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Obstacle Detector for Visually Impaired People

Abstract: We live in an interactive world where everything is connected to everything so that we can control almost everything and sensitize people. For example, interactive product could be used in urban environments to sensitize people to moving vehicles and showing the intention of the user, controlling the robotic hand or helping the blind to find obstacles on his walkway. This project report discusses the idea of implementing a device based on a microcontroller for the visually impaired people. Arduino is used as a microcontroller and two sensors such as ultrasound and water sensor have been integrated into Arduino. A buzzer was also integrated into the devices. If a visually impaired person finds a physical obstacle or water surface on their way, the buzzer uses sensors to collect information from the Arduino and the buzzer makes noises to notify the visually impaired person.

Background

The WHO surveyed and research in 39 countries says that there is about 245 million visually impaired persons. Of the 245 million individuals with visual disabilities, about 39 million are blind. The research also indicates that most visually disabled people are from an age group of '50-above.' They face so many difficulties in their everyday lives. One of the most common problems is finding a walkable road. Through this project, I plan to develop an interactive T-shirt (microcontroller based) that helps people with visual disabilities move around and encourages them to do their work comfortably. This device improves Blind people's mobility and health, particularly in unknown environments. There are so many consumer items for people with visual impairments but they're all too pricey. We must bear in mind that the world's 2/3 population is not so wealthy to purchase such costly consumer

goods. That's motivated me to develop a simple product that can help visually impaired people locate any physical obstacles and surface water. The commodity is going to be so cheap everyone can afford it. There are few studies published on IEEE about this product. They used sensors to sense physical impediments. In the study, this paper [1] utilized an ultrasonic sensor and water sensor. They initially create a device based on Arduino, and in the end, the system analyzes the results based on the distances. Another paper [2] builds a smart stick for the blind. I went through a few research papers to develop my idea and understand their implementation concept. Now I'll apply that expertise to create an interactive T-shirt for visually impaired people in my project.

Project Concept

The main goal is to develop a microcontroller-based interactive T-shirt that helps visually disabled people to identify obstacles on their walking route. Two types of hazard, water, and the physical object will be identified. The project will be designed entirely in Arduino. I need two special kinds of sensor, ultrasonic sensor, and grove water sensor to create this project. Ultrasonic waster sensor and Grove will be connected to Arduino. The ultrasonic sensors used ultrasonic sound to determine the distance to a physical body. Here, Buzzer will make a sound after receiving a signal from the ultrasonic sensor whenever a visually impaired person gets close to a physical object. By measuring the electrical conductivity, the water sensor will detect the water, and likewise, the buzzer is pressed to produce sound if a visually impaired person is near to the water surface. I also need other materials to make this product entirely that are listed in the ‘List of Materials’ section. My plan is also to analyze the distances to check how sensors are worked on different distances. I believe understanding the consistency of this

project is important to make things in the future fully commercial. The following scenario provides a summary of the project.

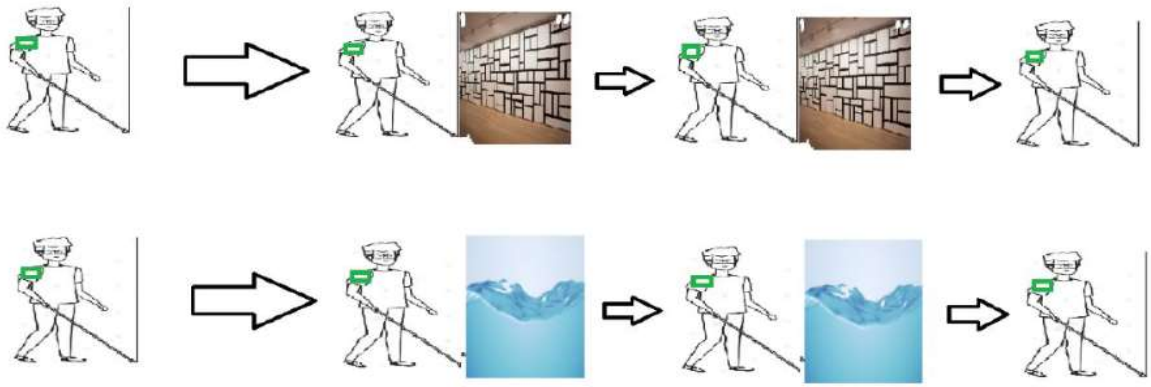

Fig 1: Illustration of project concept

Project Implementation

I need an Arduino microcontroller to bring the idea into practice. Arduino will be with T-shirt. I need a buzzer, a vibration engine and the following specifications [see material section] too. Ultrasonic and grove water sensor are the two materials most required for this implementation. I also need battery power, e.g. 9V Battery. Once the microcontroller encounter an obstacle, it will produce noise and vibration in order to alert the user. The following Program case diagram.

Materials:

- Arduino Uno (Microcontroller where the circuit will be implemented)
- Ultrasonic Sensor (to create ultrasonic sound to determine the distance of the object)
- Grove water sensor (measure electrical conductivity)
- Breadboard (help to connect components to complete circuit)
- 2x Buzzer (to generate noise)

- Jumper Wires (to connect each component)
- 4-5x 220Ohm Resistor
- 2-3x 1k Resistor
- Conductive Copper Tape (to close the circuit)

First Prototype: Since I didn't have the physical requirements then, I couldn't create a physical prototype. But using the Tinkercad web application, I made a simple diagram to show how ultrasonic sensors works. The limitation of the tinkercad and fritzing application is that they have no grove sensor. Following is my diagram and the Arduino code.

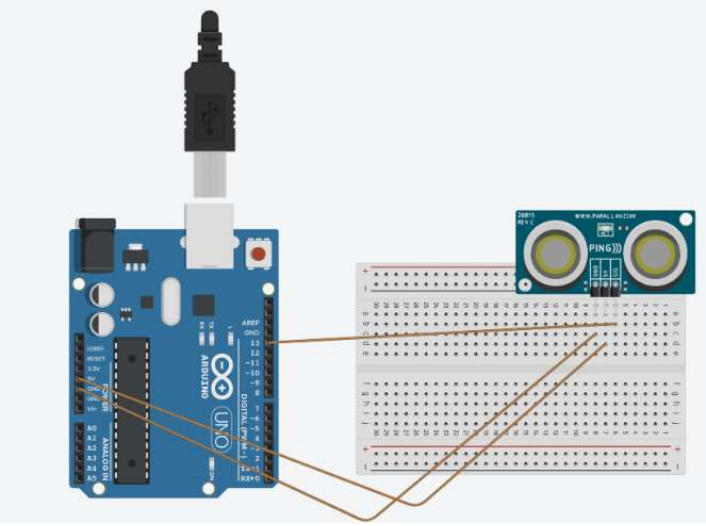

Fig 2: Prototype 1

```
const int pin = 13;
void setup() {
    Serial.begin(9600);
}
void loop() {
    float d, inch, cm;
    pinMode(pin, OUTPUT);
    digitalWrite(pin, LOW);
    delayMicroseconds(10);
    digitalWrite(pin, HIGH);
    delayMicroseconds(10);
    digitalWrite(pin, LOW);

    pinMode(pin, INPUT);
    d = pulseIn(pin, HIGH);

    inch = InchConversion(d);
```

```
    cm = CMconversion(d);

    Serial.print(inch);
    Serial.print("in, ");
    Serial.print(cm);
    Serial.print("cm");
    Serial.println();
    delay(200);
}
float InchConversion(float microseconds) {
    return microseconds / 74 / 2;
}
float CMconversion(float microseconds) {
    return microseconds / 29 / 2;
}
```

2nd Prototype: In the first prototype, I used Tinkercad to visualize a basic prototype. Here, I practically put the idea into hardware. The illustration below shows a simple prototype that recognizes a physical object. To build this prototype, I used Arduino, ultrasonic sensor, buzzer, breadboard, and wire. Whenever there is a physical object near the ultrasonic sensor, it beeps. The ultrasonic sensor generates ultrasonic sound to determine the distance of the objects. The only limitation is that I implemented the circuit with a passive buzzer so that it generates so little noise. I fixed this in the next prototype with a 5V piezo sound buzzer

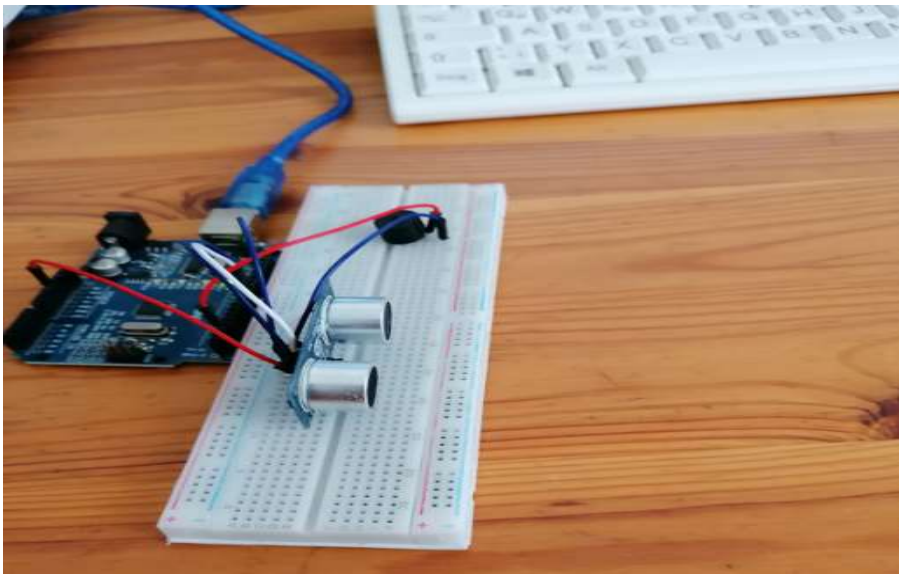

Fig 3: Prototype 2

```
int const trigPin = 10, echoPin = 9, buzzPin = 2;

```

```
3.  void setup()
4.  {
5.  pinMode(trigPin, OUTPUT);
6.  pinMode(echoPin, INPUT);
7.  pinMode(buzzPin, OUTPUT);
8.  }
9.
10. void loop()
11. {
12. int ms, range;
13.
14. digitalWrite(trigPin, HIGH);
15. delay(1);
16. digitalWrite(trigPin, LOW);
17.
18. ms = pulseIn(echoPin, HIGH);
19. range = (ms/2) / 29.1;
20.
21. if (range <= 10 && range >= 0) {
22. digitalWrite(buzzPin, HIGH);
23. delay(10);
24. } else {
25. digitalWrite(buzzPin, LOW);
26. delay(10);
27. }
28. delay(60);
29. }
```

3rd Prototype: In 2nd Prototype, I built the prototype with a passive buzzer, but the problem with the passive buzzer is that it cannot produce high noise. There is only one beep that is very difficult to hear. here I overcome this limitation by removing the passive buzzer and adding an active piezo buzzer. It responds to 3.5-5V. It makes high noise that can easily notify the user if there is a physical obstacle in front of them.

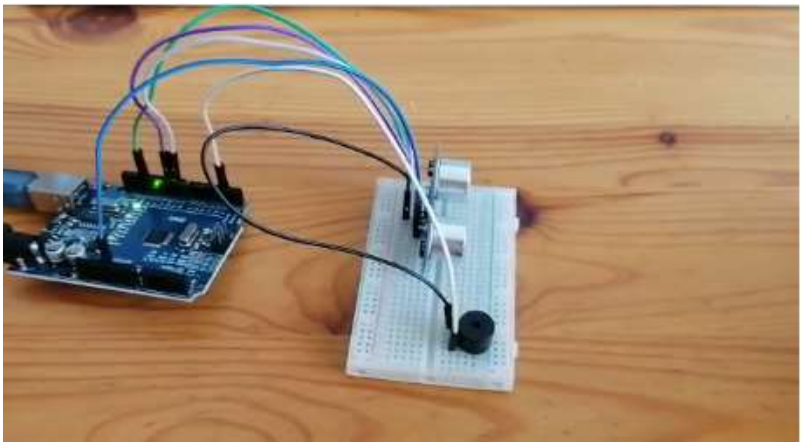

Fig 4: Prototype 3A

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The below diagram consists of the Arduino, water sensor and buzzer. There are 3 input pins in the water sensor. The first input goes to ground, the second input goes to voltage and the third input goes to pin 6 of Arduino. Similarly, one buzzer input pin goes to ground and another goes to Arduino input pin 5. The circuit is drawn using a Fritzing tool. The circuit detects water when a drop of water falls into the water sensor. Then the water measures the electrical conductivity of the water that falls into the sensor and sends a signal. Finally, the buzzer detects the signal and makes noises to notify the user. The main reason for choosing this specific sensor is that this sensor is cheap and it is easy to implement this sensor in the microcontroller.

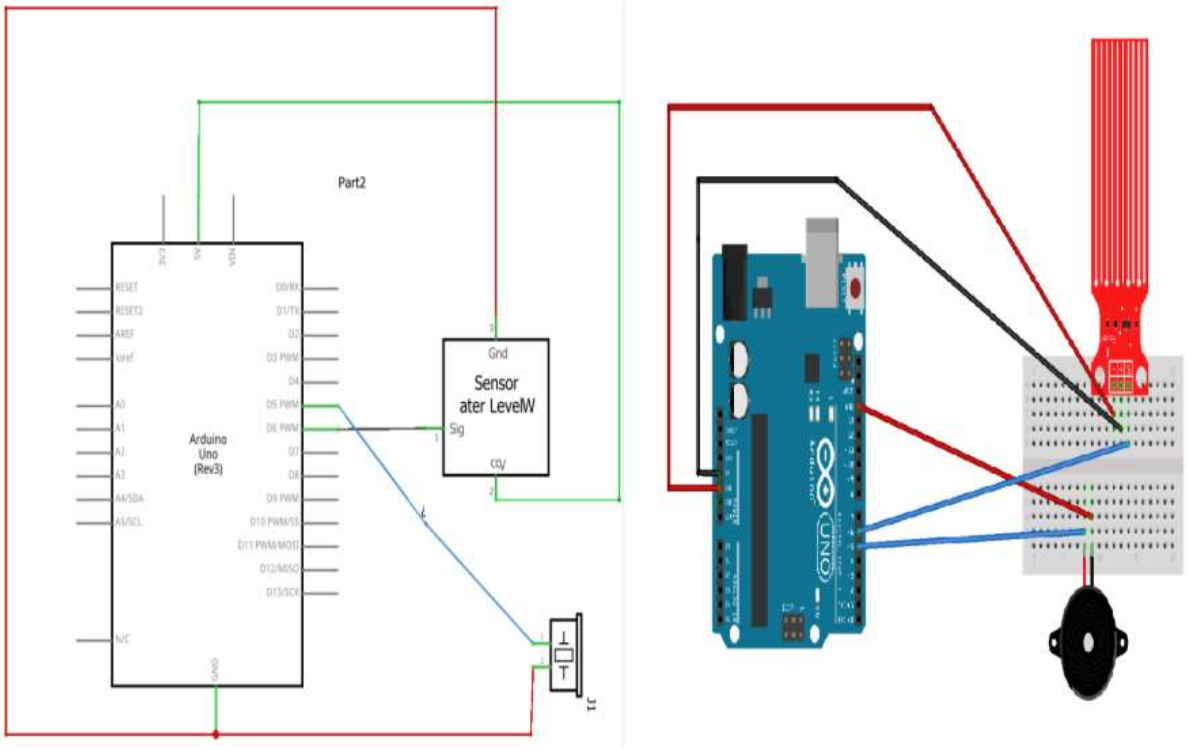
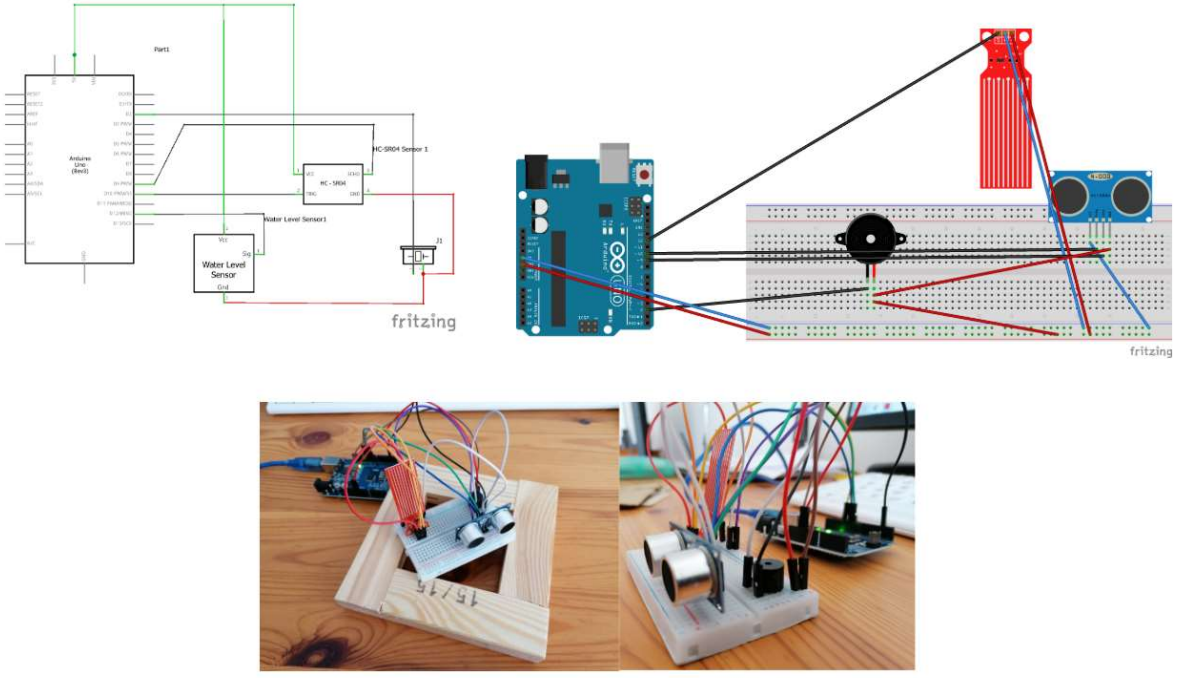


Fig 5: Diagram with Water sensor

4th Prototype: The following picture shows what the final circuit or the final product looks like. The first and second picture shows the circuit design of the product and the third picture shows the implementation of the design

in hardware. This prototype is built with both an ultrasonic and grove water sensor. This prototype shows how two different sensors react to a buzzer. When I initially built a prototype separately for the ultrasonic and water sensors, it was not complicated as I can easily set voltage and ground pin with Arduino.



The ultrasound has 4 input pins, with 2 pins representing voltage and ground. The Grove water sensor has 3 pins, with 2 pins representing voltage and ground. Here I had made the circuit that way so that I could use a voltage pin and a ground pin for both the ultrasonic and water sensors. This is one of the challenges of this prototype. To win the challenge, I use a separate knot in the breadboard. There are two types of holes in this node, e.g. positive and negative. The voltage and ground pin of both sensors are connected to this hole, and finally, 2 wires of this positive and negative hole are connected to the ground and voltage pin of the Arduino. This prototype reacts to physical

and water obstacles now. It will detect those obstacles based on the distance and water level and notify the visually impaired person via buzzer noise. The final circuit will be integrated into a 15x15 frame, which is shown in the third image which will be covered with textile fabric, and finally, the entire product will be integrated into the T-shirt shoulder.

Testing Result: In this section I discussed the test result of the product. In the test phase I tested both sensor capabilities. First, I tested the ultrasonic sensor to check whether the product works according to requirements at a distance not too far from the visually impaired person. Table 1 shows the result of this test. Then I tested the water sensor to see how it worked in the water based on voltage. Table 2 shows the result of this test.

Distance Cover	**Number of Test**	**TP**	**TN**	**FP**	**FN**
20 cm	10	1	1	0	0
30 cm	10	1	1	0	0
40 cm	10	1	1	0	0
60 cm	10	0.8	0.8	0	0
70 cm	10	0.8	0.8	0	0
Sum		4.6	4.6	0	0

Table 1: Test Result for Ultrasonic sensor

TP: True Positive; **TN**: True Negative; **FP**: False Positive; **FN**: False negative

Accuracy: (4.6+4.6) / (4.6+4.6+0+0) = 1

Precision: 4.6 / (4.6+0) = 1

Phase	Water Identified	Not Identified
1	Volt = 5.0, Buzzer = On	Volt = 3.3, Buzzer = On
2	Volt = 5.0, Buzzer = On	Volt = 0, Buzzer = On

Table 2: Test Result of Water Sensor

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Lessons Learned

- In the beginning, I used a passive buzzer in my design. The passive buzzer sound is not audible enough. So I replace it and choose an active piezo buzzer to get more noise. The lesson I learned here is that before buying or implementation a component in a microcontroller, you should first carefully review the details of the component otherwise it may cause you financially.

- Building this product required a lot of wire, which makes the circuit more complicated. It will also be a challenge to incorporate this wearable product into a 15x15 frame and eventually incorporate it into a t-shirt shoulder. If i did everything on the printed circuit board, it would look less complicated because there would be no wire to create hassle.

Vision and Outlook

So many updates are required for this product to be released in the real world. The entire circuit should be implemented in PCB. At the moment the product has so many wires and creates complexity. PCB can solve this problem and make the product business-oriented. Therefore, it would be very easy to integrate the entire circuit into the t-shirt shoulder. At first I thought about building the PCB based project. The problem, however, is funding. Due to the pandemic situation, laboratory visits are therefore restricted. Since building the entire project is not that expensive and does not take that much time, it is possible to build so many devices in the

production house and provide it to the visually impaired, as the main motivation of the project is to help the visually impaired, to find her walkway.

Resources

https://github.com/chykoushik/ISystem-Arduino

Video

https://drive.google.com/drive/folders/1BPtVM3BlYVRxdHqMPR9sZV2BGRXXgnk5?usp=sharing

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