Inexpensive Alternative Way To Build Smart Canes For The Visually Impaired Capable Of Detecting Obstacles

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ABSTRACT

In this paper we propose an inexpensive alternative assistive technology device for walking canes to help visually impaired primarily those that require screen readers to navigate easily while avoiding obstacles. Granted there are many assistive devices on the market that are able to detect obstacles, and numerous research and development currently in process to alleviate the cause, we are concerned cost of devices, size of devices, intrusiveness and higher leaning curve are preventing the visually impaired from taking advantage of available devices. As a result, the goal of this paper is to identify low cost assistive device capable of detecting obstacles with the ability to do it yourself, requires less learning curve, is less intrusive and light weight.

General Terms

Keywords

1. INTRODUCTION

According to the World Health Organization (WHO), there are approximately 45 million visually impaired individuals worldwide. Lost of vision does not only affect educational opportunities, social events but also hinders simple day-to-day activities. Focusing on visually impaired individuals that primarily rely on screen readers, meaning they rely heavily on assistive devices to perform daily tasks. It is obvious they also rely on walking canes to navigate in known and unknown environments. Widely used by the visually impaired, walking canes are simply designed and built without any assistive device. They are mere canes of different colors, sizes and height. These simply designed canes are only capable of detecting below waistline obstacles like street curves, steps and staircases and simple guidance between distances. Although these canes are capable of detecting obstacles, receiving feedback is very low. Therefore visually impaired individuals still find to difficult to navigate especially in unknown environments. On the other hand, there are numerous walking canes available to the visually impaired capable of detecting obstacles with higher feedback. This is due to assistive devices developed and built into these canes to aid navigation in known and unknown environments.

Laser built canes, tactile wand electric canes, ultrasonic canes just to mention a few are examples of canes currently available to visually impaired with high feedback which are able to detect obstacles at any level. Unfortunately, these canes are highly priced ranging from $200 to over $1000. As helpful as these canes can be, they are very unpopular on the market compared to the other canes that provide low feedback.

Another navigating aid for the visually impaired available are navigation devices like cell phones, global positioning systems, and application enabled devices to mention a few. Smart phones like the Iphone has done a great job of building application enabled tools for the visually impaired. These devices do not require the use of canes; rather visually impaired individuals rely on voice commands and tactile feedbacks in known and unknown environments. Also as helpful as these devices can be, they are intrusive and require a learning curve. Learning curves are a major issue among individuals with disability either visually impaired to mentally challenged. Individuals with disabilities are likely to abandon assistive devices due to frustrations encountered while using such device. Also, most of these devices are expensive; some individuals may require financial assistance from the government. Thus, it may take several months’ even years to receive financial assistance. As a result, individuals become frustrated for the long wait forcing them to use an already existing device to perform tasks. For instance, a visually impaired individual already using an average cane may require a more advanced assistive device to help navigate in unknown environments. Therefore, he or she applies for aid from the government to purchase said device. Due to the long wait, the individual is frustrated and goes back to using the average regular cane.

Without a doubt these devices are important and highly needed but because of above-mentioned issues, it is difficult for visually impaired individuals to navigate. To alleviate these issues, we have researched a possible solution to make navigation in known and unknown environments easy and affordable. This solution can also detect obstacles and provide feedback via tactile. It also requires minimal learning curve, not intrusive, light in weight and can be a Do It Yourself project. Meaning, visually impaired individuals can build it without much needed assistance and any financial help from the government.
Related Work

Several studies indicate vast concerns for the visually impaired. Certainly, help is needed and it is obvious there are many research and developments past and present to help ease these issues. Current research on the topic indicates Assistive Technology device are available to aid visually impaired individuals in known and unknown environments. Unfortunately, the research does not address every issue mentioned above. Clearly, they address obstacle detection and feedback, but cost, intrusiveness and portability are rarely mentioned.

Studies involving Assistive Technology aids like ultrasonic devices (sonic torch, Mowat sensor, sonic pathfinder), radio frequency identification, laser, infrared sensors and global positioning systems has been researched and developed to help improve navigation in known and unknown environments. Regardless of these studies, there are disadvantages hindering the cause. For instance, ultrasonic devices cannot be used inside closed premises like offices, houses schools etc. due to the multiple reflection of ultrasonic beam by the boundary walls (Debnath, N et al). This makes it difficult for visually impaired individuals to navigate in their homes, offices and community centers to mention a few.

Radio Frequency Identification use radio waves to read data from tags at the same distance from RFID readers to identify objects that hinder the visually impaired. They require different transmitting antennas, different frequency signals for different room in close premises. They also require end users to simply activate switch to tune the receiver to a specific carrier frequency depending on what room they want to visit (Saaid, M et al). Clearly, a learning curve is needed using this aiding device. The visually impaired must remember to flip a switch every time they want to visit a room.

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Infrared sensors on the other hand, are highly recommended by researchers due to the concept of distance measurement for obstacle avoidance. They are inexpensive, light in weight, easy to use, it is widely available and requires limited learning curve. Using infrared sensors can be applied for constructing smart walking canes for visually impaired individuals. A smart cane can be produced by selecting an infrared sensor that enables obstacles detection within a range that is approximately equivalent to the length of the cane. Infrared beam is sent out as it does for distance measurement. Moreover, the sensors come in small packages compared to other devices mentioned above, use little power to operate, have a variety of output options and very low cost. Given the positive attributes of the infrared sensor, a simple and convenient way of making it accessible for the visually impaired or perhaps making it possible for users to develop or build with affordable materials is feasible.

Interviews

During this study we conducted three separate interviews with two visually impaired individuals and a supervisor for V-LINC. V-LINC is a Maryland based non-profit organization dedicated to building and developing assistive devices for individuals with disabilities. The first interview face to face with participant one is a male in his early 40s. He has been suffering from visual impairment since birth. He currently works for the Maryland Department of Disabilities. The second interview, which was conducted over the phone, involved another male participant. He is also a male who formally worked with V-LINC to help develop and build assistive devices for the visually impaired. Participant 3 involved a supervisor from V-LINC also a male in his early 30s. His main concern was the scope of the study. He helped us identify specific areas to conduct our study, for instance, the challenges with wide variety of assistive devices for the visually impaired.

The following are interview questions:

1. What are the challenges you face when using your walking cane?
2. Have you conducted any research in areas of visual impairment?
   a. How do you keep up with latest Assistive Technology news and updates?
3. How many other assistive devices do you use to navigate?
4. Are these devices intrusive?
5. Are you familiar with Do It Yourself (DIY)?
After conducting the interview, the number one issue they had with their walking cane is the inability to detect obstacles. They also argued, various devices have been developed to prevent obstacles, and safely maneuver in known and unknown environments but cost has been the issue to take advantage of the technology. In addition, weight, portability and intrusiveness have also been the main reasons why the participants are unable to take advantage of Assistive Technology devices out on the market. Throughout the interview, the participants were knowledgeable of many assistive devices. They were current with technological innovations in the areas of visual impairment. During the interview process, we were surprised to how important it for our participants to know their environments. They expressed their dissatisfaction for the current canes they use because it was unreliable. They also expressed their desire for the new and advanced canes on the market, but it was expensive.

Here are a few quotes from the interviewees-

Interview 1- “All I want is a for my cane to notify me of an obstacle about 4-5ft away to take a different route.”

“My issue is with size and cost, I’m not interested in the sophisticated devices researchers are building”

Interview 2- “The other day I walked into a cross bar and hit my head because I didn’t know my surroundings.”

“Weight is not an issue for me, I’m interested in angle of distance 45 degrees.”

After the interview, it was clear our participants wanted a simple and affordable cane that is capable of detecting obstacles in known and unknown environments. Although, the participants were familiar with how expensive these devices were, they occasionally browsed for them to keep up with the technology. Based on the response our interviewees gave us regarding canes, it is obvious that having an ultra-portable, low cost, non-intrusive and able to detect obstacles would be a practical solution to their mobility issues. Therefore, we decided to choose between the ultrasonic sensors and infrared sensors. Given the scope which is to allow the visually impaired to navigate in both known and unknown environments, meaning their homes, offices and community centers to mention a few. It became apparent to choose infrared sensors over ultrasonic sensors.

Figure 3 - Infrared Sensor

Figure 4 – Telemeter (Ultrasonic aided sensor)

Discussion

Due to the various numbers of assistive devices mentioned above to aid the visually impaired, it was difficult to come to a final decision. Especially between the ultrasonic and infrared sensors, research showed how effective ultrasonic is in detecting obstacles. It is said to be sharp and accurate compared to infrared sensors. But because cost was one of the main concerns among our participants we decided to choose infrared. It was important to make decisions based on the results of our interview regardless of research and development. On the other hand, we believe more interviews could have been conducted to get more user input. Also, we believe more literature research could have been conducted to identify what type of energy source would be suitable. An additional study would include the levels of vibration the visually impaired would receive as a feedback when an obstacle is detected.

Conclusion

In this paper we describes an inexpensive alternative way of identifying assistive devices to develop and build a smart cane for the visually impaired to detect obstacles. This paper primarily focuses on users who rely on screen readers as another alternative way to perform tasks. Although there are many assistive devices available to detect obstacles, there are also research and developments currently ongoing to make navigation easy in known and unknown environments. But our main concerns are the cost of devices, size of devices, intrusiveness and higher leaning curve. These concerns are preventing the visually impaired from taking advantage of above mentioned devices. As a result, we have been able to identify the infrared sensor as our assistive device to help detect obstacles.

Future Work

Future work on this study would involve more research on the engineering of a smart cane. Since we plan on making it possible for the visually impaired to build these devices on their
own, it is essential to determine the feasibility. As result, we will be working closely with V-LINC to identify the possibilities and limitations of building a smart cane with an infrared sensor.

References


