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Ultra Sonic Glassses for the Blind

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ABSTRACT:
Ultrasonic glasses for the blind are a wearable technology device designed to aid in the mobility of visually impaired individuals. The glasses are equipped with ultrasonic sensors that emit high-frequency sound waves, which bounce off objects in the user's path and return to the glasses. The glasses then convert these sound waves into digital signals, which are processed and analyzed by a microcontroller. Based on the signals received, the glasses provide the user with audible or tactile feedback, alerting them to any obstacles in their path. The use of ultrasonic glasses for the blind has revolutionized mobility for visually impaired individuals, providing them with a greater sense of independence and freedom to explore their surroundings with confidence. The technology has the potential to greatly enhance the quality of life for visually impaired individuals, allowing them to navigate through environments that would otherwise be inaccessible to them.

KEYWORDS: Ultrasonic sensor, Vibrating motor, IVRSystem (Interactive voice response), Arduino Board, Raspberry pi, Microcontroller, Glass, Voice-assistant.

I. INTRODUCTION:

Visually impaired individuals face significant challenges when it comes to mobility, as the loss of their sight severely limits their ability to engage in activities. They often rely on blind navigation systems or their memory of exploring an area. A device designed to aid in their mobility is comprised of glasses, a centrally mounted obstacle detection module, a processing unit, an output device (such as a beep component), and a power supply. The obstacle detection module and output device are connected to the processing unit, which is powered by the power supply. The obstacle detection module consists of an ultrasonic sensor, which scans up to 5-6 meters within a 30-degree range in the direction the person is walking. The sensor detects obstacles and sends a signal to the device, which generates an automated voice message in a headset attached to the person's ear, alerting them to the obstacle. This device provides visually impaired individuals with greater independence and confidence in their mobility, allowing them to navigate through their surroundings more easily.

In this project, smart glasses should help blind people reach their destinations on their own. The reason it's so reliable is that it's developed on the Android operating system, and Android-based smartphones are very common and available almosteverywhere. The glass is built using an Arduino microcontroller with sensors and buzzers and a voice assistant. The glass alerts the user when they are near to an obstacle by beeping and sending an output through the voice assistant. A wand is a portable mechanical device that only detects static obstacles within a certain range. The device has a very limited range and is inflexible to protect against obstacles near the head. This wearable smart device application helps users or patients reduce the number of home visits. This reduces operating costs. Health parameters recorded by any device are instantly updated in the application used by doctors. Your data is protected and confidential at higher speeds. This portable technology makes your work easier and gives you the next result or output faster. The main goal of our current efforts is to provide a reliable, low-cost, low-power solution that allows visually impaired people to move in much the same way as other ordinary pedestrians. The speed of sound in air is used to calculate the speed of sound in air. The distance that sound travels is equal to the speed of sound in a medium multiplied by the time it travels. Due to the large number of sensors on the market, it is necessary to choose the right sensor. There are certain characteristics that must be considered when choosing a sensor. Accuracy, environmental conditions, range, calibration, resolution, cost, repeatability. However, if the object is too far from the sensor, the signal will take too long to come back (or be too weak when it returns) and the receiver will not be able to detect it. Pulse width is proportional to the time it takes for the echo to return. This time is called flight time. However, there are other factors that affect noise propagation, such as: Ambient pressure, gas density, humidity. The cost of this system is affordable for most of society, it is an effective device that allows you to spend money only once, and it guarantees a great travel guide.

II. LITERATURE SURVEY:

A sensor is a device that detects changes in volume. Specific quantities are light, heat, motion, distance, gas, pressure, and so on. It usually provides a suitable output as a controllable electrical thing. Most sensors in use today can communicate with electronic devices that measure, calculate, and transcode.

History of Sensors. The first sensor invented on the market was an electric thermostat type sensor by Warren Johnson1883

[1]. This thermostat was able to keep the temperature with constant accuracy. Then, in 1940, an infrared sensor was introduced. This was followed by the invention of motion sensors used in alarm systems by Samuel Bango. This sensor was used to locate people in a room using ultrasonic frequencies and to calculate the motion of stars. These motion sensors became widespread in mine during World War II. Mines placed underground explode when they detect movement on the surface. Modern technology uses radar to track enemies and air traffic control to prevent plane crashes.

[2].In the area of research for individuals with visual impairments, there have been several advancements in the development of data glasses and ultrasonic sensors. A group of researchers, including Mohammed H. Mahmud, Rana Saha, and Sayemul Islam, have designed a smart walking stick that utilizes electronic features to aid visually disabled persons in mobility. The hardware of the walking stick includes a microcontroller that incorporates a Ping sonar sensor, distance sensor, moisture detector, micro pager motor, and other components. This assistive system for the visually impaired can be fashioned in a compact, portable form that can be affixed to a standard white cane or utilized as a stand-alone device.

[3]. Jinqiang Bai, Shiguo Lian, Zhaoxiang Liu, Kai Wang, and Dijun Liu proposed a multi-sensor fusion-based algorithm for obstacle detection. The algorithm utilizes depth and ultrasonic sensors to detect small and transparent obstacles, which can be a challenge for traditional obstacle detection methods. The algorithm works by combining data from both sensors to create a more comprehensive understanding of the environment, improving the accuracy of obstacle detection. Multi-sensor fusion-based approaches are becoming increasingly popular in robotics and autonomous systems, as they can improve safety and performance by providing a more complete and accurate understanding of the environment.

[4]. Dania Abdul-Rasool and Susan Sabra developed a mobile embedded smart guide designed to assist visually impaired individuals. This smart guide integrates various technologies into a portable compartment that includes a Bluetooth antenna, sensors, central processing unit, memory, and speakers. The sensors in the device detect solid objects in the path of travel and send signals to the mobile application. This system aims to provide an efficient way for visually impaired individuals to navigate their environment with greater ease and independence.

[5]. The device in this article is designed to assist visually impaired individuals by detecting obstacles in their path and preventing accidents. It was developed using e-waste and is available at an affordable price. The device, which resembles glasses, utilizes SONAR sensors to detect obstacles. When an obstacle is detected, the sensor sends its distance to an Arduino, which converts the distance from milliseconds to centimeters and checks if the obstacle is within 3m. If so, a buzzer sounds, with the beep frequency decreasing as the distance to the obstacle decreases. This project offers an affordable and user-friendly alternative to other products on the market with similar capabilities. The device is built using Arduino coding, a sonar sensor, and a buzzer.

[6]. According to the World Health Organization (WHO), approximately 285 million people worldwide were visually impaired in 2012, with 246 million being blind and 39 million experiencing varying degrees of visual impairment. The majority of individuals with low vision reside in developing countries and are over the age of 50. Visually impaired individuals face challenges in effectively communicating with others, as well as with their immediate environment. They may have difficulty recognizing where someone is or moving from one place to another, which can limit their ability to interact with the world around them. These individuals often rely on other senses, such as touch, hearing, and smell, to compensate for their visual impairment. Blindness can significantly impact an individual's independence and mobility, making it difficult to navigate through daily activities and locate basic amenities such as restrooms, subway stations, and restaurants. Unfortunately, there are limited products available to assist visually impaired individuals in urban environments. However, devices like smart glasses can help these individuals "see" the world around them, promoting greater independence and freedom in city life.

[7]. The devicein this articleis not suitable for individuals who are completely blind and is only recommended for those with low vision or night blindness. Another recent attempt to assist visually impaired individuals is the Haptic Assisted Location of Obstacles (H.A.L.O) system. This system utilizes a rangefinder that takes input from an ultrasonic sensor and provides feedback to an impulse vibration motor placed on the user's head. As the user approaches an obstacle, the intensity and frequency of the vibrations increase. However, the use of vibration motors is a major limitation of this system as it is not an effective means of stimulating the senses of blind individuals.

[8]. This article presents an innovative navigation device designed for individuals who are visually impaired, which can assist them in navigating safely and efficiently through complex indoor environments. The system utilizes deep imaging and multi-sensor fusion-based algorithms to address the challenge of small and transparent obstacle avoidance. The team also developed and tested three major auditory cues specifically for individuals who are completely blind, finding that beep-based instructions were the most effective and relevant. For individuals with low vision, augmented reality (AR) technology-based visual enhancements have been incorporated to integrate movable directions into binocular images, enabling users to walk faster and safer. The device is able to quickly detect and display obstacles, and the test results demonstrate that the proposed smart guide glasses can significantly improve the travel experience of the visually impaired. Additionally, the sensors utilized in this system are simple and cost-effective, making it accessible for widespread use in the consumer market.

[9]. The proposed obstacle detection project for the visually impaired is based on Arduino and offers a simpler, portable, low-cost, user-friendly, and efficient solution. This system can easily detect the distance between objects using sensors and detect objects in all directions. It enables blind people to move independently and navigate their surroundings, improving their daily lives.

[10]. The paper describes a system that utilizes a combination of sensors and motors to assist visually impaired individuals in navigating obstacles. The system is designed to detect obstacles and provide proximity warnings, acting as a "Mobility Aid" to enable visually impaired individuals to perform daily activities independently. The system is lightweight, portable, and easy to use, with ongoing efforts to improve battery life and incorporate voice feedback for users. The authors are currently working on incorporating GPS tracking and Bluetooth connectivity, which could potentially integrate the technology into automated wheelchairs. Overall, the system has the potential to greatly improve the quality of life for visually impaired individuals.

[11]. MULTILINGUAL AUDIO FEEDBACK SYSTEM: The audio feedback system of this device is designed to support 10 languages, making it accessible to people around the world.

VERSALITY: The device is versatile, capable of detecting obstacles in five directions, including front, right, left, back, and even below.

COSTEFFECTIVENESS: The cost of the device is currently Rs.1495, but it is expected to decrease significantly with mass production, making it affordable for people with low economic status.

DESIGN: The design of the device is ergonomic and suitable for use by visually impaired individuals, eliminating the need for a traditional blind stick that they typically carry when moving outside their homes.

OBJECTIVES:

The objective of the project is to create a product that can significantly enhance the daily lives of individuals who are blind or have limited independence. To tackle this issue, the team behind Third Eye for the Blind has developed an Arduino-based obstacle detector system. This innovative solution helps to detect the distance between an object and the sensor with great ease. Sensors are devices that can identify changes in various quantities such as light, heat, motion, distance, gases, and pressure. They provide a corresponding output, usually in the form of an electrical signal that can be controlled. Most modern sensors can communicate with electronic devices, which can perform calculations, measurements, and recording of the data. The proposed system is designed to be portable, user-friendly, cost-effective, and efficient, with a host of other exciting features and benefits, making it an ideal aid for the visually impaired.

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COMPONENTS:

To support the academic pursuits of visually impaired individuals in higher education, a team has decided to develop glasses that incorporate various components. The selection of these components was made after conducting thorough research and aligning with the project's objectives:

1. RASPBERRY PI
2. ULTRASONIC SENSOR
3. BUZZER
4. IVR SYSTEM
5. ARDUINO
6. BATTERY
7. EARPHONE
8. CAMERA
9. MEMORY CARD
10. JUMPER WIRE
11. GLASS

1.RASPBERRY PI

Description:

The Raspberry Pi is a small computer that is roughly the size of a credit card. To use it, one must install a power supply, display, SD card, keyboard, mouse, and operating system. Despite its affordability, the Raspberry Pi is capable of performing a variety of important tasks, such as acting as a basic PC, a portable coding machine, or a hub for homemade hardware. It also has general-purpose input/output (GPIO) pins that can be used to control electronic components. Additionally, the Raspberry Pi can serve as an excellent tool for encouraging young people to explore computer science and improve their coding skills, which could help develop the next generation of software developers.

Functions:

The Raspberry Pi 3 is a versatile device used for a wide range of applications, such as teaching, programming, and DIY hardware projects. In this particular project, it serves as the main component, providing a cost-effective embedded system that connects and controls all the parts. The Raspberry Pi 3 can run on different operating systems such as Raspbian or NOOBs, which offer various functionalities. However, the team opted for Raspbian as the operating system of choice for this project.

2.ULTRASONIC SENSOR

Description:

Ultrasonic sensors utilize ultrasonic waves to measure distance. They emit ultrasonic waves that bounce back to them after hitting an object, allowing the ultrasonic sensor to determine the distance to the object. These sensors can sense distances from 2 to 400 cm.

Functions:

The Smart Glasses project utilizes the Ultrasonic sensor to determine the distance between the camera and an object, which is essential for extracting text from an image. The optimal range for capturing a clear image is between 40 cm and 150 cm, and the Ultrasonic sensor helps to ensure that this distance is maintained.

Distance $L = 1/2 \times T \times C$

L: The distance

T: Time between the emission and reception.

C: Sonic speed

*The value is multiplied by 1/2 because T is the time for the go-and-return distance

3.BUZZER

Description:

A buzzer is an electronic device that produces an audible sound when an electric current passes through it. The sound can be a buzzing or beeping tone, and it is often used in various applications such as alarms, notifications, and games. To operate a buzzer, a circuit is needed to connect it to a power source and control its activation. By understanding how the circuit and the applied voltage can affect the buzzer's function, we can create different types of buzzer sounds and integrate them into various projects.

Functions:

When VCC is connected to the positive pin of a buzzer, a continuous sound is produced. On the other hand, when a square wave of a specific frequency is applied to the positive pin, the buzzer produces various tones depending on the frequency. The tone changes with the change in frequency. By modifying the frequency of the signal applied to the positive pin, we can create a melody or tune for a song. This functionality allows for the creation of various sounds and musical notes using a buzzer in electronic projects.

4.IVR SYSTEM:

Description:

Interactive voice response (IVR) systems use pre-recorded voice clips that are segmented and logically combined to meet specific needs. In our project, we utilized an Arduino board to program and store the segmented voice clips in various languages, with direct interfacing of the SD Card module. Two wire terminals were also included in the system, allowing for language switching in a programmed sequence when no command is being played by the IVR. The current system supports English and Hindi, but we plan to add more languages in the future.

5.ARDUINO:

Description:

Arduino is a popular open-source electronics platform that combines easy-to-use hardware and software. Arduino boards can take inputs from various sources such as light sensors, buttons, and online messages and turn them into outputs such as motor activation, LED lighting, and online publishing. Users can program their boards by sending instructions to the microcontroller using the Arduino programming language, which is based on Wiring, and the Arduino Software (IDE), which is based on Processing.

Functions:

The Arduino board has a limited number of pins available for interfacing with external components. In our project, we needed to interface with three major components, and using all of their required pins would result in a shortage of pins. To address this, we designed a self-made Audio module with Vcc and Gnd pin-outs shorted, which provided power to the sensors. This allowed us to directly interface only the Trigger and Echo pins of each sensor to the Arduino board, while the other pins were bypassed through the audio module. The Audio module filtered the PWM bits signal received from the Arduino board and sent it to a headphone for the IVR system's audio output.

6.BATTERY:

Functions:

At first, the "Smart Glasses" project utilized the 5V, 2A battery that was included with the Raspberry Pi 3. However, the team soon realized that the battery would not be sufficient for blind students who would require the glasses for extended periods of time while moving between classes. Therefore, the updated version of "Smart Glasses" features a Power Bank that operates at 5V and 2.5A, ensuring that the glasses will have enough power to last throughout the school day.

7.EARPHONE:

Description:

To avoid using up the limited USB ports available for other peripherals, the "Smart Glasses" project will utilize the audio jack on the Raspberry Pi 3 Model B & B+ for audio output. Wired headphones will be used to listen to the audio output.

Functions:

The user can hear the voice response of the IVR System through small and lightweight headphones that are connected to the glasses. This provides convenience to the user as they do not have to worry about losing the headphones or feeling uncomfortable wearing them.

8.CAMERA:

Description:

The webcam used in the "Smart Glasses" project has a fixed focus and a viewing angle of 60°. Its maximum image resolution is 1289 x 720 pixels, and it is compatible with various operating systems, including Linux, Windows, and MacOS. The webcam comes equipped with a USB port and a built-in monophonic microphone.

Functions:

For this project, the webcam will serve as the primary visual input for the "Smart Glasses" user. The camera will capture depth images which will then be processed and converted into an augmented reality rendering. This rendering will help the user identify obstacles and navigate their environment safely.

III. METHODOLOGY:

The "Smart Glasses" project includes five ultrasonic sensors that are strategically placed to detect obstacles in four directions, with an additional sensor on a ball joint to detect small obstacles. To communicate with these sensors, the Arduino requires 20 pins (5x4) for Vcc, Trigger, Echo, and Gnd. To conserve GPIO pins for other components, Vcc and Gnd can be shared among the sensors and passed through a homemade sound module, reducing the required pins to only Trigger and Echo for each sensor. Additionally, the project includes an SD card module that requires 6 pins and a homemade 3.5mm audio module that requires 3 pins. To avoid using the limited pins of the Arduino, the sound module is designed to short 5-6 pins of Vcc and Gnd, which are the power sources for the sensors. The sound module acts as a filter for the audio received as a PWM bit signal from the Arduino board. The user can listen to the IVR system through headphones connected to the sound module.

IMPLEMENTATION:

The system primarily functions as a guide for the visually impaired and can be modified as required. The current priorities that have been identified are outlined below:

• To alert the user of an obstacle within 80 cm, the system utilizes an ultrasonic sensor. When an obstacle is detected within this range, a vibration motor will be activated to notify the user. This feature helps to improve the safety of the user and reduce the risk of accidents.

• When the front ultrasonic sensor detects an obstacle within a distance of 120 cm, the person wearing the "Smart Glasses" will receive an audio prompt from the built-in guidance system to move to the left.

• If there is an obstacle detected by the left sensor within 100 cm, with the previous point, the person will be directed to the right

• If the right sensor now detects an obstacle less than 100 cm away, at the same time as the previous point, the person will be asked to step back.

If the rear sensor detects an obstacle within 80cm, the person will be alerted that the area is congested and the system cannot navigate. This is in addition to the directions provided by the left and right sensors as mentioned in the previous points.

IV. EXPERIMENTAL RESULT:

First of all, this system is just an induction system, it does nothing by itself,It only guides how to move visually impaired people. This system does not guarantee that a visually impaired person can walk like a normal person. This is because it takes time for the system to process the sensor readings and induce you to walk at the correct speed. The system for handling and guiding them is incomparable to ordinary people who can see. This system has some limitations and application issues have been identified. They are:

1.Sometimes, the directionality of a sensor can cause issues. For instance, if there is an obstacle placed diagonally between the front and right sensors, the guidance may frequently change. However, this issue only occurs within a specific range and not everywhere..

2.Improper placement of an ultrasonic sensor can result in the sensor failing to detect obstacles that are 10 to 15 cm high and located on the ground. These obstacles could be things like steps, speed humps, and other similar objects.

3.Placing the ultrasonic sensor in the front section and using it to detect small obstacles is a reliable way to ensure that the sensor functions effectively for the most part.

4.Based on their experience, blind individuals typically walk in a straight and narrow path unless they receive instructions from a system to turn in a specific direction. This is to avoid potential obstacles that may be in their path**.**

To obtain accurate distance measurements, the sensor readings were taken three times at each distance with a 5 cm difference from the previous measurement. The average of the three readings was then calculated. The distance between the sensor and the object was determined using the wave transit time, as outlined in Equation 2:

Distance (cm) = (travel time * 10^-6 * 34300) / 2 ……(2)

Table 1 presents the results of the measurements, including the actual distances and the calculated distances. It was found that there was a significant difference between the actual distances and the measured distances, particularly at shorter distances. To quantify this difference, the percentage error was calculated and is also shown in Table 1. Additionally, a graph of the error between the actual distance and the measured distance was generated to further illustrate this discrepancy.

Table 1. Distance and Error Calculation

S.no	Actual distance(cm)	Travel time (sec)	Measured distance(cm)	%Error
1	5	390	6.68	33.77
2	10	720	12.45	23.4
3	15	1060	18.18	21.2
3	20	1270	21.78	8.9

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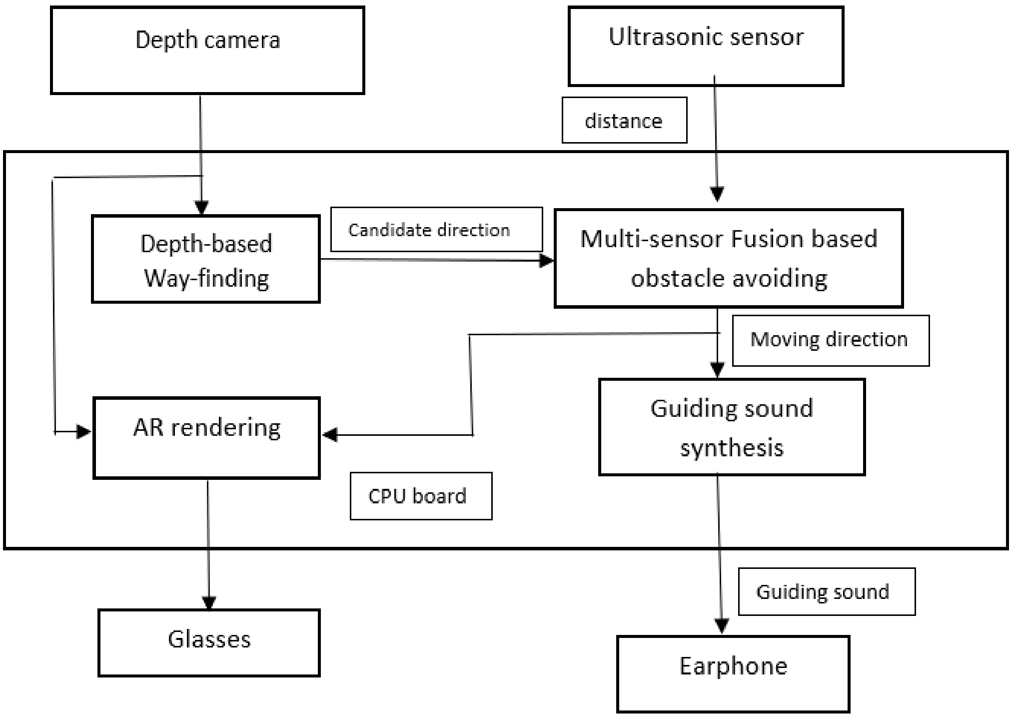
BLOCK DIAGRAM:



V. CONCLUSION:

The aim of the Third Eye for the Blind project is to create a device that is useful for visually impaired individuals, allowing them to navigate their surroundings with greater confidence and independence. The device consists of a wearable band that uses ultrasonic waves to detect nearby obstacles and notifies the user with a buzzing sound or vibrations. This allows users to move around freely and avoid obstacles that they might not have been able to detect otherwise. The device utilizes an Arduino to detect obstacles and a Raspberry Pi to provide instructions through a voice assistant that has been programmed by the developers.In the future, there is potential to further improve the device by adding new features such as directional and warning messages to prevent accidents, battery level notifications, video detection to enhance the user's experience, a mobile application to control the device, a 270-degree camera to provide a wider field of view, and GPS notifications. Additionally, the design of the device could be further developed to make it lighter and more comfortable for the user to wear.

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