International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 12 Issue: 2
Article Received: *25 November 2023* ***Revised:*** *12 December 2023* ***Accepted:*** *30 January 2024*

Prototype Using Ultrasonic Sensor to Assist Visually Impaired Individual in the Philippines

Joyce Cadiz Malubay
College of Information Technology and Computer Science
University of the Cordilleras
Baguio City, Philippines
joycemalubay@gmail.com

Mary Grace Abellano Buban
College of Information Technology and Computer Science
University of the Cordilleras
Baguio City, Philippines
marygracebuban1117@gmail.com

Melinda A. Beninsig, MIT
College of Information Technology and Computer Science
University of the Cordilleras
Baguio City, Philippines
mabeninsig@uc-bcf.edu.ph

Engr. Dionisio R. Tandingan Jr.
College of Information Technology and Computer Science
University of the Cordilleras
Baguio City, Philippines
drtandingan@uc-bcf.edu.ph

Abstract— People who are visually impaired deals with number of difficulties when exercising the most basic things in daily life. Some are frequently rely on others, which makes them less confident in an unusual setting and some use tools like white cane or simple sticks, but for some cirsumstances these could put their lives at risk while traveling. Since the Philippines has limited access to technological resources that could reduce the risk, the researchers came up with the idea of using an ultrasonic sensor to detect obstacles that are above or in front of the user. The study aims to develop a functional prototype that helps visually impaired individual and determine how well the functional prototype responds to the needs of the blind individual. Utilizing a problem-based approach to problem solving, the Design Thinking Methodology was the methodology employed in this study. As a result, using different sound and vibration frequencies the prototype can identify minimum distances of 120 cm, 80 cm, and 30 cm as an output. The study concludes that a successful tool could be a design prototype that uses sensor-equipped sticks to assist blind individuals in moving around and increasing their awareness of their surroundings. However, the scope of this study is limited as it is unable to determine the material of the obstruction or whether a hole exists in front of the user because the tool used in this work can only detect barriers above and in front of the user.

Keywords- Visually Impaired Person; Obstacle Detection; Ultrasonic Sensor; Internet of Thing (IoT)

I. INTRODUCTION

Walking is the most fundamental and popular form of transportation, and it has been shown to have positive benefits on a number of physical and psychological outcomes. Daily walking, especially for seniors, has considerable health advantages, hence preventing impairments. Today's, more mature adults live more vibrant lives than those of the past (they travel more, for example). With a prevalence rate of 1.98% [1] in the Philippines, a lower-middle income nation in southeast Asia, blindness and visual impairment are significant public health concerns. Despite this, socioeconomic, barriers prevent access to sight-saving care for an estimated 4 million Filipinos who have eye disorders [1]. There were 21,430 (7.86%) registered visually impaired people in the Region 5 (Bicol Region) Philippines from January 2010 to January 2022, according to the Persons with Disabilities (PWD) Office.

Therefore, disability is a problem in today's society and one of the most active threats to the independent life of blind people is the quantity and variety of obstacles they face while moving, including those that are embedded in the ground or that emerge from building walls [2]. In addition, visually impaired individual, even someone who is entirely blind, typically needs a guiding stick for aid when moving around and carrying out daily duties [3] and their inability to see and move about causes visually impaired persons a lot of challenges in their daily lives [4]. Also, blind or handicapped people experience many difficulties in daily life because it is difficult for them to move, which is extremely harmful [5], and people who are visually impaired encounter daily accessibility and mobility challenges [6], those (VIP) frequently rely on others and assistive technologies [7].

In addition, most crucial senses for human mobility and environment awareness are vision. Blindness can make it difficult for sufferers to trust themselves and navigate their surroundings [8] and blind people who are visually impaired find it more difficult to navigate when navigational aids still rely on manual instruments [9]. Significantly the amount of research has been done on the creation of mobility aids for those who are visually impaired person (VIP). However, none of them appear to meet the demands of visually impaired individuals, which may indicate that these needs were not taken into account sometime [10].

Undoubtedly, the functional prototype offers assistance for visually impaired people in our community in overcoming some of the challenges they have when accomplishing daily duties that require them to go from one place to another. This is to help the blind people find roadblocks. In this situation, the author of this study uses the body of prior research to give a low-cost solution for the detection of impediments and travel aids for people who are blind or visually impaired. Although the study's functionality is comparable to other existing researches, there are differences in the suggested devices in terms of dependability and cost. In addition, the device is designed to assist the visually impaired person and providing those with low incomes and limited access to government assistance. Taking into account the same findings of previous researches, this study intends to develop a functional prototype that helps visually impaired individual and determine how well the functional prototype responds to the needs of the blind individual in the Philippines.

II. Methodology

In order to better understand the needs of users and applications, design thinking has become popular as a method of problem-solving from the viewpoint of the user or customer [11]. The design thinking process consists of five steps: empathy, define, ideate, prototype, and test, and these strategies form the foundation of the framework [12]. Therefore, each step that the researchers take in creating and designing a prototype are discuss below and presented in Fig. 1.

Figure 1. Design Thinking Methodology.

Stage 1: Empathize - the first phase of design thinking, wherein the researchers gain real insight into users and their needs.

Stage 2: Define - researchers define the problem statement in a human-centered manner.

Stage 3: Ideate - identify innovative solutions to the problem statement created by the researchers.

Stage 4: Prototype – the researchers identified the best possible solution.

Stage 5: Test – this is the stage for testing the solutions that derives a deep understanding of the product and its users done by the researchers.

III. Methods and Materials

A. *Circuits View and Components*

For functional-checking purposes, the study runs the simulation on the completed circuitry using the free online Arduino simulator TinkerCad. A complete wiring diagram for the new Assisting Visually Impaired Person (AVIP) is shown in Figure 2. The written program code from the IDE software is tested in a simulation to determine if all the related components can work together to make it through the test. This theoretical test can detect even a single misconnection and pinpoint the exact position of the issue.

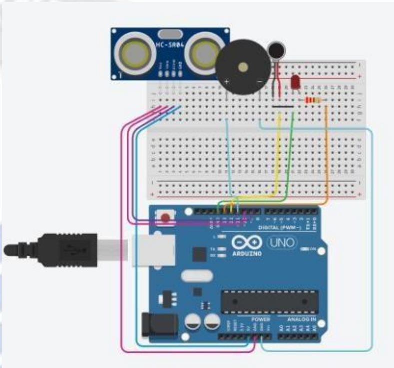

Figure 2. Circuit View of (AVIP) simulation.

Sensors that have been incorporated in the device:

Ultrasonic sensor: The ultrasonic sensor is utilized to give the stick's user a greater understanding of the obstacles that are in front of and all around him.

Light sensor: The automatic light sensor will automatically turn on when it detects obstacles, so giving the elderly person improved vision. This feature is quite helpful for elderly people who have issues with his vision but not totally blind.

Vibration motor (with a buzzer): The vibration motor, which also has a buzzer will vibrate if any barrier is present identified in the user's line of sight. This engine will be given a one of the three ultrasonic sensors' input signal, which provide a 360-degree field of detection, which gets activated, it begins to buzz and vibrate, offering the elderly person to move out of the way or should reorient his path.

B. *Schematic Design and Simulation*

Ultrasonic sensor is a very well-known device with its functionality to measures distance of an object using sound waves. It works by transmitting a sound wave at ultrasonic frequency and waits for it to bounce back from the object. The time delay between transmission of sound and receiving of the sound is used to calculate the distance using the formula of:

$$\text{Distance} = \frac{(\text{Speed of Sound x time delay})}{2}$$

In Fig. 3 shows as the overall connection and coding synchronization. It is simple to use and quite beneficial for systems because it emphasizes circuit elements and illustrate how their functions relate to each other.

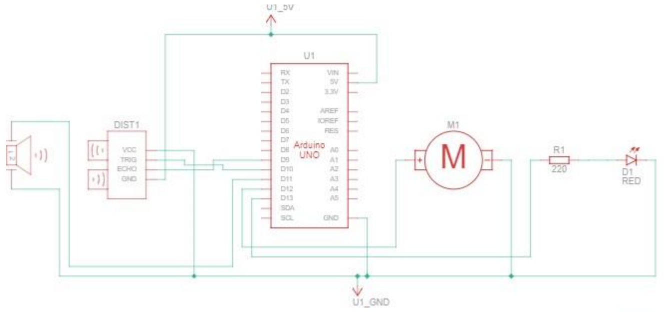

Figure 3. Schematic circuit of (AVIP) simulation.

IV. Results and Discussion

A. Simulation example of Algorithm

The first simulation shows in Fig. 4 demonstrate that when an obstruction is identified at a level of 120cm to 81cm, the buzzer, vibratory motor, and LED light, turns into active mode. The tone of the buzzer is 500 frequencies with 1000m/s delay. The tested distance shown in the diagram below is about 120 cm or 1.2 meters, and it detects obstacles above the user.

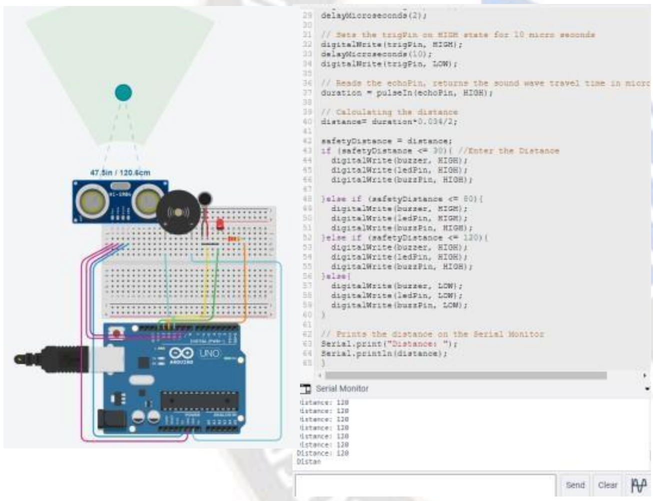

Figure 4. Simulation 01: 120cm to 81cm.

However, the second simulation shown in Fig. 5 demonstrates that when an obstruction is identified at a level of 80cm to 31 cm, the buzzer, vibratory motor, and LED, turns into active mode. The tone of the buzzer is 1000 frequencies with 600m/s delay. The diagram's tested distance is around 80cm or 0.8 meters, and it detects obstacles in front of the user.

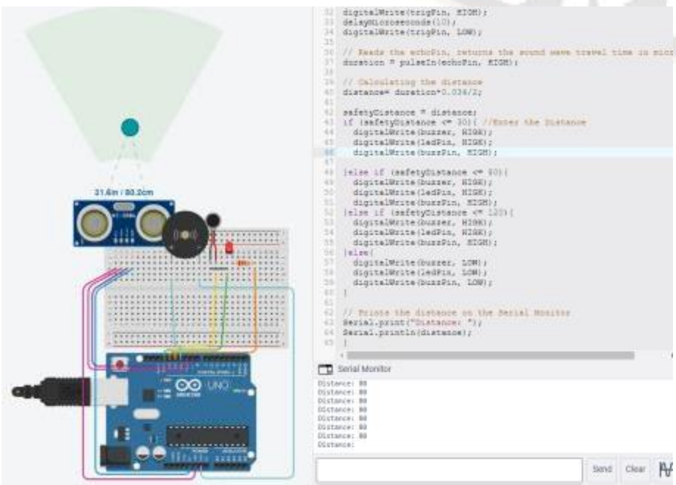

Figure 5. Simulation 02: 80cm to 31cm.

In the final simulation, as shown in Fig. 6 demonstrates that the LED, vibrating motor, and buzzer are all in the inactive mode and the tone is low, indicating that there are no obstacles in the user's field between 0 and 30 cm. The buzzer has a 500 m/s delay and a 1500 frequency tone. The diagram's tested distance is approximately 30cm or 0.3 meters.

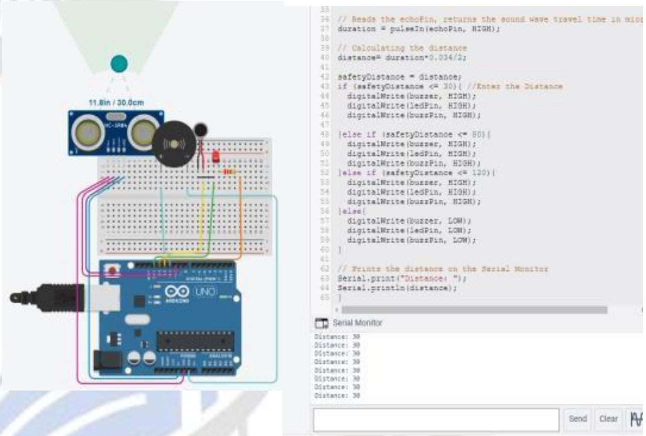

Figure 6. Simulation 03: 30cm and below or 121cm and above.

B. Architectura functional framework of the prototype

This prototype was created using the C++ programming language, which is commonly used in the creation of microcontroller programs. This utility operates on the basis of instructions or commands included that are programmed into the microcontroller. The sensor can function as an input or output. When the ultrasonic sensor detects an obstacle above, in front of and around the user, it will give awareness with the help of the stick's wherein the device is attached. Also, if a barrier is detected in the user's line of sight, the vibration motor will vibrate, and the and different tone will turn on depends on the distances detecting different obstacles like having an object above, like stairs infront of, or other obstacles as an example shown in Fig. 7.

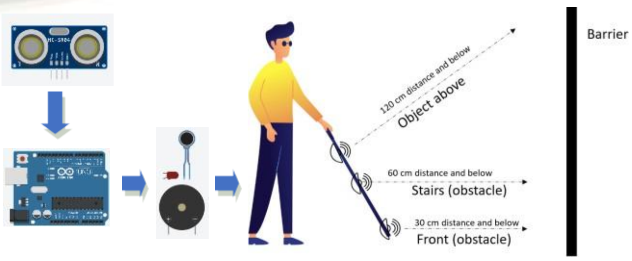

Figure 7. Architectural functional framework of the prototype

C. Systems Flow Chart Diagram

In Fig. 8 depicts that if a blind person were to start walking from 0 to 30 cm, the buzzer would continue to sound with a 2 m/s delay but the vibrator motor and LED lights would be off, it means that there would be no obstacles in the way. On the other hand, if there is an obstacle between 31cm to 80cm, the buzzer turns to 1000 frequencies with 600m/s delay, and the vibration motor and LED lights would be ON. While if there is an obstacle between 81cm to 120cm, the buzzer still on with 500 frequencies and with 1000m/s delay, therefore, the vibration motor and LED lights would still be ON. But if a blind person were still walking and there are no obstacles form a distance of 121 cm and above then it is the same with 0 to 30cm, the buzzer would still continue to sound with a 2 m/s delay but the vibrator motor and LED lights are also be off.

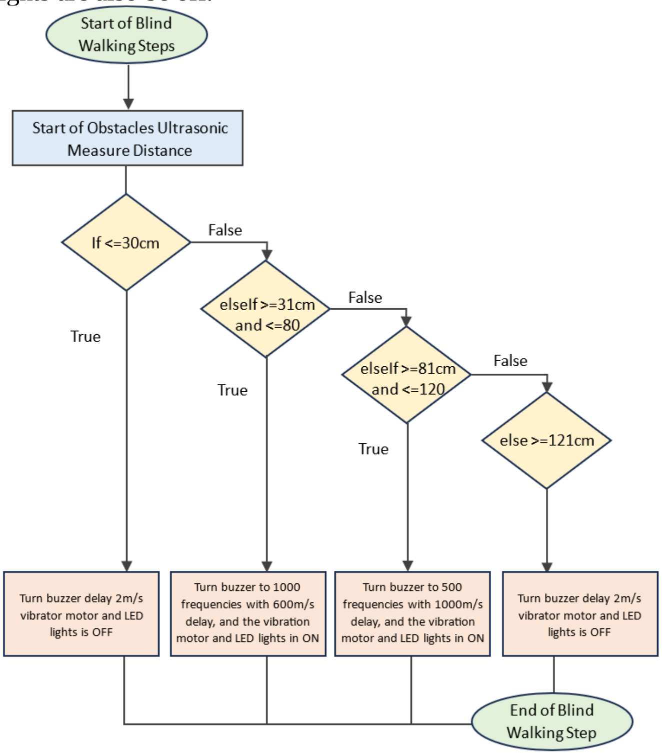

Figure 8. Flow Chart Diagram

V. CONCLUSION

It is clear from the prototype that blind people have benefited greatly from ultrasonic sensor sticks. The number of blind accidents will be decreased as a result of this prototype, both when it comes to complicated road structures and obstacles that they must navigate while moving from one location to another. The stick's length against the sensor can be adjusted to detect obstacles up to 120 cm, 80 cm, and 30 cm. These settings are effective because if the stick is set too far away, the obstacles that are detected close to the stick may frequently be censored. The stick design is a frame made up of comprised in one piece, including a stick rod, and the sensor unit, to be more flexible and makes it more practical to carry.

ACKNOWLEDGMENT

The authors would like to express their gratitude to the Persons with Disabilities (PWD) Office for their assistance during interview and providing the data needed; Melinda A. Beninsig, MIT our research adviser, for her guidance; Dr. Gerry P. Lopez, whose insightful comments significantly enhanced the paper's quality; Engr. Dionisio R. Tandingan Jr. and Jeffrey S. Ingosan, MCS for fostering and assessing the abilities of the authors; and to our family, who provides us with spiritual support. The researchers also express our gratitude to the anonymous reviewers whose suggestions helped to improve the quality of the paper. The writers gratefully acknowledge financial support from SIKAP Philippines' CHEDRO5.

REFERENCES

[1] Caraga, N. N. C. (n.d.). Keep your vision guarded. Www.nnc.gov.ph. https://www.nnc.gov.ph/regional-offices/mindanao/caraga/8892-keep-your-vision-guarded
[2] Pereira, A., Nunes, N., Vieira, D., Costa, N., Fernandes, H., & Barroso, J. (2015). Blind Guide: An Ultrasound Sensor-based Body Area Network for Guiding Blind People. Procedia Computer Science, 67, 403–408. https://doi.org/10.1016/j.procs.2015.09.285.
[3] Obaid, N. M., Hamad, I. A., Madkhane, A. M., Hamad, Y. A., & El-Hassan, F. T. (2019, November). Design and testing of a practical smart walking cane for the visually impaired. In 2019 IEEE/ACS 16th International Conference on Computer Systems and Applications (AICCSA) (pp. 1-5). IEEE.
[4] Salama, R. M., Idoko, J. B., Meck, K., Halimani, S. T., & Ozsahin, D. U. (2022). Design and implementation of a smart stick for visually impaired people. In Modern Practical Healthcare Issues in Biomedical Instrumentation (pp. 77-85). Academic Press.
[5] Salama, R., & Ayoub, A. (2019). Design of smart stick for visually impaired people using Arduino. New Trends and Issues Proceedings on Humanities and Social Sciences, 6(6), 58-71.
[6] Cardillo, E., & Caddemi, A. (2019). Insight on electronic travel aids for visually impaired people: A review on the electromagnetic technology. Electronics, 8(11), 1281
[7] Aarthi, V., Sre, C. S., Delfina, M. S., Arasi, G. S., & Kumar, M. T. (2021, April). Smart Alert and Intimation System for Vip (Visually Impaired Person). In 2021 5th International Conference on Computing Methodologies and Communication (ICCMC) (pp. 1284-1289). IEEE
[8] Harshita Shetty1, Richa Khade2, Prof. Rohini Bhosale3 (May 2020), Design And Construction Of Arduino Based Aid For Visually Impaired People, International Research Journal of Engineering and Technology (IRJET) Volume: 07 Issue: 05
[9] Yasir, M., Lestari, I. N., Setiawan, C., Effendi, M. R., & Hamidi, E. A. Z. (2021, August). Design and Implementation of The Blind Navigation Aids Using Ultrasonic Sensor. In 2021 7th International Conference on Wireless and Telematics (ICWT) (pp. 1-6). IEEE
[10] Argüello Prada, E. J., & Santacruz Forero, L. M. (2022). A belt-like assistive device for visually impaired people: Toward a more collaborative approach. Cogent Engineering, 9(1), 2048440.
[11] Shapira, H., Ketchie, A., Nehe, M., 2017. The integration of Design Thinking and Strategic Sustainable Development. Journal of Cleaner Production, 140, 277-287.
[12] Dam, R., Siang, T., 2016. 5 Stages in the Design Thinking Process. [Online]. Available from: https://www.interaction-design.org/literature/article/5- stages-in-the-design-thinking-process/ 2016.12.09.