

Smart Walking Stick for Visually Impaired

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Abstract

Current walking stick design unable to offer the blind and visually impaired a level of independence that can be achieved with modern technology due to its primitive design. Therefore, this paper proposed a Smart Walking Stick prototype by increasing security and usability of the stick while ensuring an affordable price for an older and lower income demographic. The propose prototype used an ultrasonic sensor to detect potential obstacles from a longer distance from the stick, vibrating motors used to alert users on the obstacles through haptic feedback with buzzer that produced sound, a comfortable handle added to increase the stick's comfort and ease, and a mini GPS (Global Positioning System) used to receive and identify the blind user (longitude / latitude). Observations and basic testing confirmed the effectiveness of the handle vibrations and ultrasonic sensor accuracy up to 1.0 meters from the walking stick end.

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1. INTRODUCTION

As reported the WHO, as at 2019, there are currently 2.2 billion (WHO, 2019) people in the world have some form of "blindness and visual impairment". Malaysia, itself, has 1.2% of blind people from 28.33 million citizen (Malaysian Society of Ophthalmology, 2016). For them to move around and get on with their daily life, they need assistance. One of the tools invented for their use is walking cane. Walking stick or also known as walking cane is the most important mobility aid that used by blind or visually impaired person. Conventional walking stick used by visually impaired people is not effective in detecting the object or obstacles. It can only detect obstruction upon impact. To solve this problem, the idea of developing the Smart Walking Stick came up as a project.

a. White Cane History

In the West, cane has many usages, some use it as symbol of power and strength but in its early days it is used as protection to the user from thieves and farmer used it to ensure livestock are in line. Canes are categorized in many ways, for the blind the cane used by them is called White cane. It was reported (Fashionablecanes.com, 2019) that a guy, James Biggs from Bristol claimed that he invented it in 1921. He used the cane as his walking

stick and painted it white so that people can see him in the dark.

In February 1931, a guy named, Guillyd' Herbemont (Fashionablecanes.com, 2019) make a national rally of the white stick for the visually impaired in France. To cut long story short, Congress of America make a law that let the president in announcing a National White Cane Safety Day, that create awareness and acknowledgement of the white cane. Until now, the National Federation of the Blind in the USA (Drupel Commerce by Acro Media, 2019), has since created the Free White Cane Program and more than 64,000 of the cane were freely distributed.

b. Work Done

Many works have been done with regards to the proposed prototype but with using different methods, using different microcontroller and more added features. One of the research done by (Odong Sam, 2018) proposed a walking stick with radio frequency waves which is used to locate the user once the button is pressed. In (Mohammad Hazzaz Mahmud, 2013), the smart stick make use of PIC series microcontroller, PING ultrasonic obstacle sensor, proximity sensor and vibrating motor, while work proposed by (Abhishek Bhokare, 2016) make use of Artificial vision and object detection method. It used RF, Ultrasonic, Atmega Microcontroller but it does explain on how the design is used. Explanation on how the object detection method is used was not available.

While authors (Dada Emmanuel Gbenga, 2017) claimed that the stick developed can detect obstacle be it wet or dark through the use of beeping sound. This model used ultrasonic sensors with obstacle and moisture detection sensors. Obstacle detection is within 2m from the user. In another application (Romteera Khlaikhayai, 2011) combine the stick with wireless sensor with adhoc networks which provide navigation information. Equipped with voice alert system, it works only if the distance walk is out of bound of the safety zone. It claimed that the stick can communicate with other stick with the use of the technology. Many other works (Rashidah Funke Olanrewaju, 2017), (Saptari, 2019), (Rohit Sheth, 2014) (Hussain et al. 2016a, 2016b), (Ghani et al. 2019) and (Akhila Jose, 2016) used almost similar methods with added features such as detect water obstacles, design of the grip and GPS for tracking user.

2. Research Development

In proposing this prototype, Rapid Application Development (RAD) is applied as the start of the research process. It is one of the research methodology currently available in the field. Researcher starts with a meeting or series of meetings in this first phase. Researcher discusses who the target user is, what problem the target user faced, what problem the target user faced, what limitation, and what needs to be considered by the user requirement. Researcher to do an investigation into the current environment.

Researcher proposed that the Smart Walking Stick to have their owned emergency button on the stick to send location to their guardian smartphone, in case they get lost. These meetings initiate the process of development by establishing a mutual understanding of the development project objectives in general and the system in particular. Figure 1 showed the process of the requirement.



Figure 1: Task in Requirement Planning

a. User Design

This stage is for the planning and creating the critical system components of the prototype model, type of data and processes flow of the system. Action diagrams that define the process and data interactions for the prototype were completed. The whole task that the researchers must

complete during the user design phase is shown in Figure 2.

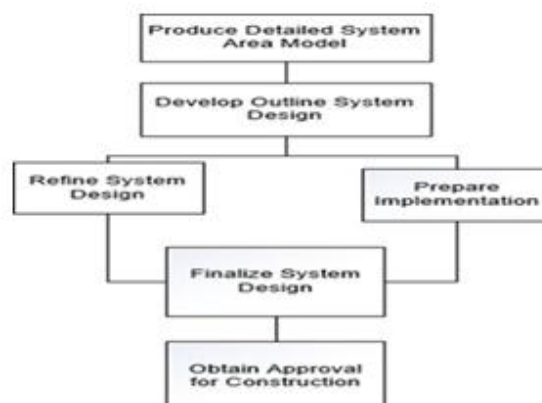


Figure 2: User Design Tasks

3. Prototype Development

During the development of the proposed prototype, focus is given in finding the best software and hardware to be used.

a. Hardware Components

Arduino Uno, shown in Figure 3, is the brain of the hardware that starts the prototype to work. It is a microcontroller board used to create projects for electronics.



Figure 3: (a) Arduino Uno board(Arduino 2019, 2019); (b) 1Sheeld board and GUI

Arduino consists of both a programmable physical circuit board and a piece of software or IDE (Integrated Development Environment), which is used to write and upload computer code to the physical board. It does not need separate hardware to load new code to the board. The board comes with another hardware named 1Sheeld that connected to the existing board, which become the wireless middle-man, conveying data from Arduino to any Android smartphone. Another software is needed to create communication between the shield and the board, so the 1Sheeld board comes with its software. It can become input or output and use all of the sensors and peripherals on board the Android phone.

4. Result

Figure 4 is working flow of the proposed design. Range of obstacle detection is less or equal to 50cm.

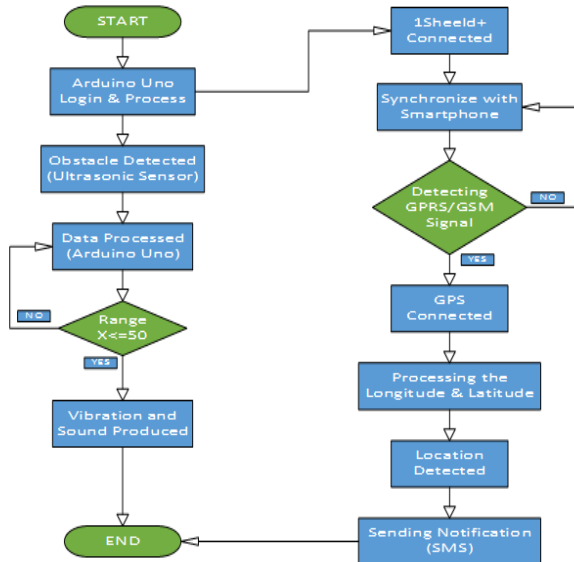


Figure 4: Flow of the design

From the chart, it can be seen that once the stick is used, caretaker can monitor the whereabouts of their patient and if anything happens to them, notifications is sent through SMS.



Figure 5: Proposed Prototype

Figure 5 above showed the proposed prototype ready to be used. Figure 6 below depicts the use case diagram to further clarify the flow of the proposed prototype. It is used to collect the information of the desired functions of the system.

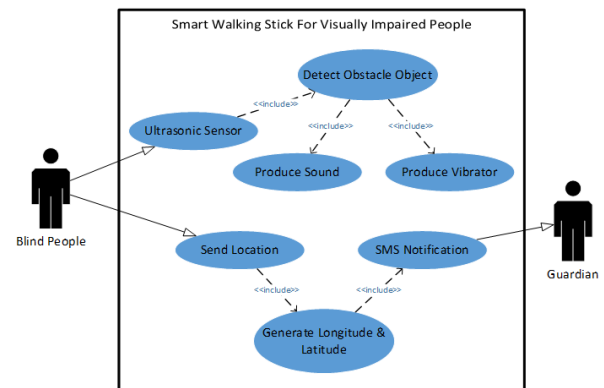


Figure 6: Use Case diagram.

5. Conclusion

In conclusion, the proposed prototype is easy to build and used by visually impaired person. The proposed prototype can be commercialized to the association and organization that provide support to the blind people. Malaysian Foundation for The Blind is one of the organizations that support blind and partially sighted people by providing and equipping them with relevant technological aids. Thus, this project will give benefit of new technology to the organization as well as the blind people for a better life.

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