Assistive Eyewear: Arduino Powered Eyeglasses for Blind Individuals

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Abstract

The quality of life for individuals with visual impairments has been significantly enhanced by assistive technologies. This paper introduces a new solution called Arduino Powered Eyeglasses (APE) for Blind Individuals tailored specifically for blind individuals. APE integrates sophisticated sensors, microcontrollers, and audio feedback systems into a wearable device, enhancing spatial awareness and navigation capabilities. Utilizing ultrasonic sensors, the system detects obstacles in the user's path and delivers real-time audio feedback through a buzzer embedded in the eyeglasses frame.

Furthermore, it has an embedded vibration motor that acts as a feedback system as well when navigating an outdoor and indoor environment that is noisy. The design, implementation, and preliminary evaluation of APE are presented herein, emphasizing its effectiveness in aiding blind individuals with various daily tasks and promoting independence and mobility. APE's affordability and user-friendly interface position it as a promising solution for empowering individuals with visual impairments to navigate the world with increased confidence and autonomy.

1. Introduction

Millions of people around the world live with vision impairment, making everyday tasks and moving around safely a constant challenge. Traditional aids like white canes and guide dogs are helpful, but they can be limited in what they offer and aren't accessible to everyone. Our project aimed to create something more intuitive and affordable. Arduino-powered eyewear that used sensors to detect obstacles and provided real-time feedback through vibrations and sounds. By developing these smart glasses, we hoped to give visually impaired individuals greater confidence and independence in navigating their daily lives.

In the visually impaired community, blind individuals, such as the Massage Therapists at Mall , and blind residents faced unique challenges that needed assistive technology. Blind individuals require assistance in daily tasks, ranging from navigating spaces to identifying potential hazards for both indoor and outdoor environments. This project, entitled "Assistive Eyewear: Arduino Powered Eyeglasses for Blind Individuals," sought to empower blind individuals by providing them with specially designed eyewear, driven by Arduino technology, to enhance their daily activities. The lives of visually impaired individuals have seen substantial improvements through the development of assistive technology, and though the implementation of assistive eyewear may pose challenges, when executed effectively, it proved highly impactful.

The benefits of this project included increased independence, access to information, and improved quality of life. However, there were challenges as well, such as cost, usability, and limited availability of certain technologies.

Assistive eyewear held immense significance for blind individuals, offering a transformative bridge to a world largely experienced through touch, sound, and other senses. For people who are blind or visually impaired, the term "assistive eyewear" may seem contradictory, but it actually referred to a variety of cutting-edge technologies that were intended to improve the visually impaired person's sensory environment. Smart glasses, for example, that were fitted with sophisticated sensors and artificial intelligence could translate visual data into tactile or auditory feedback, giving users vital context awareness.

The focus of this study was to introduce the assistive eyewear to blind individuals. This study aimed to provide support to their daily activities by enabling them to navigate their surroundings through this assistive eyewear. This would be conducted within Tayug, Pangasinan.

Additionally, assistive eyewear promotes social inclusion by allowing blind individuals to recognize signals and facial expressions, led to deeper interpersonal relationships. Assistive eyewear significantly improved the quality of life for people who are completely blind by enabling the blind to navigate, communicate, and interact with the world in ways that were previously unthinkable by surpassing the limitations of traditional vision.

1.1 Literature Review

As per Bhowmick, A., and Hazarika, S.M., the study entitled "An insight into assistive technology for the visually impaired and blind people: state-of-the-art and future trends," highlighted how research in this field is becoming more and more important. The field's rise was attributed to the increase in interest from other disciplines, which acknowledged the field's substantial social influence on the growing number of elderly and blind people in our society. The authors set out on a lengthy journey to address important concerns and delve into the nuances of the area. They used advanced information analysis and network theory tools to perform an objective statistical survey across multiple sub-disciplines. To conduct a thorough analysis of the topic, a database of scientific research articles covering the last 20 years was systematically assembled.

As stated by R. Agarwal, et al., the low-cost ultrasonic smart glasses for the blind, offered a comprehensive solution for obstacle detection and navigation. This innovative device comprised a pair of glasses housing an obstacle detection module at its center, a processing unit, an output component (a beeping mechanism), and a power source. The obstacle detection module and the output component were intricately connected to the processing unit, while the power supply ensured continuous operation of the central processing unit. The obstacle detection module employed ultrasonic sensors, while the processing unit incorporates a control module to interpret data received from the sensors. Subsequently, the output unit, comprising a buzzer, conveyed pertinent information to the user based on the detected obstacles. These ultrasonic smart glasses boasted portability, ease of use, lightweight design, user-friendly interface, and affordability, making them an accessible aid for the visually impaired. With their ability to effectively guide individuals through various environments and assist in obstacle avoidance, their project represented a significant advancement in enhancing independence and mobility for the blind community.

Thus, “Assistive Technologies for Visually Impaired and Blind People" by National Library Service for the Blind and Print Disabled (2017) provided an overview of a variety of assistive technologies that could be used by people who were blind or visually impaired. The article discussed the different types of assistive technologies available, such as screen readers, magnification software, and braille displays. It also provided information on how to obtain assistive technologies.

Furthermore, the study "An assistive eyewear prototype that interactively converts 3d object locations into spatial audio", Tang, T. J., & Li, W. H. (2014) presented an end-to-end prototype for an assistive EyeWear system aimed at Vision Impaired users. A key novelty of the system was that it operated in real time (15Hz), allowing the user to interactively affect the audio feedback by actively moving head worn sensors. Twelve individuals, wearing blindfolds, participated in a quantitative user research where they used their system to execute an object localization and placement task. This comprehensive investigation of near-field interactive spatial audio for users working at around arm's length varies from previous research that concentrated on far-field audio and non-interactive systems. The EyeWear prototype showed great promise as a real-world assistive technology based on the object localization accuracy attained on naïve users. Several possible paths to further enhance system performance is shown by user input gathered from surveys and mathematical modeling of user failures.

2. Research Methods

In this study, a quantitative approach was employed to evaluate the performance of Arduino-powered eyeglasses compared to conventional mobility aids. By systematically measuring navigation capabilities, obstacle detection accuracy, and user satisfaction, this research sought to ascertain the tangible benefits and potential drawbacks of adopting such assistive technology.

The outcomes of this investigation held significant implications for the design and development of assistive devices tailored to the needs of visually impaired individuals. Moreover, insights gained from this study may inform policymakers, healthcare professionals, and technologists in advancing the accessibility and inclusivity of assistive technologies in diverse settings.

Through collaborative efforts and empirical inquiry, this research or capstone project aimed to contribute to the ongoing dialogue surrounding assistive technology innovation, ultimately striving towards a more equitable and empowered future for individuals with visual impairments. This project was being conducted in Tayug, Pangasinan, focused on gathering insights and feedback from blind individuals in the community. To assess the acceptability of the proposed system, the proponents collected data directly from these individuals.The data gathering technique used by the proponents of this study is "Likert Scale" because it consists of a series of statements or questions related to the proposed project study and respondents are asked to express their level of agreement or disagreement with each question. The answer choices are usually organized on a numerical scale. Likert Scale provides a structured and standardized way to collect and analyze data and offers insights of respondent's perspectives in a logical manner.

3. Result and Discussion

The proponents of the project used Arduino Nano microcontroller which cost 199php, the other components such as ultrasonic sensor, buzzer, vibration motor and 9V battery costs 227php. The eyeglass, which served as the main component was 69php. The selection of this specific eyeglass was based on its accessibility and simplistic design, both of which contribute to its affordability without sacrificing functionality. By exercising careful spending and resourceful sourcing, the project successfully attained a total cost of 296 PHP, showcasing its commendable approach to budget management.

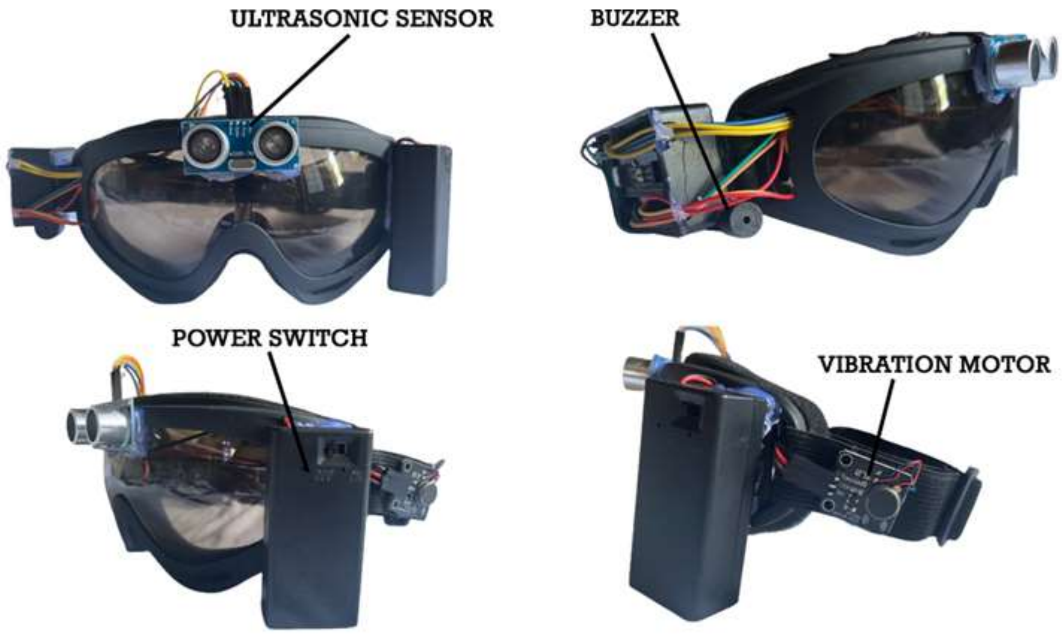

Fig. 1 Design

In fig. 1 above, shows the design of the Arduino powered eyeglasses, the power switch has a 9V battery inside and the ultrasonic sensor is integrated for the obstacle detection, the buzzer and vibration motor will react when the ultrasonic sensor detects obstacles.

Table 2. User Acceptability Testing

No	Criteria for User Acceptability	4	3	2	1	Average Weighted Mean	Interpretation
1.	The incorporation of obstacle detection using ultrasonic sensors in the assistive eyewear is a valuable feature.	3	1	0	0	3.75	SA
2.	The feedback mechanisms of buzzer and vibration motor will effectively assist blind individuals in navigating their surroundings.	3	1	0	0	3.75	SA
3.	The integration of buzzer feedback provides no delays to alert users.	2	2	0	0	3.5	SA

4.	The system device adequately addresses the needs of blind individuals for improved mobility and safety.	2	2	0	0	3.5	SA
5.	The feedback provided by the buzzer and vibration motor will effectively alert users to obstacles in their path.	3	1	0	0	3.75	SA
6.	The integration of ultrasonic sensors for obstacle detection makes the device very helpful for blind individuals.	2	2	0	0	3.5	SA
7.	The project lacks innovation or usefulness for blind individuals.	0	0	2	2	1.5	D
8.	The project's understanding of the needs and preferences of individuals with visual impairments.	3	1	0	0	3.75	SA
9.	The device is redundant or unnecessary in the realm of assistive technologies for blind individuals.	0	0	0	4	1	SD
10.	Easily exchange a device component within a specified environment.	0	4	0	0	3	A
11.	There is less effort in identifying device failure causes.	0	4	0	0	3	A
12.	There is minimal frequency of hardware faults/failures.	0	0	1	3	1.25	SD
13.	The assistive eyewear managed the version control of its procedures and protocols.	1	3	0	0	3.25	A
14.	Device's performance is re-establishing from failure.	0	0	3	1	1.75	D

15.	The device represents a significant step forward in promoting independence and autonomy for blind individuals.	3	1	0	0	3.75	SA

Legend	SD – Strongly Disagree 1.00 – 1.74	D – Disagree 1.75 – 2.49	A – Agree 2.5 – 3.24	SA – Strongly Agree 3.25 – 4.00

Table 2 shows that the respondent of this project strongly agrees with most of the statements, the incorporation of the features like obstacle detection, tactile feedback and audio feedback is very helpful for their daily tasks. The project's usability also meets the requirements of the respondents. However, this study does not lack innovation or usefulness for blind individuals. The device is user-friendly and operates reliably without any malfunctions.

4. Conclusions

The blind residents in Tayug deal with everyday difficulties such as navigating their work area and operating equipment without the assistance of visual aids. It could be concluded that the Arduino-powered assistive eyewear for blind individuals would significantly enhance the overall navigation and well-being experience.The blind residents of Tayug, effectively agreed to the statement according to their needs. Most of the respondents strongly agreed with the needs of assistance with navigating the work environment, the needs of assistive eyewear to support them to accomplish their tasks, and the needs of an accessible, inclusive, and supportive work environment for meeting the diverse needs of visually impaired individuals in their workspace. This innovative device not only revolutionized how visually impaired individuals guide their surroundings but also improved the user's safety to effectively interact with their environment. With features such as obstacle detection using ultrasonic sensors, shaking feedback via vibration motors, and sound alerts through a buzzer, the assistive eyewear streamlines the entire navigation process.The incorporation of features like obstacle detection, tactile feedback, and audio feedback was very helpful for their daily tasks. The project's usability also met the requirements of the respondents, and the cost of the assistive eyewear was acceptable. This study demonstrated innovation and usefulness for blind individuals. The device was not difficult to use, and there were no failures in the device. The project successfully addresses the needs of blind individuals, providing effective and reliable assistance in their daily lives. The project facilitated easy verification of environmental obstacles, ensuring accuracy and efficiency. Users can easily access their surroundings with confidence, promoting independence and accessibility. The adoption of this technology resulted in fewer limitations, leading to a more refined and reliable assistance overall.

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