Blindsight Glove: Empowering the Visually Impaired with Sensor Technology

Amruta Bhawarthi, Kaustubh Muley, Kavya Amrutkar, Devendra Kawade, Anushka Kausadikar, Ayush Kawane, Kaustubh Singh
Department of Engineering, Sciences, and Humanities (DESH)
Vishwakarma Institute of Technology, Pune, 411037, Maharashtra, India

***Abstract*—A straightforward, physically grounded analysis demonstrates the detection of objects in the front-end area. Barrier detection is achieved using notification tools such as buzzers and disk vibrators. The project utilizes wave transmission principles and ultrasonic sound waves' reflection. An ultrasonic sensor is employed to transmit sound waves, which subsequently bounce back when they encounter obstacles and are received by the sensor. Upon receiving the reflected waves, the Arduino code is designed to activate the buzzer and vibrating motor immediately. This system aims to alert visually impaired individuals, enabling them to navigate their surroundings independently and safely. By providing audio feedback and utilizing a vibrating mechanism, this tool can enhance mobility, ensure safety, and contribute to an improved overall quality of life for visually impaired individuals.**

***Index Terms*—Arduino, Barrier detection, Buzzer, Convenience, Safety, Ultrasonic sensor, visually impaired.**

I. INTRODUCTION

In today's world, there is a significant population of approximately 2.2 billion visually impaired individuals, including those who are also deaf. Among them, there are 9.3 million people in India who suffer from both blindness and deafness, making it crucial to develop solutions that empower these individuals to lead normal lives. To address this need, we have created a device called the "Blind Sight Glove" that aims to enhance their interaction with the physical world.

As part of our research, we recognized the importance of gaining insights into the specific difficulties encountered by individuals with visual impairments to address their unique challenges effectively. To gather information, we extensively studied research papers that provided valuable insights into the issues at hand. With this knowledge, we focused on utilizing specific components such as an ultrasonic sensor, Arduino Uno, a buzzer, and a vibration motor. The Blind Sight Glove is specifically designed to detect obstacles or objects that appear in front of the blind person. By utilizing an ultrasonic sensor, the glove is capable of detecting the presence of obstacles within a predefined threshold distance. Once an obstacle is detected, the code programmed in the Arduino Uno triggers the activation of the buzzer and vibration motor, alerting the user about the obstacle in their path.

Through the use of the Blind Sight Glove, we aim to provide visually impaired individuals with a reliable tool to detect and navigate obstacles, thereby allowing them to interact with their surroundings more confidently and independently.

II. LITERATURE REVIEW

This paper discusses the concept of ultrasonic smart glasses, which incorporate an Obstacle detection module and an output device. This system consists of a buzzer, an ultrasonic sensor, and a control module. The buzzer is a part of the output unit [1]. At the beginning of 2014 device consisted of two RGB cameras, feedback audio, and obstacle detection. But here the cameras were unable to dif-ferentiate between the environment textures. So by that time research was going on till 2019. By the time improvements were done and at the end, the research included two main components which are RGB-D cameras and ultrasonic sen-sors. But it is applicable only in indoor environments. Early devices include the navigation system which is pretty helpful for the sufferers which are there in the (2016) model whose paper was published [6] This paper provides advanced solu-tions for problems faced by blind persons. The integration of an ultrasonic sen-sor, along with light and water

sensing capabilities, is incorporated into the design of the blind stick [2]

This paper talks about obstacles Avoid gloves for blinds to alert them while walking. The Gloves are designed Using Arduino Nano, an Ultrasonic sensor, speakers, and alarm [3] The measurement of distance to objects or obstacles is crucial in various applications such as robotics, vehicle control, and blind navigation. Among the available options, ultrasonic sensors offer a cost-effective solution. This research paper introduces a distance measurement system that utilizes individual units for ultrasonic transmission and reception, both of which are controlled by a microcontroller. The experimental setup and results demonstrate the feasibility of this approach. However, the measured distances exhibit errors that can be attributed to factors such as the generation and processing times of the burst pulse signals. To address this, corrections are applied to improve the accuracy of the measured distances. Overall, this system holds promise for applications in sewer inspection and other scenarios requiring distance measurement of objects.

III. METHODOLOGY

A. Theory

The world can be a challenging and intimidating place for the visually impaired. Tasks easily accomplished by sighted people may seem like a burden for the visually impaired. However, advancements in technology provide us with an opportunity to enhance our quality of life. This research focuses on the development of a comprehensive system that incorporates both hardware and software components. The hardware components required for this system include a microcontroller, ultrasonic sensor, buzzer, vibrating motor, and battery. The Blindsight Glove provides users with real-time feedback about their environment and guides them to avoid obstacles and make informed decisions about their movements. With the support of the glove, the visually impaired can navigate surroundings with greater ease and confidence.

B. Proposed System

This research aimed to create a device for visually impaired individuals to navigate safely. The design principles can be summarized as follows:

a) Reliability: Highly reliable hardware is chosen to ensure consistent performance.
b) Advancement: State-of-the-art technology and advanced software engineering techniques are applied.
c) Expandability: The design allows for future expansion and integration of enhancements.

These principles ensure a dependable, advanced, and adaptable device for visually impaired individuals to navigate their surroundings confidently.

The hardware components are assembled to create the hardware prototype for BlindSight Glove. The microcontroller is then programmed to control and provide feedback to the user. This feedback is delivered in auditory and vibratory form through a buzzer and vibration motor respectively. The data required for this feedback is obtained with the help of an ultrasonic sensor. In the programming of the microcontroller, a predefined distance of 30 inches is set as the threshold for detecting obstacles. If the ultrasonic sensor detects an obstacle within this distance range, the system will trigger both auditory and vibratory alerts to notify the user of the obstacle's presence. On the other hand, if the obstacle is farther than 30 inches from the sensor, it is considered a safe path. To provide more nuanced feedback, the intensity of the vibration motor changes inversely with the distance between the obstacle and the system, giving the user a clear indication of the proximity and potential danger.

During the testing phase, it is observed that the prototype achieves maximum efficiency when the ultrasonic sensor is angled at approximately 15°. This angle allows for optimal detection and accuracy, ensuring reliable obstacle recognition. A serial monitor is used to verify the accuracy of the distance calculations made by the program. By comparing the distances calculated by the program with the predefined values assigned to the program, the effectiveness of the device is found.

In summary, the assembly of the hardware components, programming of the microcontroller, and prototype testing are critical steps in the development of the BlindSight Glove.

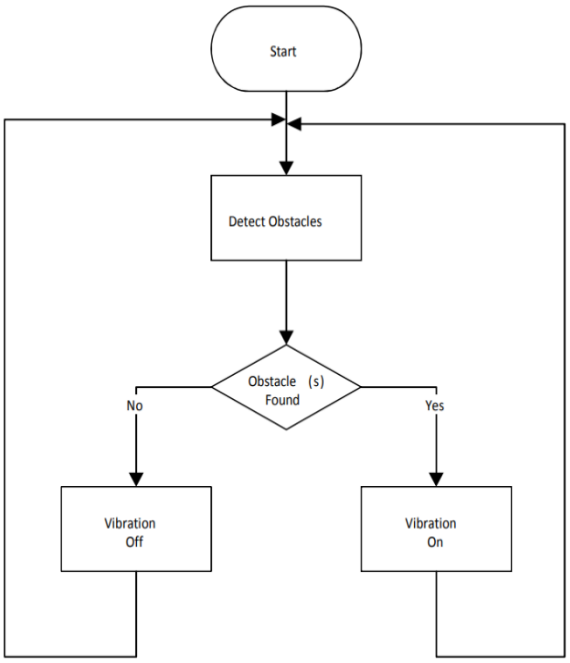

Fig. 1. Flowchart of Software Implementation

C. Diagrams

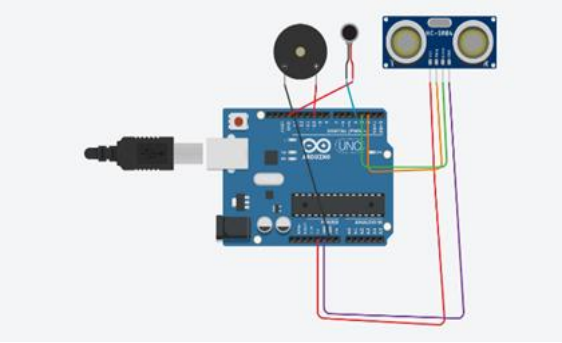

Fig. 2. Circuit Diagram

Fig. 3. Project Prototype

IV. RESULTS AND DISCUSSION

The ultrasonic glove is a promising new technology that has the potential to revolutionize the way the visually impaired navigate the world. It is an affordable and practical alternative to the existing assistive technologies, like electronic travel aids and guide dogs. It can become an invaluable tool for the visually impaired. It offers confidence, mobility, and a greatly enhanced life for those visually impaired.

V. CONCLUSION

The proposed device known as the Blindsight glove offers a more convenient alternative to traditional white canes for visually impaired individuals. Additionally, by incorporating a disc vibrator, individuals with both visual and hearing impairments can benefit from this device.

To further enhance its functionality, it is recommended to expand the field of view of the ultrasonic sensor, allowing for better analysis of data and detection of distant objects. Moreover, the addition of object recognition and visualization capabilities would enable blind users to identify specific obstacles or objects in their path. In future iterations, integrating GPS and a smart tutor could provide even more support, allowing relatives to monitor the user's location and assist with navigation. The smart tutor feature could also offer guidance and assistance in troubleshooting potential issues. These proposed enhancements aim to improve the device's usability and effectiveness in assisting blind individuals.

VI. FUTURE SCOPE

The proposed glove system lays the foundation for further advancements and improvements. Some potential areas for future development include Enhanced Object Recognition: Integrating advanced object recognition algorithms can enable the system to identify specific objects and provide more detailed information to the user. This would assist blind individuals in differentiating between various objects and obstacles.

a) Gesture Recognition: Incorporating gesture recognition capabilities can enhance the functionality of the glove, allowing users to perform specific gestures to trigger different actions or access additional features.

b) Wireless Connectivity: Adding wireless connectivity options, such as Bluetooth or Wi-Fi, can enable the glove to communicate with other devices or systems, opening up possibilities for integration with smartphones or navigation aids.
c) Machine Learning Integration: Leveraging machine learning techniques can enhance the system's performance by continuously learning from user interactions and improving object detection accuracy.

By exploring these areas of future development, the glove-based system can evolve into a more sophisticated and reliable tool to assist blind individuals in their daily activities.

ACKNOWLEDGMENT

We would like to express our sincere appreciation to our project guide for her invaluable guidance, insightful perspectives, and unwavering support throughout this project. Her expertise and encouragement played a crucial role in keeping us motivated and on track. Furthermore, we extend our heartfelt thanks to all the individuals who contributed to the successful completion of this project. Each person's unique skills and efforts were instrumental in overcoming the various challenges encountered. We are deeply grateful to every individual involved in this project, and we sincerely hope that the BlindSight Glove will help the visually impaired navigate surroundings with greater ease and confidence.

REFERENCES

[1] R. Agarwal et al., "Low cost ultrasonic smart glasses for blind," 2017 8th IEEE Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON), Vancouver, BC, Canada, 2017, pp. 210-213,doi: 10.1109/IEMCON.2017.8117194.

[2] M. Bousbia-Salah, A. Redjati, M. Fezari and M. Bettayeb, "An Ultrasonic Navigation System for Blind People," 2007 IEEE International Conference on Signal Processing and Communications, Dubai, United Arab Emirates, 2007, pp. 1003-1006, doi: 10.1109/ICSPC.2007.4728491.

[3] Zhou, R. (2019) Obstacle Avoidance Gloves for the Blind Based on Ultrasonic Sensor. Intelligent Control and Automation, 10, 107-117 doi: 10.4236/ica.2019.103007.

[4] J. W. Simatupang and B. R. Prasetya, "Embedded Smart Glove using Ultrasonic and Flame Sensors for Helping Visually Impaired People," 2021 International Conference on Radar, Antenna, Microwave, Electronics, and Telecommunications (ICRAMET), Bandung, Indonesia, 2021, pp. 115-119, doi: 10.1109/ICRAMET53537.2021.9650494.

[5] https://ieeexplore.ieee.org/iel7/6287639/9668973/09837057.pdf

[6] N. Ahli, H. Aljassmi, H. Alahmed, "Smart Wearable Obstacle Detection Glasses for Low-Vision People", University of Sharjah, UAE 2015-2016.

[7] G. Raj, R. Singh Faculty of Architecture & Ekistics Jamia Millia Islamia "Creating Smart & Barrier Free Environment for Elderly or Physically Restrained People." Inter-national Journal of Engineering Research & Technology Vol. 10 Issue 09, (2022)

[8] H. Chen, Y. Zhang, K. Yang, M. Martinez, K. Muller, and R. Stiefelhagen, ''Can we unify perception and localization in assisted navigation? An indoor semantic visual po-sitioning system for visually impaired people,'' in Proc. Int. Conf. Comput. Helping People Special Needs pp. 97–104(2020)

[9] ang K., Wang K., Lin S., Bai J., Bergasa L.M., Arroyo R. Long-Range Traversability Awareness, and Low-Lying Obstacle Negotiation with RealSense for the Visually Im-paired; Proceedings of the 2018 International Conference on Information Science and System; Jeju, Korea. pp. 137–141(2018)

[10] S. Kayukawa, T. Ishihara, H. Takagi, S. Morishima, and C. Asakawa, ''BlindPilot: A robotic local navigation system that leads blind people to a landmark object,'' in Proc. Extended Abstr. CHI Conf. Hum. Factors Comput. Syst pp. 1–9. (2020)

[11] A. Bhuniya, S. Laha, D. Kumar Maity, A. Sarkar, S. Bhattacharyya, "Smart Glass for Blind People" MSE JOURNALS-AMSE IIETA publication; Vol. 38; N°1; pp 102-110(2017)

[12] K. Shrivastava, A. Verma, and S. P. Singh. Distance Measurement of an Object or Ob-stacle by Ultrasound Sensors.International Journal of

Computer Theory and Engineer-ing.[Online].vol
2, pp-1793 – 8201(2010)