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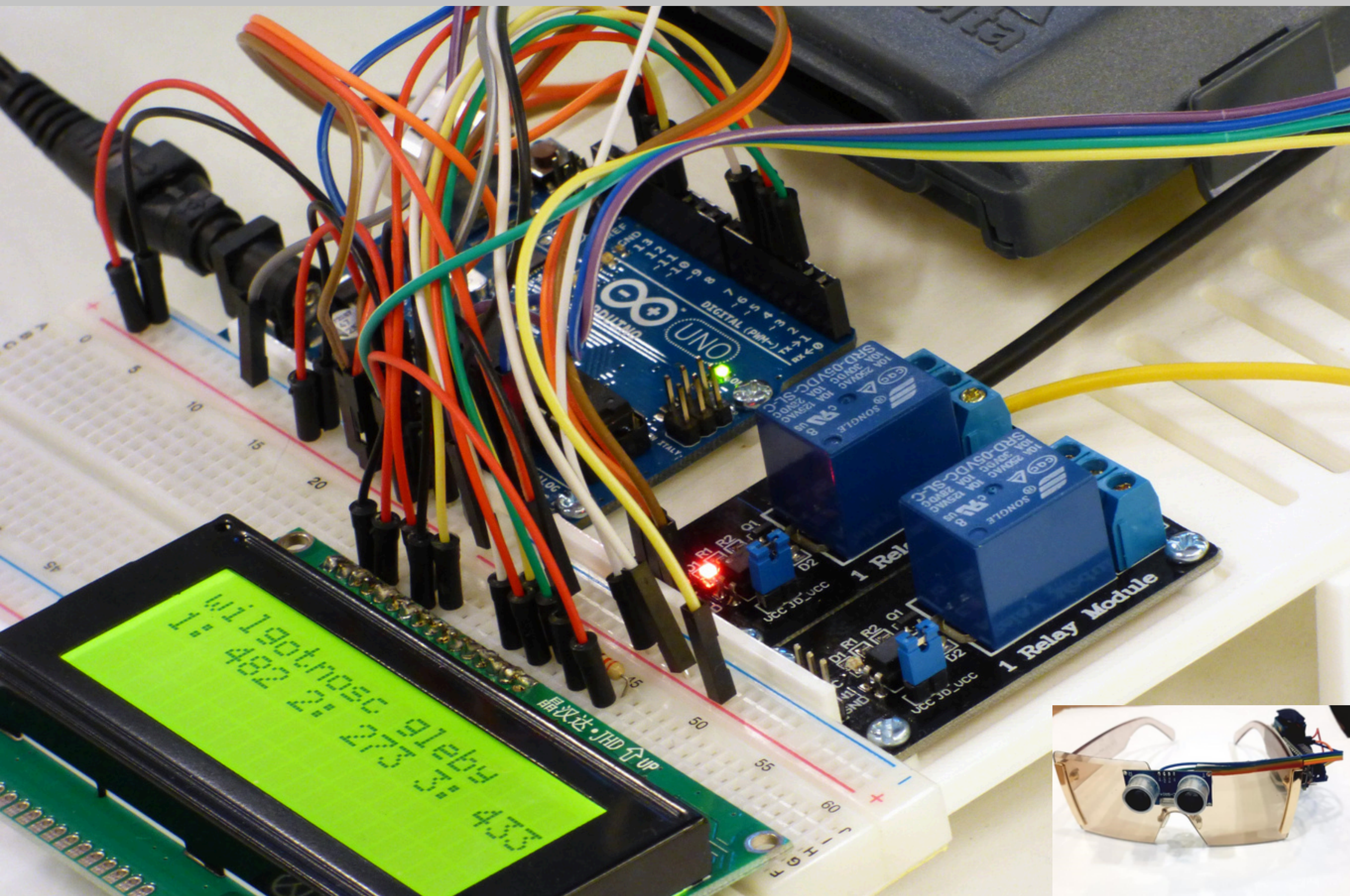
THIRD EYE FOR BLIND PEOPLE BASED ON ARDUINO



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ABSTRACT

From the survey by WHO, 39 million people are blind all over the world. the existing methods that merely assist them are not just enough. What they need are alternative methods by which they can navigate with greater comfort, speed, and confidence.

By taking these into consideration, two usable prototypes have been designed that work with echolocation technology that can solve existing road problems. Ultrasound sensors are used to detect obstructions. The sensors are interconnected with the Arduino for processing purposes. Thus, there is hope for the visually impaired to pass without injury.

Where it works to alert the blind person in the event of an obstacle by giving an audio warning to avoid the obstacle. They can simply use the models that were manufactured such as glasses or a stick that can work very accurately. The only thing required is some training to use as it is easy to manufacture and low cost to be accessible to everyone.
Keywords (Design Third Eye. Help for the blind. Using Arduino for the blind. Guiding the blind to the road)

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CHAPTER ONE

CHAPTER ONE

1.1. Introduction

Third Eye for the Blind is a groundbreaking innovation designed to help visually impaired people navigate their environments with greater speed and confidence. This device uses ultrasonic waves to detect nearby obstacles and alerts users with a buzzer. It can be comfortably worn like glasses or attached to a cane. According to the World Health Organization, approximately 39 million people worldwide are classified as blind and face significant difficulties in their daily lives. Traditionally, many have relied on the white cane, which, while effective, has a number of limitations. As an alternative, some choose guide dogs, which can be prohibitively expensive. Therefore, the aim of this project is to create an accessible and more efficient solution that allows visually impaired people to navigate more comfortably, quickly and confidently. Third Eye for the Blind uses an ultrasonic sensor and is designed as a wearable device based on an Arduino board.

In this project, two models were used, one or both of them can be used. The first model is a stick that senses the distance between the blind person and the obstacles in front of him and gives a warning in case there is an obstacle the second model is a pair of glasses that also works with an ultrasound sensor that senses the distance in front of it and in the event of an obstacle, it gives a warning of the presence of an obstacle through sound.

-Background

As living standards have improved, society has increasingly become materialistic, often overlooking the challenges faced by individuals with physical disabilities. These individuals frequently encounter harsh, apathetic, and indifferent attitudes due to their disabilities. Their daily routines often require reliance on others for assistance. For those who are blind or visually impaired, this dependence is particularly pronounced, as they rely on others for mobility. The eyes serve as a crucial sensory organ for understanding the surrounding environment; when this function is compromised, it significantly hampers one's ability to perceive and interact with the world. Consequently, navigating through various environments presents substantial challenges for blind individuals, who cannot rely on their vision and thus encounter numerous obstacles. [1].

The aim of the project, The Third Eye for the Blind, is to create a product that significantly benefits individuals with visual impairments, particularly those who frequently depend on assistance from others. This innovative initiative facilitates mobility for visually impaired individuals, enabling them to navigate their surroundings with greater speed and confidence by identifying nearby obstacles. The wearable band emits ultrasonic waves that alert users through buzzing sounds, allowing them to walk independently by detecting obstacles in their path. Users simply need to wear this device on their person.

According to the World Health Organization (WHO), approximately 39 million individuals globally are estimated to be blind, facing significant challenges in their daily lives. Those with physical disabilities have traditionally relied on the white cane, a method that, while effective, presents numerous disadvantages and limitations. An alternative solution involves the use of guide animals, such as dogs; however, this option can be prohibitively expensive. Consequently, the objective of the project "Third Eye for the Blind" is to create an affordable and more efficient means for blind individuals to navigate with enhanced comfort, speed, and confidence. This initiative focuses on developing wearable technology that addresses the shortcomings of existing solutions. Although there are various technologies and smart devices available for the visually impaired, many require extensive training and effort to operate effectively. A key feature of this innovation is its affordability, with a total cost of under $25, making it accessible to a wider audience. Currently, there are no comparable devices on the market that combine wearability with such low cost and simplicity. By implementing this improved device on a large scale and refining the prototype, it is expected to provide substantial benefits to the visually impaired community. The traditional walking cane serves as a basic mechanical tool designed to detect static obstacles on the ground, such as uneven surfaces, holes, and steps, through tactile feedback. While this device is lightweight and portable, it is limited in size and does not facilitate dynamic obstacle detection.[4].

These devices work similarly to radar systems, using ultrasonic wave technology to detect the height, direction, and speed of nearby objects. The distance between a person and an obstacle is determined by measuring the time it takes for the waves to travel. Current systems provide blind users with information about the presence of objects at certain distances in their environment. This information helps users, especially blind people, recognize obstacles and adjust their path accordingly. By providing detailed information about the location and characteristics of obstacles in their path, these systems can improve the spatial perception and memory of people with visual impairments. To address the above limitations, this work proposes a simple, effective, and customizable virtual solution for blind people.

1.2. Aim of the study

The Third Eye for the Blind project aims to create a cost-effective and efficient solution that enables visually impaired people to navigate their environment with greater comfort, speed and confidence. By detecting obstacles, this technology allows users to move freely and independently.

1.3. Problem Statement

This device is not intended for underwater applications, as ultrasonic sensors can be damaged when exposed to water. Consequently, users are advised against operating this device during rainy conditions.

1. Sensing accuracy is influenced by temperature variations of 5 to 10 degrees or greater; both lower and higher temperatures can impact system performance. The majority of ultrasonic sensors operate effectively within a temperature range of 25° C to +70° C.

2. Ultrasonic sensors possess a restricted detection range, with a maximum capability of 10 meters.

CHAPTER TWO

CHAPTER TWO

The project is divided into the software system and the hardware system these two systems complement each other to show results in the devices

2.1. IDE Programming (Arduino Software)

1.The Arduino Integrated Development Environment (IDE) is a versatile application compatible with multiple operating systems, including Windows, macOS, and Linux. It is developed using functions from the C and C++ programming languages. The IDE facilitates the writing and uploading of programs to Arduino-compatible boards, and, through the use of third-party cores, it also supports various other vendor development boards.

The source code for the IDE is released under the GNU General Public License, version

2. The Arduino Integrated Development Environment (IDE) accommodates the programming languages C and C++ through specific coding structure guidelines. It includes a software library derived from the Wiring project, which offers numerous standard input and output functions. Code written by users necessitates only two fundamental functions: one for initializing the sketch and another for the primary program loop. This code is compiled and linked with a program stub main() to create an executable cyclic executive program utilizing the GNU toolchain, which is also part of the IDE package. Furthermore, the Arduino IDE utilizes the Arduino IDE program to transform the executable code into a hexadecimal-encoded text file, which is subsequently uploaded to the Arduino board via a loader program

embedded in the board's firmware.[7] By default, Arduino is used as the uploading tool to flash the user code onto official Arduino boards.

Arduino IDE is a derivative of the Processing IDE, however, as of version 2.0, the Processing IDE will be replaced with the Visual Studio Code-based Eclipse Theia IDE framework. (Fig 2-1).[8]

(Fig 2-1) Arduino IDE

2.2. Hardware Sections

The system comprises the Arduino source, which is recognized as open source, with all sensors linked to the Arduino. The Arduino interfaces with a computer through USB for programming downloads, and it can function either via USB or battery power. The primary advantage of utilizing Arduino lies in its affordability and user-friendly nature.

2.2.1. ARDUINO

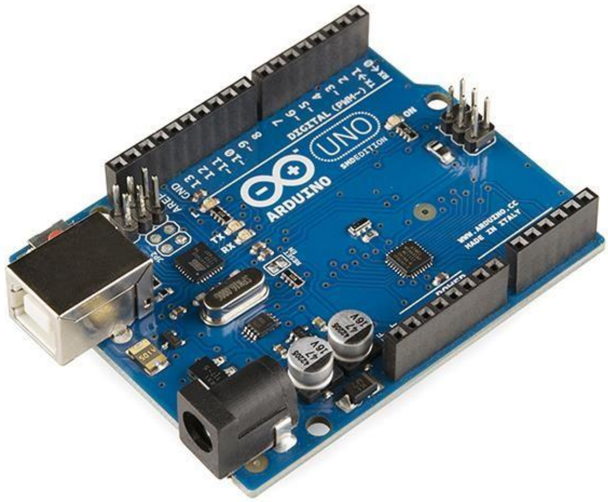
Arduino is a community-driven initiative that focuses on open-source hardware and software. It specializes in the design and production of single-board microcontrollers and kits intended for the creation of digital devices. The hardware offerings are available under a CC-BY-SA license, whereas the software is distributed under either the GNU Lesser General Public License (LGPL) or the GNU General Public

License (GPL). This licensing framework allows for the manufacturing of Arduino boards and the distribution of its software by any individual or entity. Arduino boards can be purchased directly from the official website or through authorized distributors. [2][3].

Arduino board designs incorporate a range of microprocessors and controllers. These boards are furnished with a collection of digital and analog input/output (I/O) pins, which can be connected to various expansion boards, commonly referred to as 'shields', or to breadboards for prototyping purposes, as well as other circuits. They are equipped with serial communication interfaces, including Universal Serial Bus (USB) on certain models, which are utilized for program loading. The microcontrollers can be programmed using the C and C++ programming languages, employing a standard application programming interface (API) often referred to as the "Arduino language." In addition to conventional compiler toolchains, the Arduino project offers an integrated development environment (IDE) and a command line tool (Arduinocli), which is developed in the Go programming language.

The Arduino initiative was launched in 2005 as a resource for students at the Interaction Design Institute Ivrea, located in Ivrea, Italy. Its primary objective was to offer an affordable and accessible means for both beginners and experienced individuals to develop devices that engage with their surroundings through the use of sensors and actuators. Typical examples of devices designed for novice hobbyists encompass basic robots, thermostats, and motion detection systems. [2][3].

The term Arduino is derived from a bar located in Ivrea, Italy, where several of the project's founders would convene. This establishment was named in honor of Arduino of Ivrea, who served as the margrave of the March of Ivrea and held the title of King of Italy from the years 1002 to 1014.



(Fig 2-2) Arduino UNO SMD

2.2.2. Arduino NANO

The Arduino Nano is a compact and fully functional board that is compatible with breadboards, based on the ATmega328P microcontroller, which was introduced in 2008. It provides the same connectivity options and specifications as the Arduino Uno but in a more compact design.

This board features 30 male I/O headers arranged in a DIP-30 configuration and can be programmed using the Arduino integrated development environment (IDE), which is available for both online and offline use across all Arduino boards. Power can be supplied via a type-B micro-USB cable or a 9V battery.In 2019, Arduino launched the Arduino Nano Every, an upgraded version of the Nano that maintains pin compatibility. This new iteration is powered by a more robust

ATmega4809 processor and offers double the RAM capacity.The Arduino Nano is equipped with various communication capabilities, allowing it to interface with a computer, another Arduino, or different microcontrollers. The ATmega328 supports UART TTL (5V) serial communication, accessible through digital pins 0 (RX) and 1 (TX). An FTDI FT232RL chip on the board facilitates this serial communication over USB, with FTDI drivers included in the Arduino software providing a virtual COM port for computer applications. The Arduino software also features a serial monitor that enables the exchange of simple textual data with the board. The RX and TX LEDs on the board illuminate during data transmission via the FTDI chip and USB connection to the computer, although they do not indicate serial communication on pins 0 and 1. Additionally, a Software Serial library allows for serial communication on any of the Nano's digital pins, while the ATmega328 supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to streamline the use of the I2C bus.. Figure (2-3) Arduino [1]

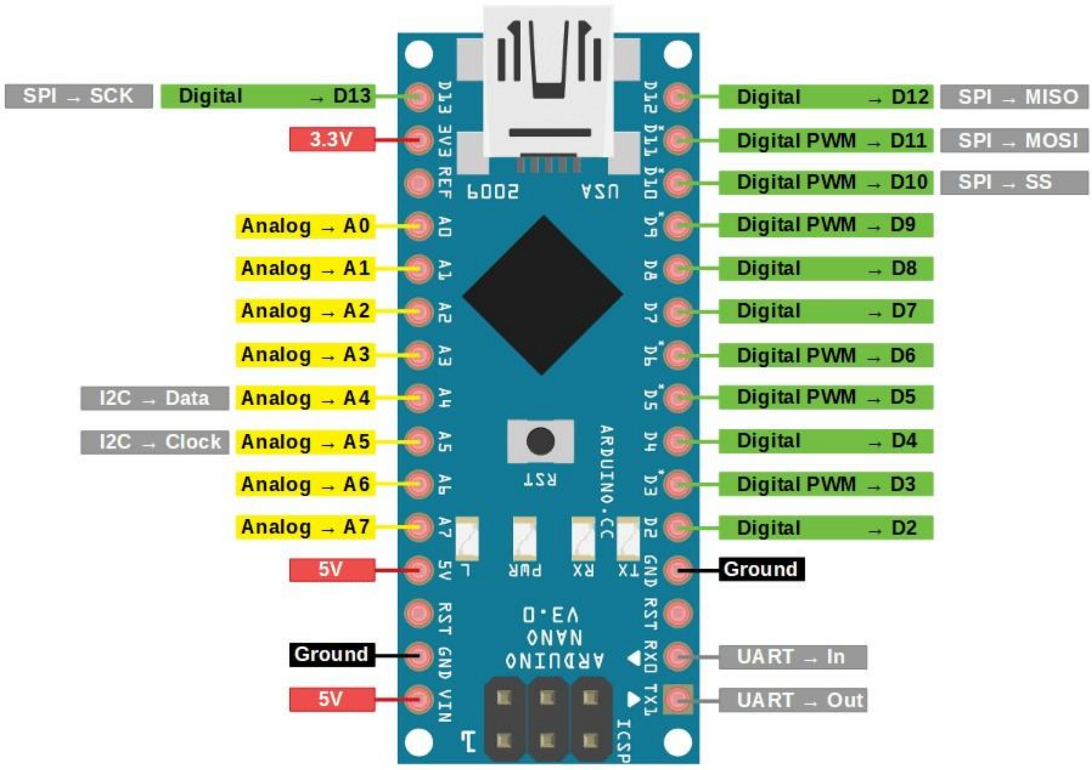


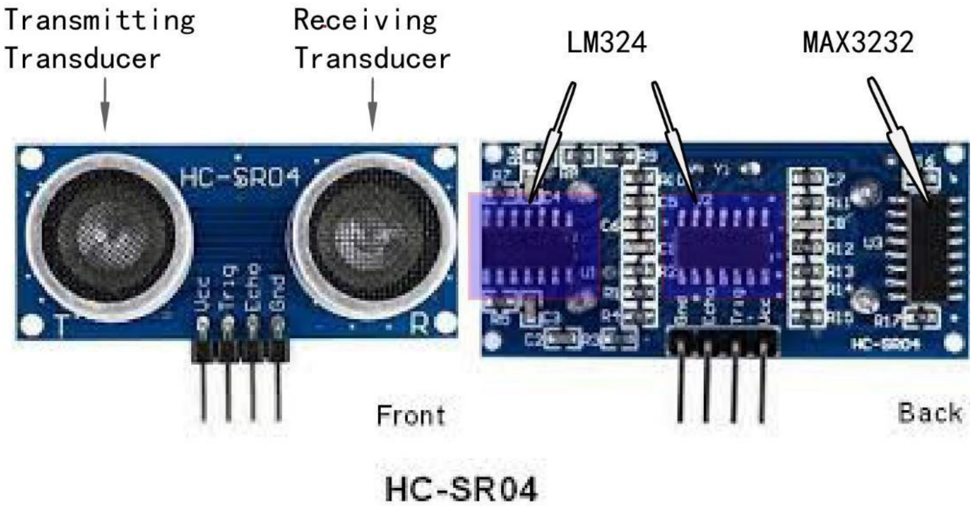
Figure (2-3) Arduino nano

2.2.3. Ultrasonic HC-SR04 Sensor.

An ultrasonic sensor is a device designed to measure the distance to an object through the use of sound waves. It operates by emitting a sound wave at a designated frequency and then detecting the echo that returns. By calculating the time interval between the emission of the sound wave and its return, the sensor can determine the distance from itself to the object.

The HC-SR04 ultrasonic sensor employs sonar technology to ascertain the distance to an object, similar to the echolocation used by bats. This sensor provides exceptional non-contact range detection, delivering high accuracy and stable measurements within a user-friendly design. It can measure distances ranging from 2 cm to 400 cm, or approximately

1 inch to 13 feet. Unlike Sharp rangefinders, its performance remains unaffected by sunlight or dark surfaces, although it may struggle to detect acoustically soft materials such as cloth. The sensor is equipped with both an ultrasonic transmitter and a receiver module..

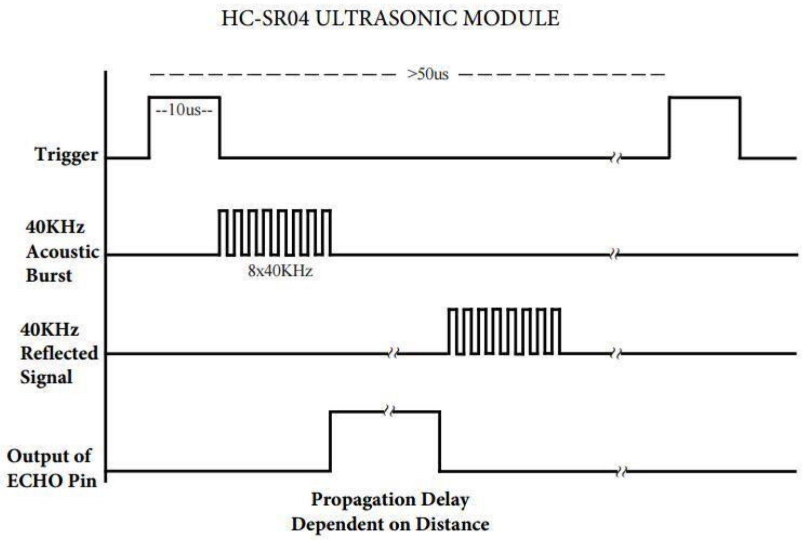


(Fig 2-4) Ultrasonic sensor

The ultrasonic rangefinder has two metal cylinders located on its front that act as transducers. These transducers are responsible for converting mechanical forces into electrical signals. Inside the device, there is a transmitting transducer and a receiving transducer. The transmitting transducer converts an electrical signal into an ultrasonic pulse, and the receiving transducer converts the reflected ultrasonic pulse back into an electrical signal. Looking at the back of the rangefinder, you can see an integrated circuit (IC) located behind the transmitting transducer, labeled MAX3232. This chip is responsible for controlling the operation of the transmitting transducer. In addition, behind the receiving transducer is another chip labeled LM324. This component is a quad op amp that amplifies the signal produced by the receiving transducer, providing it with enough power to transmit to the Arduino.

2.2.3.1. TIMING DIAGRAM

The timing diagram for the HC-SR04 is presented. To commence measurement, the Trig pin of the SR04 must receive a high pulse (5V) lasting a minimum of 10 microseconds. This action triggers the sensor to emit eight cycles of ultrasonic bursts at a frequency of 40 kHz and subsequently awaits the return of the reflected ultrasonic waves. Upon detecting the reflected ultrasonic signal, the sensor activates the Echo pin to high (5V) and maintains this state for a duration that corresponds to the measured distance. To calculate the distance, one must measure the duration (Ton) of the Echo pin.[9].



(Fig 2-5) Ultrasonic timing

Time = Width of Echo pulse, in us (micro second)

Distance in centimeters = Time / 58

Distance in inches = Time / 148

One can employ the speed of sound for distance measurement, as it is established that sound propagates through air at approximately 344 meters per second (1129 feet per second). By measuring the time taken for the sound wave to return, one can multiply this duration by 344 meters (or 1129 feet) to ascertain the total round-trip distance of the sound wave. The term "round-trip" indicates that the sound wave has traveled to the object and back to the sensor, effectively covering the distance twice; this encompasses the journey from the sonar sensor to the object and the return journey after the sound wave reflects off the object. To determine the distance to the object, one simply divides the round-trip distance by two.

The time variable refers to the duration required for the ultrasonic pulse to depart from the sensor, reflect off the object, and return to the sensor. This time is halved in the calculation, as we are interested solely in the distance to the object, not the total distance for the round trip. The speed variable denotes the rate at which sound travels through air, which is influenced by factors such as temperature and humidity. Consequently, to achieve an accurate distance calculation, it is essential to take into account the prevailing temperature and humidity conditions. The formula for calculating the speed of sound in air, while considering temperature and humidity, is as follows:

$$c = 331.4 + (0.606 \times T) + (0.0124 \times H)$$

$c : \ Speed\ of\ sound\ in\ meters\ per\ second\ (m/s)$
$331.4 : \ Speed\ of\ sound\ (in\ m/s)\ at\ 0\ °C\ and\ 0\%\ humidity$
$T : \ Temperature\ in\ °C$
$H : \ \%\ Humidity\ (relative\ humidity)$

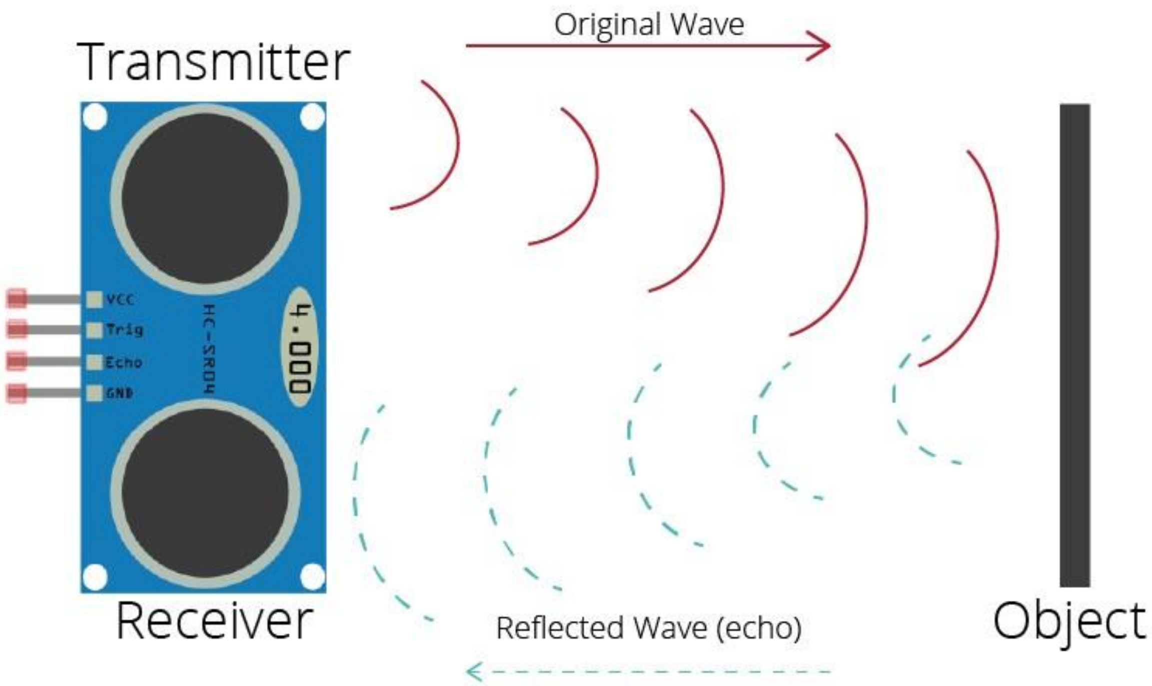
For example, at 20 °C and 50% humidity, sound travels at a speed of:

$$c = 331.4 + (0.606 \times 20) + (0.0124 \times 50)$$
$$c = 344.02\ m/s$$

2.2.3.2. How Ultrasonic Work?

The ultrasonic sensor uses sonar to determine the distance to an object. Here's what happens:

1. The ultrasound transmitter (trig pin) emits a high-frequency sound (40 kHz).
2. The sound travels through the air. If it finds an object, it bounces back to the module.
3. The ultrasound receiver (echo pin) receives the reflected sound (echo).



(Fig 2-6) Ultrasonic wave

The interval between the sending and receiving of the signal enables us to determine the distance to an object. This calculation is feasible due to our understanding of the speed of sound in the air. The following formula illustrates this relationship:

distance to an object = ((speed of sound in the air)*time)/2 speed of sound in the air at 20ºC (68ºF) = 343m/s

2.2.4. BUZZER

A buzzer or beeper is an audible signaling device that can be classified as mechanical, electromechanical, or piezoelectric (commonly called piezo). These devices are commonly used in a variety of applications, including alarm systems, timers, and to confirm user actions such as mouse clicks or key presses.

(Fig 2-7) buzzer

2.2.5. jump wire

A jump wire, commonly referred to as a jumper, jumper wire, jumper cable, or DuPont wire, is an electrical conductor, either as a single wire or a collection of wires within a cable, featuring a connector or pin at each end, although some may be simply tinned without connectors. These wires are primarily utilized to connect various components on a breadboard or within other prototype or test circuits, facilitating internal connections or linking to additional equipment or components without the need for soldering. Individual jump wires are connected by inserting their end connectors into designated slots on a breadboard, the header connector of a circuit board, or a testing device.[2] as shown in figure (2-8)

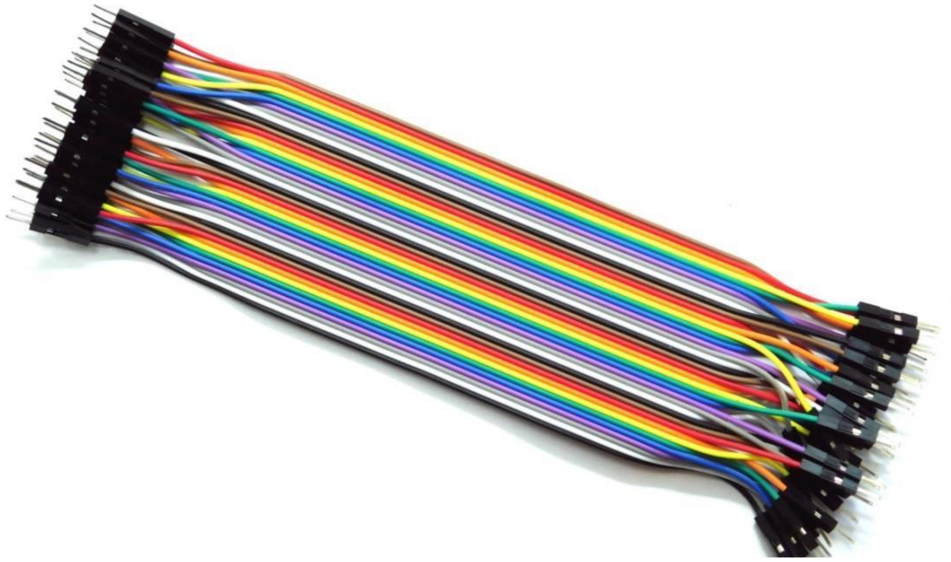


figure (2-8) jump wires

2.2.6. (9V) battery

A nine-volt battery, often so-called a 9-volt battery, is a widely used battery size originally developed for early transistor radios. It has a rectangular prismatic shape with rounded corners and features a polarized snap-on connector located on the top. This type of battery is often used in devices such as smoke detectors, gas detectors, watches, walkie-talkies, electric guitars, and various effects devices. Figure (2-9)

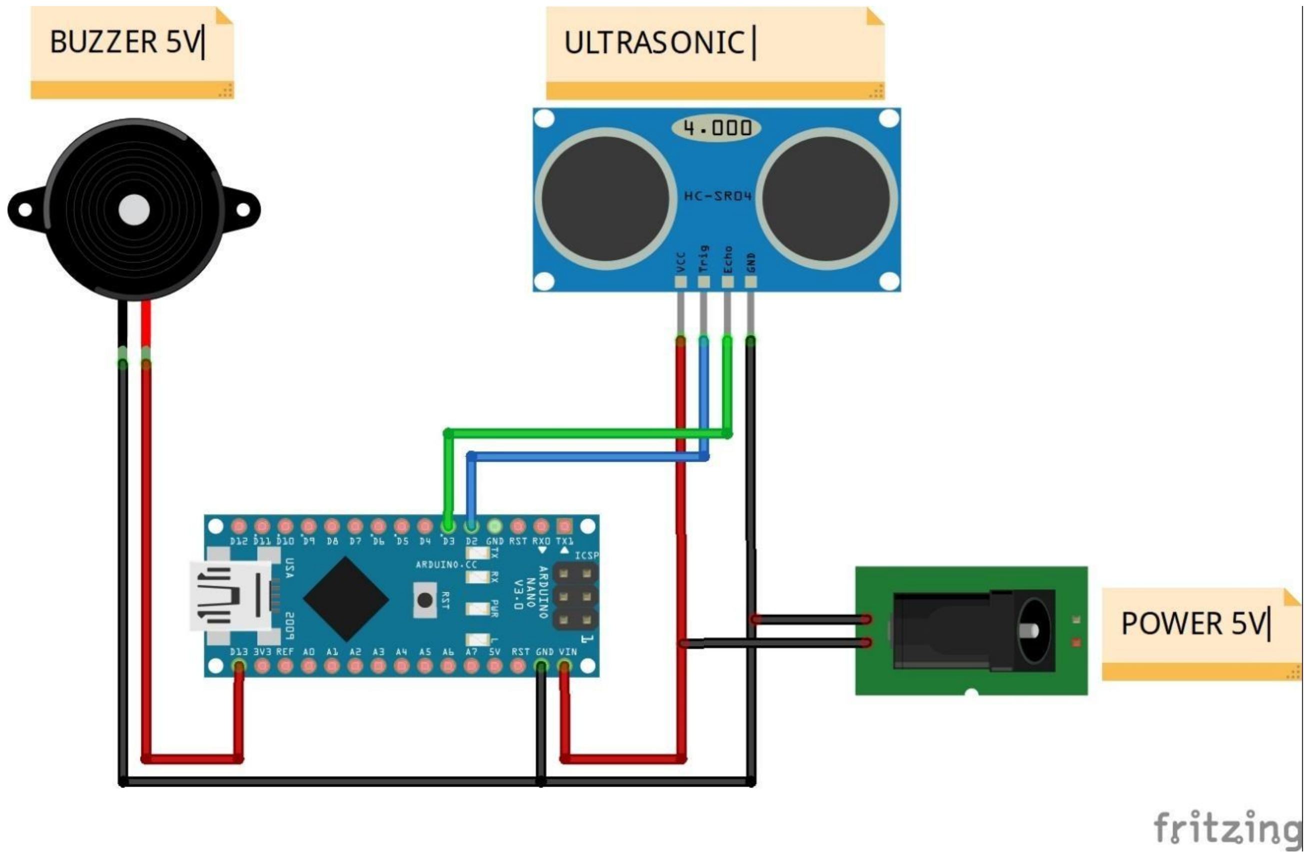
Figure (2-9) 9V battery

CHAPTER THREE

CHAPTER THREE

3.1. Electronic circuit diagram of the project

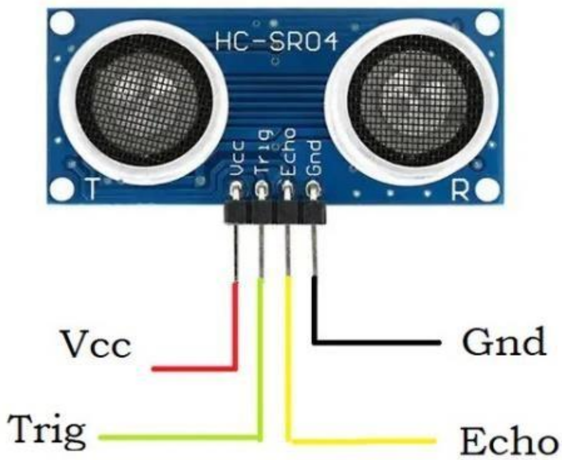
The scheme consists of the Arduino and several sensors that are connected with the Arduino directly and take direct instructions from the Arduino to perform a specific task in the project. As in the chart below



(Fig 3-1) diagram of the project

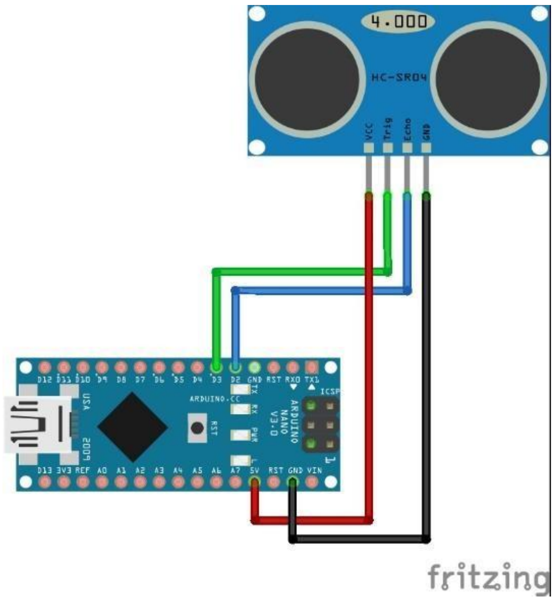
3.2. Ultrasonic sensor with Arduino

The ultrasonic sensor module consists of four pins: Gnd, Vcc, Echo, and Trigger. The Gnd pin serves as the negative connection and is linked to the system's ground. Vcc provides power to the sensor, usually requiring a voltage of 3.3V. The Trigger (Trig) pin is responsible for initiating the emission of ultrasonic sound pulses. Meanwhile, the Echo pin generates a pulse upon receiving the reflected signal.[11].



(Fig 3-2) Ultrasonic pins

Arduino NANO is the brain of this system. It is a microcontroller board based on the ATmega328P microcontroller. Arduino is able to read the input, process it, and generate the output. Ultrasonic sensor we can start to build our circuit. The connections are as follows: Gnd to Gnd from Arduino Echo to D3 from Arduino Trig to D2 from Arduino Vcc to 5v from Arduino. as in the diagram below[11]

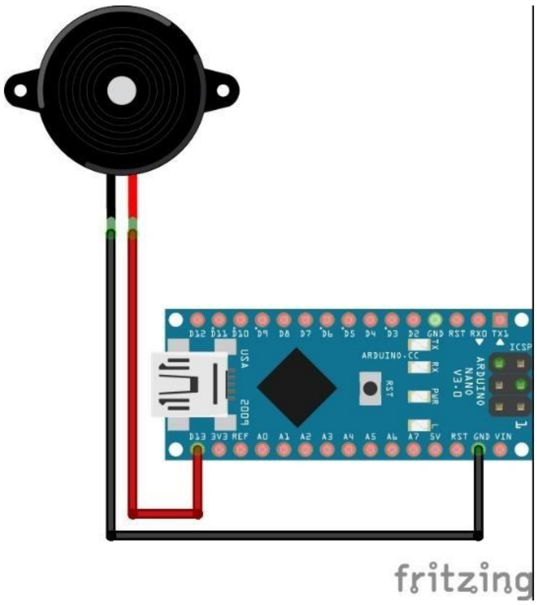


(Fig 3-3) Ultrasonic with Arduino

3.3. Buzzer with Arduino

In numerous projects, the inclusion of a bell is essential. This article focuses on the process of connecting a piezoelectric buzzer to the Arduino NANO. Many individuals are familiar only with the high-frequency sounds produced by bells. The piezoelectric buzzer is a straightforward device capable of generating beeps and tones. Its operation is based on the piezoelectric effect, with the primary component being a piezo crystal. This unique material alters its shape when a voltage is applied. The buzzer is interfaced with the Arduino using two pins: the shorter pin (GND) connects to the GND port on the Arduino, while the other shorter pin (VCC) connects to the D13 port on the Arduino

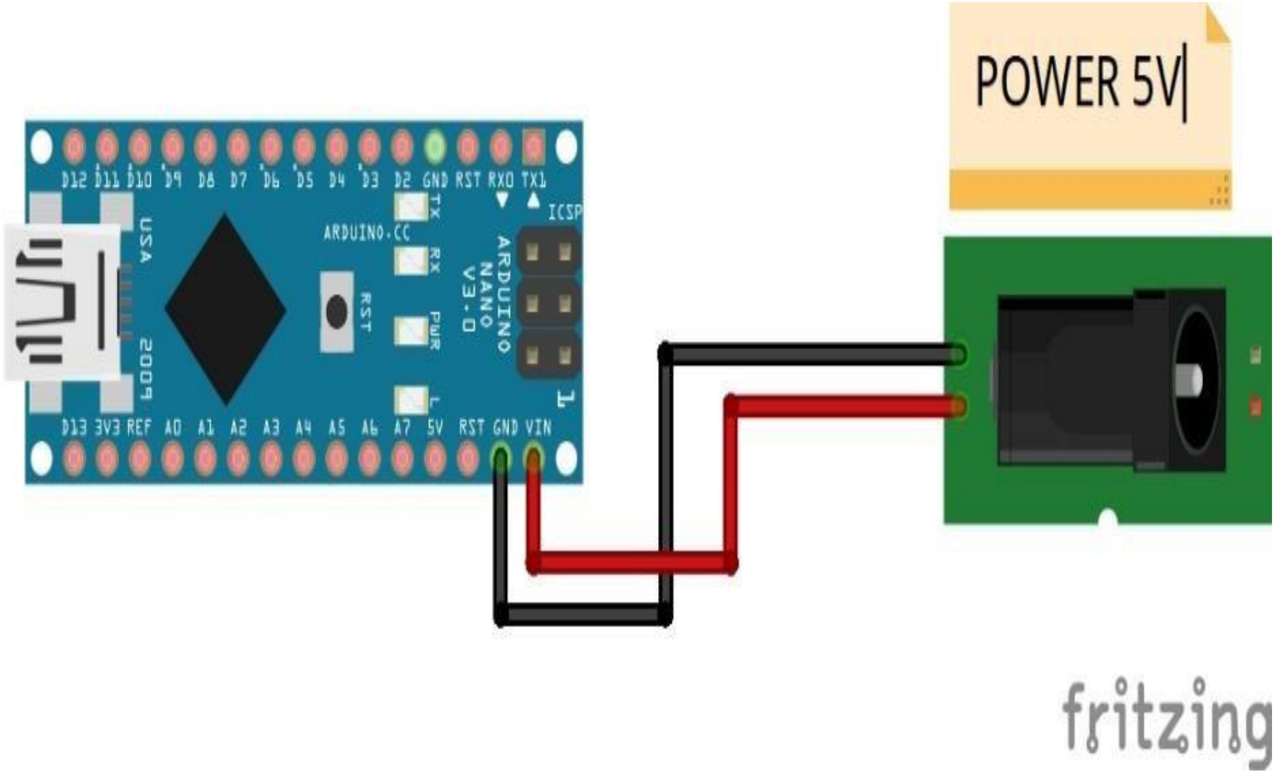
. As in the figure below



(Fig 3-4) Buzzer with Arduino

3.4. Arduino Power Supply

Most of the controllers work with voltage and direct current, including the Arduino, where it works with voltage (5v-9v) and current (3v). In this project, the Arduino will be equipped from two ports, either through (USB) where it is equipped (5V) from the computer or mobile charger, or through a voltage converter (5V) from the port designated for it in the Arduino. Also equipped from 9 volt battery



(Fig 3-5) Arduino Power Supply

CHAPTER FOUR

CHAPTER FOUR

4.1. Results

Two models, similar in work, but different in shape and method of use, were made to cover all tastes and existing cases with regard to blind people. The first model, as shown in the figure (4.1), has all the electronic parts installed on glasses that can be worn easily without affecting the injured person. It is also aesthetic for the person who uses them, where the Arduino, the battery, the power button and the buzzer are placed on the side, taking into account the last appearance, while the distance sensor with waves was placed above The sound is in the front of the glasses to feel any object that may be in front of the blind person, and in case there is something in front of the injured person, the alert is made with the buzzer placed on the side to avoid collision or injury. It is very sensitive to anything solid, including building glass. It also runs on batteries that are very easy to replace.

(Fig 4-1) First module of the third eye

The second model has been manufactured as a device that can also be installed on the stick of the blind as shown in Figure (4.2), which helps blind people avoid obstacles in their way or on the ground, where any solid foreign object is sensed from a distance of half a meter, which in turn gives the person sounds The one who uses the device to avoid this obstacle by going around it and avoiding it. This device works on a microcontroller of the Arduino Uno type, which is powered by a 9-volt battery, which can be easily replaced. The distance sensor and the speaker are connected to the Arduino, and the distance sensor is placed at a distance of 40 cm from the ground to pick up any foreign object on the ground, for example, large stones, and alert the blind person through a buzzer.

(Fig 4-2) Second module of the third eye

CHAPTER FIVE

CHAPTER FIVE

5.1. Conclusions

The suggested system serves as an assistive device for individuals with visual impairments. It aids in identifying various obstacles in their path, thereby facilitating easier mobility. This device is designed to be a cost-effective solution for individuals from middle and lower-income backgrounds.

Two devices were manufactured, one in the form of glasses and the other a stick. Both models can be used with blind people, as they help to identify obstacles and give alerts to the blind person to change his path, taking into account the high accuracy, ease of use, low cost and ease of manufacture to be accessible to everyone

5.2. Future Work

In the future, a speaker or a headset can be added to be placed in the person's ear to alert by sound or the presence of a barrier in front of him, and the alarm bell can also be converted into a speech utterance to alert the person of the presence or absence of a barrier. A vibrator can also be added for additional alert .

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