Arduino Uno Third Hand-Eye Project for Visually Impaired Individuals

Sayan Roy, Akash Ghoral, Abhisek Chakraborty and Supriyo Sarkar

Abstract— **The Arduino Uno Third Hand-Eye Project aims to provide assistance to visually impaired individuals by utilizing the capabilities of Arduino Uno, an ultrasonic sensor (HC-SR04), and a buzzer. The project focuses on detecting obstacles in the environment and alerting the user through audio feedback, enhancing their mobility and safety.**

I. INTRODUCTION

The "Arduino Uno Third Hand-Eye Project for Visually Impaired Individuals" harnesses innovative technology to empower those with visual impairments. Utilizing Arduino Uno as the central microcontroller, the system integrates an ultrasonic sensor as its "eyes" and a buzzer for auditory feedback, creating a reliable obstacle detection mechanism.

This project addresses the unique challenges faced by visually impaired individuals by providing real-time environmental awareness. The Arduino Uno orchestrates seamless communication between components, offering a comprehensive solution for enhanced mobility and safety.

II. COMPONENTS DESCRIPTION

A. Arduino Uno

The Arduino Uno serves as the project's central microcontroller, functioning as the system's processing hub. Responsible for data analysis from the ultrasonic sensor, it effectively controls the buzzer based on detected obstacle distances. As the project's brain, the Arduino Uno ensures seamless coordination between components, enhancing the overall functionality of the Third Hand-Eye Project for visually impaired individuals.

B. Ultrasonic Sensor (HC-SR04)

The ultrasonic sensor, akin to the "eyes" of the system, gauges distances by emitting ultrasonic waves. It measures the time taken for these waves to return after encountering obstacles, enabling precise distance calculations. This pivotal component allows the Arduino Uno Third Hand-Eye Project to accurately sense and respond to obstacles in the visually impaired individual's surroundings.

C. Buzzer

Functioning as the auditory feedback mechanism, the buzzer plays a crucial role in alerting visually impaired individuals to the presence of obstacles within a specified range. When an obstacle is detected, the buzzer emits a sound, providing a clear and immediate indication of the obstacle's presence.

III. PERFORMANCE OF ARDUINO UNO

The Arduino Uno is a popular open-source microcontroller board based on the ATmega328P microcontroller. Developed by Arduino LLC, it serves as an accessible platform for electronics enthusiasts, hobbyists, and professionals to create interactive projects. Here, we delve into the key details of the Arduino Uno, focusing on its central component, the ATmega328P microcontroller.

A. ATmega328P Microcontroller

- Architecture: The ATmega328P is an 8-bit AVR (Advanced Virtual RISC) microcontroller featuring a modified Harvard architecture. It integrates flash memory for program storage, EEPROM for data storage, and SRAM for runtime data storage.
- Clock Speed: The ATmega328P operates at a clock speed of 16 MHz. This clock speed determines the speed at which the microcontroller executes instructions.
- Processing Power: The ATmega328P is an 8-bit microcontroller, which means it processes

data in 8-bit chunks. While this architecture might be considered limited compared to 32-bit or 64-bit systems, it is well-suited for a wide range of embedded applications and projects.

- Flash Memory: With 32 KB of Flash memory, the Arduino Uno can store relatively complex programs. The Flash memory is used to store the user's code, including the Arduino bootloader, which facilitates easy programming.
- SRAM: The 2 KB of SRAM is used for dynamic variable storage during program execution. Adequate SRAM is essential for handling variables, arrays, and other data structures in the running program.
- EEPROM: The 1 KB of EEPROM provides non-volatile storage for data that needs to be retained even when power is removed. This can be useful for storing configuration parameters or small amounts of user data.
- I/O Pins: The Arduino Uno offers 14 digital I/O pins and 6 analog input pins. These pins provide flexibility for interfacing with various sensors, actuators, and other peripherals.
- Communication Interfaces: Supporting USART, I2C, and SPI, the ATmega328P enables communication with other devices, expanding the possibilities for project connectivity.
- Timers/Counters and PWM: The three timers/counters and 6 PWM channels enhance the Uno's capability for precise timing, frequency generation, and analog signal simulation.
- ADC (Analog-to-Digital Converter): The 10-bit ADC allows the Arduino Uno to convert analog signals into digital values, making it suitable for applications that involve reading analog sensor data.
- Power Consumption: While not directly a performance metric, the Arduino Uno's power efficiency is crucial for battery-powered or low-power applications. The microcontroller can be put into sleep modes to conserve power when not actively processing tasks.

IV. HARDWARE IMPLEMENTATION

The successful implementation of the Arduino Uno Third Hand-Eye Project relies on the precise integration of the components. Each element plays a crucial role in ensuring the proper functioning of the system. To establish the necessary connections for the project, follow the steps below:

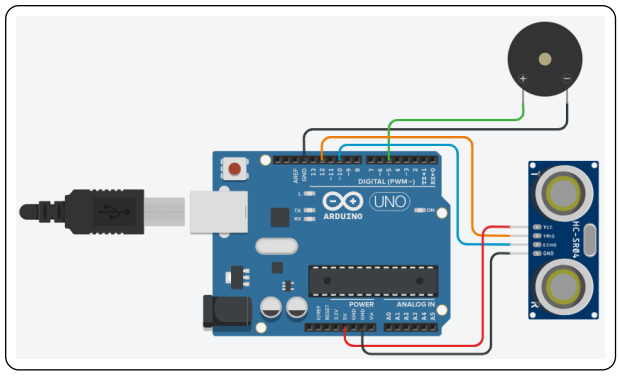

Fig. 1. Circuit Diagram

A. Ultrasonic Sensor (HC-SR04)

The ultrasonic sensor is a key component responsible for measuring distances within the environment. It operates based on the principle of sending ultrasonic waves and calculating the time taken for these waves to return after hitting an obstacle. The sensor consists of two main components: the transmitter and the receiver.

1) Transmitter (Trigger): Connected to digital pin 12 (`pingTrigPin`). Initiates the emission of ultrasonic waves when triggered by the Arduino Uno.

2) Receiver (Echo): Connected to digital pin 10 (`pingEchoPin`). Detects the reflected ultrasonic waves and provides input to the Arduino Uno for further processing.

B. Buzzer

The buzzer serves as the auditory feedback mechanism, alerting the user when an obstacle is detected within the specified range. It operates based on the signals received from the Arduino Uno.

- The positive terminal of the buzzer is connected to digital pin 5 (`buz`) on the Arduino Uno.
- The negative terminal is connected to the ground (GND) pin on the Arduino Uno. When triggered by the Arduino Uno, the buzzer emits a sound, providing the user with a clear indication of the obstacle's presence.

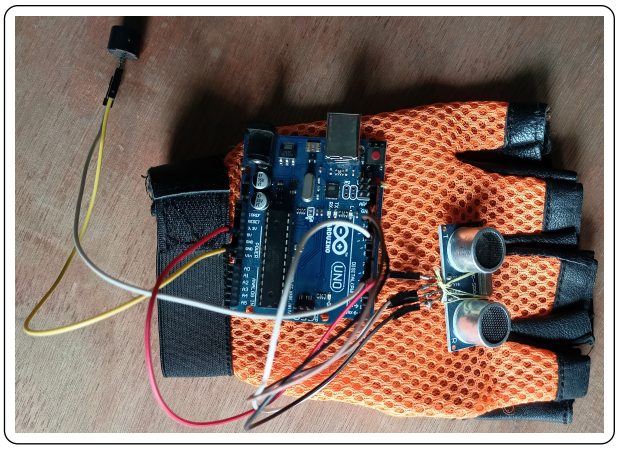

Fig. 2. Practical Implimetation

Ensure that all connections are secure and that the components are appropriately powered. This wiring configuration facilitates the flow of signals between the ultrasonic sensor, buzzer, and Arduino Uno.

V. ARDUINO UNO THIRD HAND-EYE PROJECT CODE EXPLANATION

A. Code Overview

```
const int pingTrigPin = 12; //
   Trigger connected to PIN 12
const int pingEchoPin = 10; //
   Echo connected to PIN 10
int buz = 5; // Buzzer connected
   to PIN 5
```

B. Constants Declaration:

- **const int pingTrigPin = 12;:** Defines a constant integer variable pingTrigPin and assigns it the value 12. This constant represents the digital pin to which the trigger pin of the ultrasonic sensor is connected.
- **const int pingEchoPin = 10;:** Defines another constant integer variable pingEchoPin and assigns it the value 10. This constant represents the digital pin to which the echo pin of the ultrasonic sensor is connected.
- **int buz = 5;:** Declares an integer variable buz and assigns it the value 5. This variable represents the digital pin to which the positive terminal of the buzzer is connected.

```
void setup() {
  Serial.begin(9600);
  pinMode(buz, OUTPUT);
  pinMode(pingTrigPin, OUTPUT);
}
```

C. Function `setup()`:

- **Serial.begin(9600);:** Initializes serial communication with a baud rate of 9600. This enables communication between the Arduino and an external device, such as a computer, for debugging purposes.
- **pinMode(buz, OUTPUT);:** Configures the buz pin as an output, indicating that it will be used to send signals to the buzzer.
- **pinMode(pingTrigPin, OUTPUT);:** Configures the pingTrigPin as an output, designating it as the trigger pin for the ultrasonic sensor.

```
void loop() {
  long duration, cm;
  digitalWrite(pingTrigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(pingTrigPin, HIGH);
  delayMicroseconds(5);
  digitalWrite(pingTrigPin, LOW);
  pinMode(pingEchoPin, INPUT);
  duration = pulseIn(pingEchoPin,
     HIGH);
  cm = microsecondsToCentimeters(
     duration);
  if (cm <= 100 && cm > 0) {
    digitalWrite(buz, HIGH);
    delay(100);
    digitalWrite(buz, LOW);
    delay(10);
  }
  Serial.print(cm);
  Serial.print("cm");
  Serial.println();
  delay(10);
}
```

D. Function `Loop()`:

- **long duration, cm;:** Declares long integer variables duration and cm to store the dura-

tion of the pulse and the converted distance measurement, respectively.

- **digitalWrite(pingTrigPin, LOW);:** Sets the trigger pin of the ultrasonic sensor to low.
- **delayMicroseconds(2);:** Introduces a delay of 2 microseconds.
- **digitalWrite(pingTrigPin, HIGH);:** Sets the trigger pin to high, initiating the ultrasonic pulse.
- **delayMicroseconds(5);:** Introduces a delay of 5 microseconds.
- **digitalWrite(pingTrigPin, LOW);:** Sets the trigger pin back to low.
- **pinMode(pingEchoPin, INPUT);:** Configures the echo pin of the ultrasonic sensor as an input to receive the returning pulse.
- **duration = pulseIn(pingEchoPin, HIGH);:** Measures the duration of the pulse received on the echo pin.
- **cm = microsecondsToCentimeters(duration);:** Converts the pulse duration to distance in centimeters using the `microsecondsToCentimeters` function.
- **if (cm <= 100 && cm > 0) ... :** Checks if the distance is within the acceptable range (1 to 100 cm).
- **digitalWrite(buz, HIGH);:** Activates the buzzer by setting the buz pin to high.
- **delay(100);:** Introduces a delay of 100 milliseconds during which the buzzer remains active.
- **digitalWrite(buz, LOW);:** Deactivates the buzzer by setting the buz pin to low.
- **long duration, cm;:**delay(10);: Introduces a short delay before the next iteration.
- **Serial.print(cm);:** Prints the distance value to the serial monitor.
- **Serial.print("cm");:** Prints the unit (centimeters) to the serial monitor.
- **Serial.println();:** Moves the cursor to the next line in the serial monitor.
- **delay(10);:** Introduces a delay before the next iteration.

```
long microsecondsToCentimeters(
   long microseconds) {
  return microseconds / 29 / 2;
}
```

E. Function `microsecondsToCentimeters()`

- **long microsecondsToCentimeters(long microseconds) ... :** Defines a function that takes the pulse duration in microseconds as input.
- **return microseconds / 29 / 2;:** Calculates and returns the distance in centimeters based on the speed of sound in the air (29 microseconds per centimeter) and accounting for the two-way travel of the ultrasonic pulse.

VI. CONCLUSION

The Arduino Uno Third Hand-Eye Project showcases the practical application of technology in assisting visually impaired individuals. By providing real-time obstacle detection through an Arduino-based system, the project contributes to enhancing the independence and safety of individuals with visual impairments. Future improvements could involve additional sensors, increased range, and integration with wearable devices for a more seamless user experience.

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