing a Smart Walker Device. The components that are affected directly by the user are the sensors and power supply. After the aspects of how an individual and walker affect these components the method in determining and/or testing sensors and a power supply will be explained.

What aspects of an individual should be considered during the design process?

Physical Characteristics

An individual's physical attributes can affect the performance of a Smart Walker Device and must be considered when designing one for each individual. This includes what disabilities they have that may constrain the following needs to be considered:

Height

The height will play a key factor in determining sensor choice. If the individual is taller this will allow for more sensor choices due to not being restricted by the sensor's angle of operation. However, if the individual is shorter, this greatly restricts the sensor possibilities. Make sure to find out how tall the individual is and see how that affects the height of the adjustable hand bars. In Team 4's situation, David is a shorter individual which after testing different types of sensors, found that the angle of operation would be an issue. This is because the placement of the Smart Walker Device will be attached on

the top bracket or on a fabricated bracket that is attached to the adjustable hand bars on the walker. How this specifically affects certain sensors and performance of the device will be discussed more under “Choosing a Sensor”.

Mobility

How well the individual moves with their walker will determine the distance that they can stop in. This will be discussed in further detail below in “Response Time”.

Vision and Hearing

Vision and hearing all play a critical role in deciding the feedback system that will alert the individual to stop before a drop off. The feedback system will be dependent on the disabilities of the individual in these fields. If someone may be visually impaired, using a haptic system (vibrating the handles) or an auditory system (certain frequency tone) that will trigger when a drop off is near would be the best option. On the other hand, if an individual has hearing impairments, the option of a visual system (a blinking LED) would be the better choice. In the end, ask the individual how they would like to be alerted with those following choices and others as well. For auditory systems, keep in mind that when this may be the best option, an individual may have an impairment in a certain frequency range, so confirm that before deciding on the frequency of the auditory system. David is visually impaired in the lower right quadrant of his vision, which is critical in deciding the feedback system. After Team 4 asked David what he recommended for a feedback system, he chose to go with an auditory system over a haptic system.

Environment

The environment of where the individual lives needs to be considered as a result of components such as sensors having certain outside temperatures where the sensor will work as expected. Such as in Michigan during winter when temperatures can drop below 0 degrees. Also certain sensors may be affected from sunlight. To know this and how much the individual will use the Smart Walker Device out is important to find out and record when deciding on components. The effects on environment on sensors will be detailed more in “Choosing a Sensor”.

Response Time

The response time of an individual planning to use a Smart Walker Device is critical. It will depend on the disability and/or disabilities and how well the individual can control their speed and movement with their walker. To test the response time, first set up a time to meet with the individual in an open area where the testing can proceed. Whether it is for an elderly person who has difficulty moving or an individual who has mobility impairments with visual and/or auditory impairments testing can be done with a similar method. Begin with laying out a tape measure and marking where the individual will begin and a certain distance every time with tape (i.e. mark every six inches with tape) or anything else that will satisfy these requirements. Do this for up to ten feet or in respect to another measurement unit. Next, have a designated video camera at two separate vantage points to allow for reviewing the individuals movement patterns with their walker. Use the individual's requested feedback choice that was discussed in "Physical Characteristics". Once the individual begins walking, use the feedback choice to simulate a drop off approaching when the front of the walker reaches a specific marked position not known by the individual being testing. After the individual stops, measure from the specific marked position to the front of the walker at the end position of the individual. Record this value and run this test eight to ten times or until a consensus is made. In Team 4's project, David was stopping in an average distance of 3.5 feet after hearing the auditory feedback. From this and watching the recordings taken during the testing, it was decided that to ensure David's safety at least four feet needed to be left in front of David's walker when the feedback is triggered in order for him to stop before the drop off.

Walker Dimensions

The dimensions of the walker will help to determine the dimensions of the fabricated bracket (if needed) that will hold the Smart Walker Device. These measurements can either be found online for certain walkers or they can be measured in person. The adjustable hand bars for Team 4 was decided as the best position for applying the fabricated bracket which would also hold the fabricated housing for the sensors and microcontroller. This was the best option because it would provide

additional height to the position of the sensors on the walker. The width between the two adjustable hand bars was measured in order for the bracket to be fabricated correctly. See Figure 1 for basic measurements of a walker that can be considered.



Figure 1 - Walker Dimensions

Duration of Device Usage

How long will the individual be using their walker for? Will it be the whole day or only in certain circumstances? Depending on an individual's needs, this will vary and is an important question to ask when designing the Smart Walker Device. This is because of the power supply; so if the walker is used all day by the individual a power supply that can operate and run the device all day on one charge is critical. This allows the user to not worry about the device turning off because of low battery on their walker. Make sure to find out the duration the individual uses their walker for in a given day and apply that along with the component power consumption in determining a power supply. Team 4's choice and how it was decided is detailed in "Choosing a Power Supply"

How do you choose the components?

Choosing a Sensor

When choosing a sensor all the testing and specific characteristics of the individual and walker need to be considered. First, what height will the sensors be at when the Smart Walker Device is applied to the walker? This will depend on the walker design, height of the individual, and the individual's response time with their walker. Also, where will the individual be using their walker (outside, inside, or both?). This is why evaluating the individual's characteristics and needs is a critical part in designing a Smart Walker Device because components and the overall design can and will change per user. The following sensor types and the specific sensors that Team 4 looked at will be detailed below with how they can be used in designing a Smart Walker Device and the constraints that may not allow them to be used depending on the individual's evaluation and testing as discussed above (see "Evaluation and Testing Process" section).

Infrared

Infrared sensors can be looked at as an option after the following considerations must be made. For David, Team 4 found that he needed at least a four foot warning before the drop off so he could stop safely. However, due to his short stature of being around five foot and four inches the bar on the walker would not be successful in being used at three feet high. A bracket was then fabricated that attached to the adjustable handle that raised the sensors to 3.5 feet. Any higher could cause the device to hinder the user's vision in front of the walker if not blind, so this must be considered when fabricating brackets to extend the height of the sensors. This is because of the angle of operation infrared sensors will not reflect the beam back to the sensor if the angle of operation or better known as the angle of depression is less than 45 degrees. So if the height of the sensors on the walker can only reach 3.5 feet, which will mean that it will have the ability to sense only as far as 3.5 feet. Figure 2 displays if the angle of depression is 45 degrees, then "H" (height) and "D" (distance) will be equal known from simple trigonometry. This same issue will arise when looking at the ultrasonic sensors as well. Another issue that would occur with infrared is the effect of ambient light (i.e. the sun) will have on the accuracy of the sensors. There are many ways of filtering this

light out with circuitry but the primary concern is infrared light, like any other light, it is absorbed by dark surfaces such as black asphalt. This affects the accuracy because where the infrared sensors may be calibrated to sense a certain distance on one type of surface, once it hits a black-like surface the light will be absorbed more than being reflected and the sensor would need to be closer to gain enough feedback to read the distance. This is a major issue because the consistency of the sensors on a Smart Walker Device is vital to the performance and safety of the user.

Ultrasonic

Ultrasonic sensors which do not have issues with surface color and ambient light was thought to be a better option by Team 4. It has its benefits and in the right design could be utilized in a Smart Walker Device. A specific sensor that Team 4 considered was the PING))) Ultrasonic Distance Sensor and the specifications and constraints described in this article can relate to other ultrasonic sensors as well. The angle of depression that the sensors will operate at is a critical part of deciding if ultrasonic is the right choice. As discussed for infrared, the ultrasonic sensors will not operate as expected if the angle of depression is less than 45 degrees. This can be seen in Figure 2.

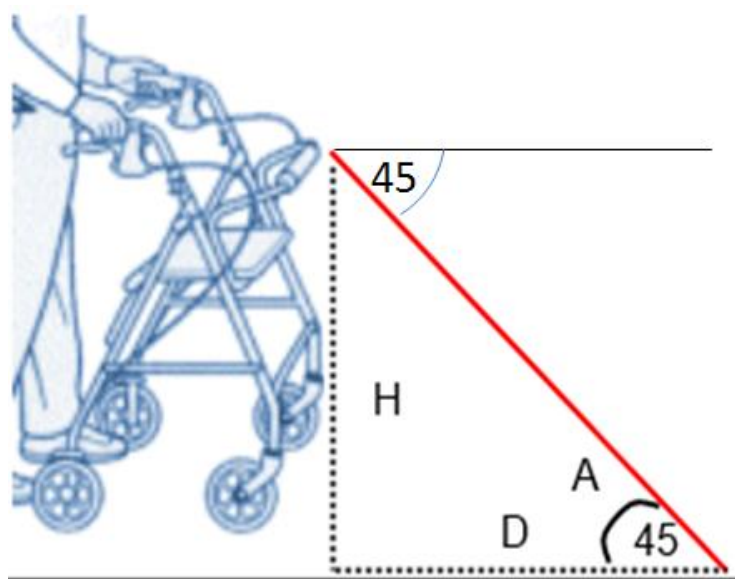


Figure 2 - Angle of Depression at 45 Degrees

Also from the datasheet for the PING))) sensor, Figure 3 displays this as an issue to be aware of along with many others which are the following: distance of object, size of

object, and softness of object being detected. When designing this device for a walker, the softness of the object could absorb a large portion of the ultrasonic pulse and not allow enough to reflect back for feedback. So knowing where the individual will use the Smart Walker Device is important for that reason. Others may find that the other constraints shown can be considered too. Team 4 ran into the issue of not being able to bring the height of the sensors high enough so the angle of depression was at least 45 degrees. This conclusion came after further testing at the designated height of the walker where David would be using it. No testing went into if a much taller individual used this, but it is something to consider looking into further because ultrasonic is an accurate way of detecting distance as long as it fits within the constraints.

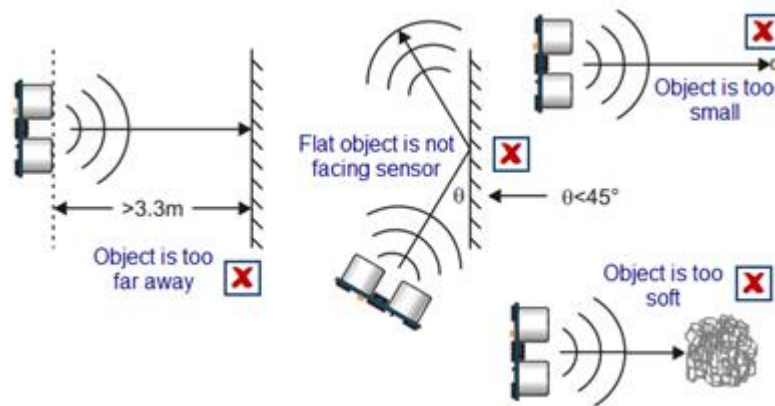


Figure 3 - Constraints of Ultrasonic Sensors

Other Options (LiDAR)

Those are the two options that have been considered currently in the design process for Team 4 and now LiDAR technology is the next sensor that will be tested. The Pulsed Light LiDAR Lite Laser Module is being considered and from the datasheet it has a range up to 40 meters compared to the two to three meter range of the ultrasonic sensors. This feature may allow for the angle of depression to be less than 45 degrees. Until it is tested and a conclusion is made infrared and ultrasonic have their advantages and in the right circumstances could be used to create a Smart Walker Device.

Choosing a Power Supply

The major aspects to consider when choosing a power supply is know how long the individual uses their walker for in a given day and the power consumption of the

sensors, microcontroller, and feedback system if planning to power all three individually from the microcontroller. Another option is powering only the microcontroller and then using the microcontroller to power the other components of the Smart Walker Device if applicable. For Team 4, David will be using his walker all day, so that means the power supply needs to be able to power the device for an entire day and be able to be charged once he gets home. Discuss this with the individual and find out how long they use their walker for, some cases may be only temporary usage. However, when designing a safety device, always plan to allow usage for an entire day. Team 4 found that between the microcontroller, four ultrasonic sensors, and the feedback system would draw about 750 mW continuously. Choosing a power supply of 10000 mAh or higher is the best way to go. Also choosing one that can be turned on easily and charged easily by an individual disabled is ideal. Many companies make great power supply options with displays to let the user know the percentage of battery left and when it is on.

Conclusion and Device Expectations

The primary goal in designing a Smart Walker Device is that it keeps the specific individual using it safe from any possible drop offs. Figures 4 and 5 shows how any expected Smart Walker device should work for any individual with a walker when a drop off is not there and when one is approaching.



Figure 4 - Smart Walker Device: No Drop Off Near



Figure 5 - Smart Walker Device: Drop Off Near

A device that is customizable to each disabled individual allows them more freedom and Team 4 would like to create a universal mounting procedure for the Smart Walker Device that allows the users to easily change the device from one walker to another and have it calibrated ready to operate. Knowing the individual through testing and evaluation will help to make an efficient design where the components will do as expected.

References

Parallax Inc.,. (2015). Retrieved 3 April 2015, from <http://datasheet.octopart.com/28015-Parallax-datasheet-7278097.pdf>

PulsedLight,. (2015). Retrieved 3 April 2015, from <https://s3.amazonaws.com/cdn.freshdesk.com/data/helpdesk/attachments/production/5007466446/original/LIDAR-Lite-Laser-Datasheet.pdf?AWSAccessKeyId=AKIAJ2JSYZ7O3I4JO6DA&Expires=1428075825&Signature=y71rpHBPzvef%2BtfCcvNiGYGoaGs%3D&response-content-type=application%2Fpdf>

Sharpsma.com,. (2015). Retrieved 3 April 2015, from http://www.sharpsma.com/webfm_send/1208