Arduino and UV Sensors Embedded Assistive Hat for Visually Impaired

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Abstract:

The World Health Organization (WHO) reported that there are 285 million visually-impaired people worldwide. Among these individuals, there are 39 million who are totally blind. There have been several systems designed to support visually-impaired people and to improve the quality of their lives. In this paper, we present an Arduino and UV sensors embedded hat to provide a 3-dimensional guidance for the blind which is wearable and portable in order to show the progress in assistive technology for this group of people. We thus contribute in assisting this population and highlight the improvements, advantages, disadvantages and accuracy. Our aim is to address and present to researchers in this area to design devices that ensure safety and self reliable mobility to visually-impaired people.

Keywords: assistive devices, visually-impaired people, obstacles detection, Arduino UNO , Ultrasonic sensor *HC-SR04*, vibrator.

1. Introduction

The World Health Organization (WHO) fact reported 100,000 students, who are visually impaired according to the American Foundation for the Blind [1,2] and National Federation for the Blind [3]. Over the past years, blindness that is caused by diseases has decreased due to the success of public health actions. However, the number of blind people that are over 60 years old is increasing by 2 million per decade. Unfortunately, all these numbers are estimated to be doubled by 2020 [4].

The need for assistive devices for navigation and orientation has increased. The simplest and the most affordable navigations and available tools are trained dogs and the white cane [5]. Although these tools are very popular, they are not wearable and adds to the discomfort of carrying by engaging one of the hands. The present work involves a wearable hat which is embedded with an Arduino UNO and three ultrasonic sensors to provide a 360 degrees pseudo view to avoid an obstacle hitting the person who is wearing it.

1.1. Assistive Technology

All the systems, services, devices and appliances that are used by disabled people to help in their daily lives, make their activities easier, and provide a safe mobility are included under one umbrella term: assistive technology [6].

In the 1960s, assistive technology was introduced to solve the daily problems which are related to information transmission (such as personal care) [7], navigation and orientation aids which are related to mobility assistance [8,9,10].

Visual assistive technology is divided into three categories: vision enhancement, vision substitution, and vision replacement [10,11]. This assistive technology became available for the blind people through electronic devices which provide the users with detection and localization of the objects in order to offer those people with sense of the external environment using functions of sensors. The sensors also aid the user with the mobility task based on the determination of dimensions, range and height of the objects [6]

2. Components and Specifications

2.1. Physical Assembly

Figure 1a shows the schematic of the circuit employed in the assistive hat along with the components namely ultrasound sensors, Arduino Nano, vibrators and buzzer. It also comprises of the battery holder and a reset button . The circuit design is implemented in Proteus simulator and the Arduino nano is programmed in embedded C using the Arduino IDE 1.8.13

2.2. Circuitry Design and Implementation

The Arduino Nano [**8**] microcontroller, in which the copper wires from the sensor pins of the ultrasonic sensor (Figure 2a), and reset button were soldered with a 9 V battery supplying 3.3 to 5 V to the circuit (Figure 1a).

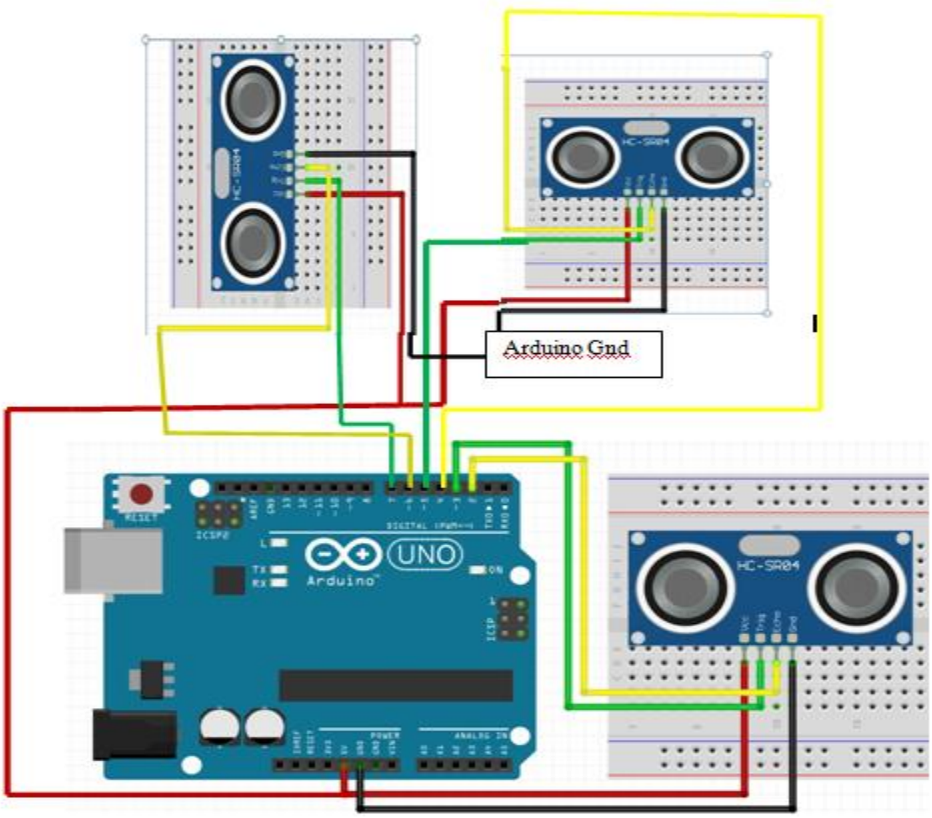

Figure 1a Circuit Schematic showing the Arduino UNO microcontroller and UV sensors

Figure 1b &1c The physical picture of the assistive hat and ***consisting of: Ultrasonic sensor HC-SR04, reset button, Arduino Nano board, vibrators and buzzer.***

3 Experiment

To make an assistive hat for the blind we used an Arduino Uno, 3 Ultrasonic sensors, 2 vibrators. An ultrasonic sensor has trigger and echo pins as shown in figure 1c. The first sensor echo pin is connected to Arduino digital pin number 2 and the Trig is connected digital Pin 3. The second sensor echo is connected to Arduino digital pin number 4 and the Trig is connected to digital Pin 5. Similarly, the third sensor echo is connected to Arduino digital pin number 6 and the Trig is connected digital Pin 7. Left vibrator Vcc is connected to digital pin 9 and ground to the Arduino ground. Similarly right vibrator Negative is connected to digital pin 10 and ground to Arduino ground. The third sensor output is given to a buzzer in order to differentiate the direction of the obstacle. After making all these connections our circuit is ready. The code using embedded C language is developed in Arduino IDE 1.8.13 and uploaded using the USB to AB cable in order to dump into the Arduino board.

3.1 Working

Ultrasonic sensors send ultrasonic waves. These waves are absolutely invisible and come back after hitting an obstacle there by activating the Trig pin of the respective sensor. The Trig pin activates (D3 or D5 or D7) to which a left vibrator, right vibrator and a buzzer are connected and thereby gets activated through embedded C program. The obstacle closeness is fixed to 10 cm so that the buzzer or the vibrator gets activated depending on their directional position if the obstacle comes closer than this distance.

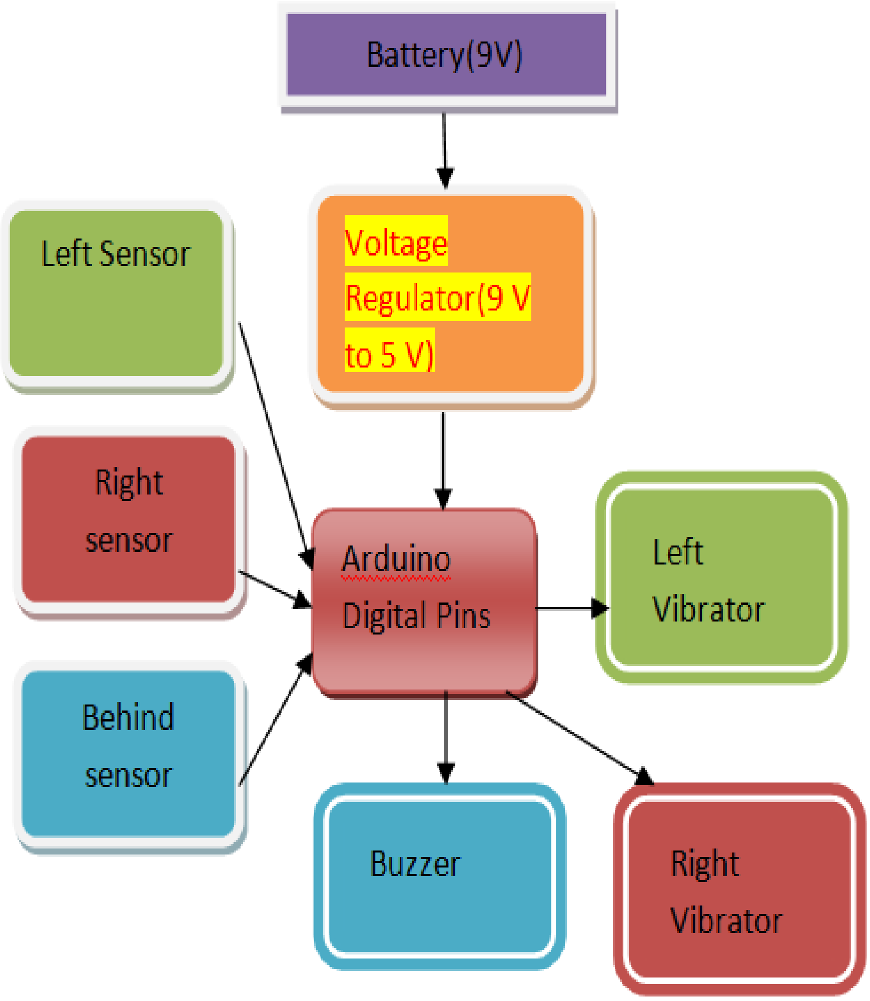

Figure 1d Flowchart of the algorithm fed into the Arduino UNO

Arduino Sketch for the assistive Hat

File Edit Sketch Tools Help

HAT_code §

```
const  int trigPin_1=2;
const int echoPin_1=3;
const  int trigPin_2=4;
const int echoPin_2=5;
const  int trigPin_3=6;
const int echoPin_3=7;
long duration;
int distanceleft;
int distanceright;
int distancebehind;
void setup() {
  // put your setup code here, to run once:
Serial.begin(9600);
pinMode(trigPin_1,OUTPUT);
pinMode(echoPin_1,INPUT);
pinMode(trigPin_2,OUTPUT);
pinMode(echoPin_2,INPUT);
pinMode(trigPin_3,OUTPUT);
pinMode(echoPin_3,INPUT);
}

void loop() {
  // put your main code here, to run repeatedly:
digitalWrite(trigPin_1, LOW);
delayMicroseconds(2);
digitalWrite(trigPin_1, HIGH);
delayMicroseconds(10);
duration =pulseIn(echoPin_1,HIGH);
```

Done compiling.

```
Sketch uses 2918 bytes (9%) of program storage space. Maximum is 32256 bytes.
Global variables use 190 bytes (9%) of dynamic memory, leaving 1858 bytes for local variables. Maximum is 2048 bytes.
```

HAT_code §

```
if(distanceleft<10)
{

  digitalWrite(2,HIGH);
  digitalWrite(3,HIGH);
  }
else
{

  digitalWrite(2,LOW);
  digitalWrite(3,LOW);
}

 if(distanceright<10)
{
  digitalWrite(4,HIGH);
  digitalWrite(5,HIGH);

}
else
{
  digitalWrite(4,LOW);
  digitalWrite(5,LOW);
}
if (distancebehind<10)
{
  digitalWrite(6,HIGH);
  digitalWrite(7,HIGH);
```

Done compiling.

```
Sketch uses 2918 bytes (9%) of program storage space. Maximum is 32256 bytes.
Global variables use 190 bytes (9%) of dynamic memory, leaving 1858 bytes for local variables. Maximum is 2048 bytes.
```

4 Sensor considerations

4.1. Ultrasound Sensor

The ultrasound sensor (figure 2a) consists of a transmitter sending an ultrasound wave and a receiver detecting the reflected wave by the targeted physical object. The time taken between the transmission and detected wave is registered for the calculation of the distance from the speed of ultrasound waves at 330 m/s by the programmed Arduino Nano.

The sensors sends a sequence of ultrasonic pulses. If the obstacle is detected, then the sound will be reflected back to the receiver as shown in Figure 2b. The micro-controller processes the readings of the ultrasonic sensors in order to activate the vibrators by sending pulse width modulation. It also provides a low power consumption [15]. Figure 2c shows the arrangement of the three sensors embedded in to the wearable hat in order to have a 360^{0} obstacle finding range

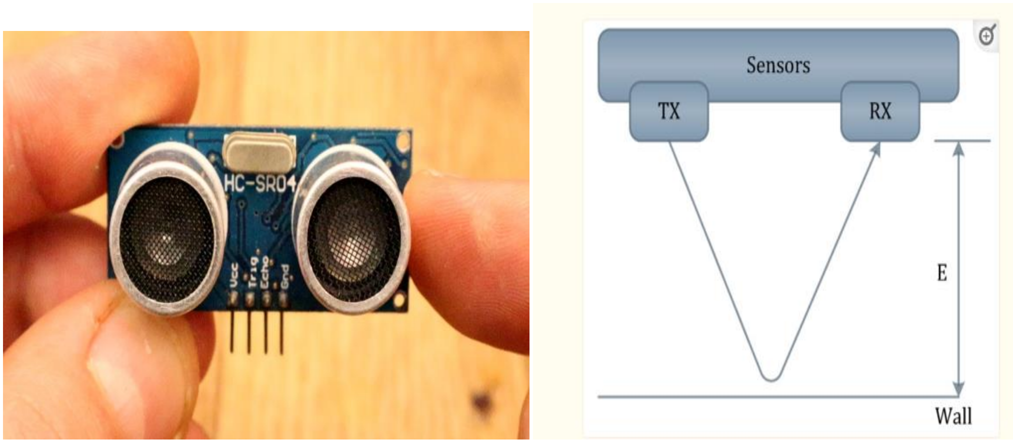

Figure 2a and 2b Ultrasonic sensor HC-SR04 component range of signal

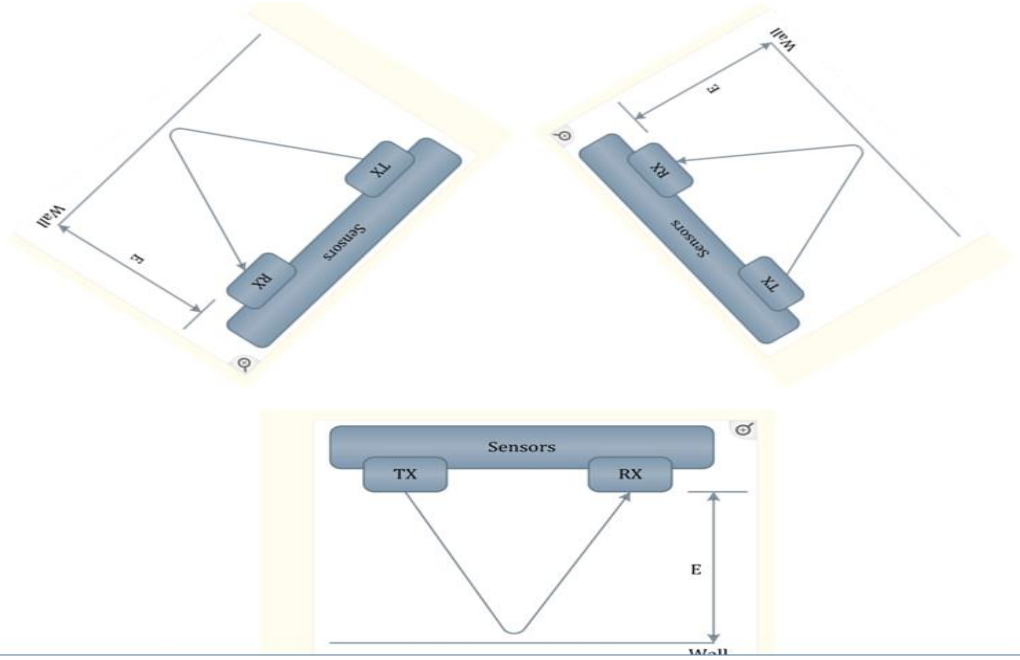

Figure 2c Arrangement of the three sensors within the Hat for a 360 degrees view

5 Results and Discussions

The experiment is performed on 10 undergraduate students by covering their eyes in order to study the accuracy of the unit. The observations were recorded by placing an obstacle of 3 to 4 ft height on a concentric circle of radius 12 cm and then of 10 cm. The observations were found to be quite satisfactory where in the buzzer alarmed and the vibrator gave a signal depending on the position of any obstacle for this distance giving a feel of presence of an obstacle for the subject wearing the assistive hat.

Conclusions

We thus conclude the successful working of a prototype of an assistive hat for visually handicapped people which is economical, long lasting, reliable and portable at the comfort of just wearing as a hat there by enhancing their physical appearance.

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