Page 2

Obstacle Detector for Visually Impaired People

1. Project 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.

2. Project Iteration

Project Iteration can be found on page 1. Click Here.

3. 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.

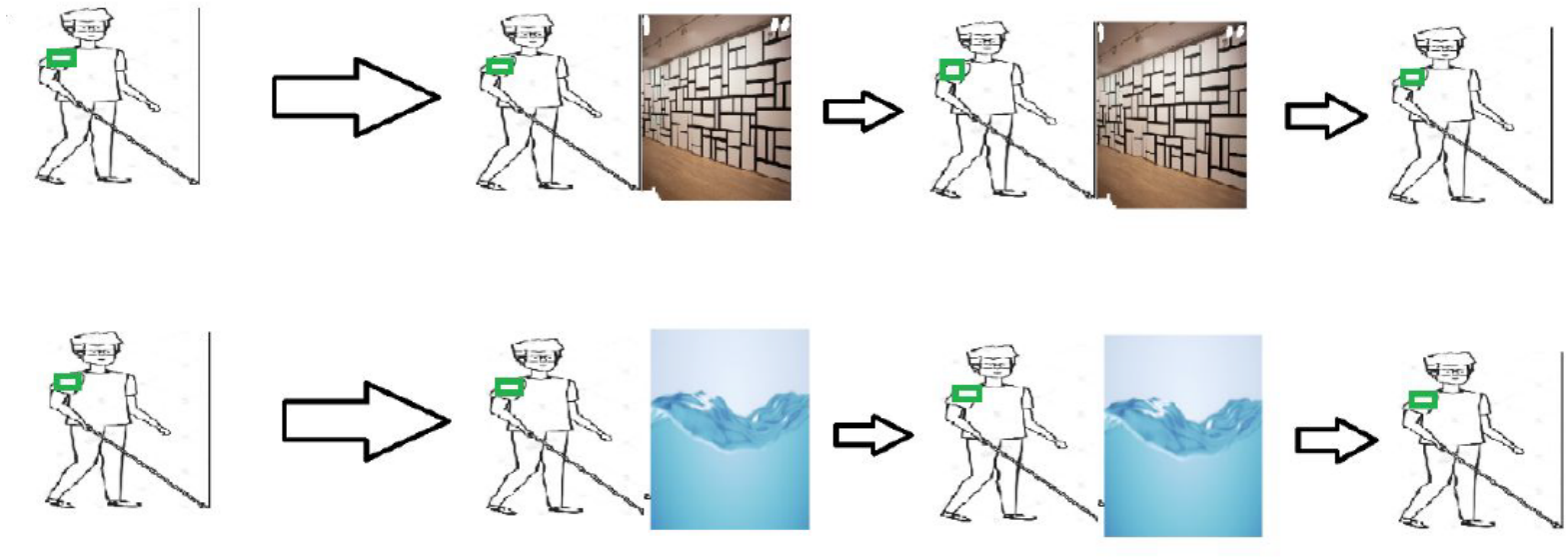


Fig 1: User Scenario (for clear picture: idea1.png)

Existing commercial products: I found a commercial product in here: https://wewalk.io/en/. They are investing money, time, and huge budget to build this thing. The device also costs approximately USD 500. This device is so advanced that it can detect obstacle from 160m and it also has many advanced features such as voice control, Bluetooth mobile communication, and touch screen.

Existing art or DIY projects: I found a very simple DIY project here**:** https://www.instructables.com/id/Smart-Blind-Stick/**.** To build this smart blind stick he used an ultrasonic sensor. His projects and my projects will vary slightly. The differences will be the following.

- He used a stick to make his tool, but I'm going to use textile gloves or hand band.
- He used only the ultrasonic sensor, but I'm going to use both the ultrasonic sensor and the Grove water sensor.
- He has not analyzed, but to get a more accurate view, I will analyze my result with different distances from the physical object and water surface.

4. Project Implementation

I need an Arduino to bring the idea into practice. Arduino will be with gloves or textile band. 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 gloves or band encounter an obstacle, it will produce noise and vibration in order to alert the user. The following Program case diagram. The following use state diagram illustrates the idea of implementation.

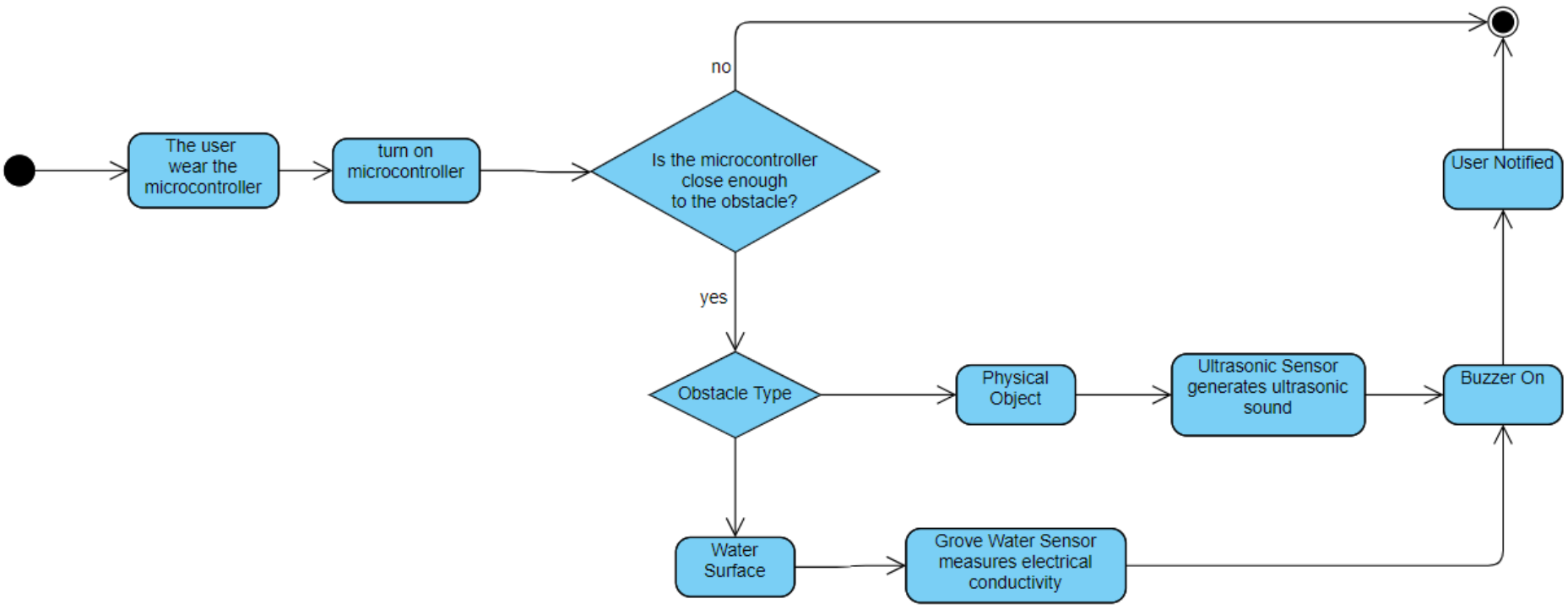


Fig 2: Implementation State Diagram (for clear picture: state_diagram.pdf)

Minor Changes: I made just a few changes after discussing it with the tutor. Instead of hand band or glove, the circuit will be integrated with a T-shirt, specifically in T.shirt shoulder. To close the circuit I'll use conductive copper tape. Textile glue will also be used for connecting wire to Arduino and breadboard.

List of Material (Updated):

- Arduino Uno (Microconoller 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)
- Textile Glue (to permanent integrate the circuit with breadboard)

Assignment Submission 4: Week 1: 04.06-11.06

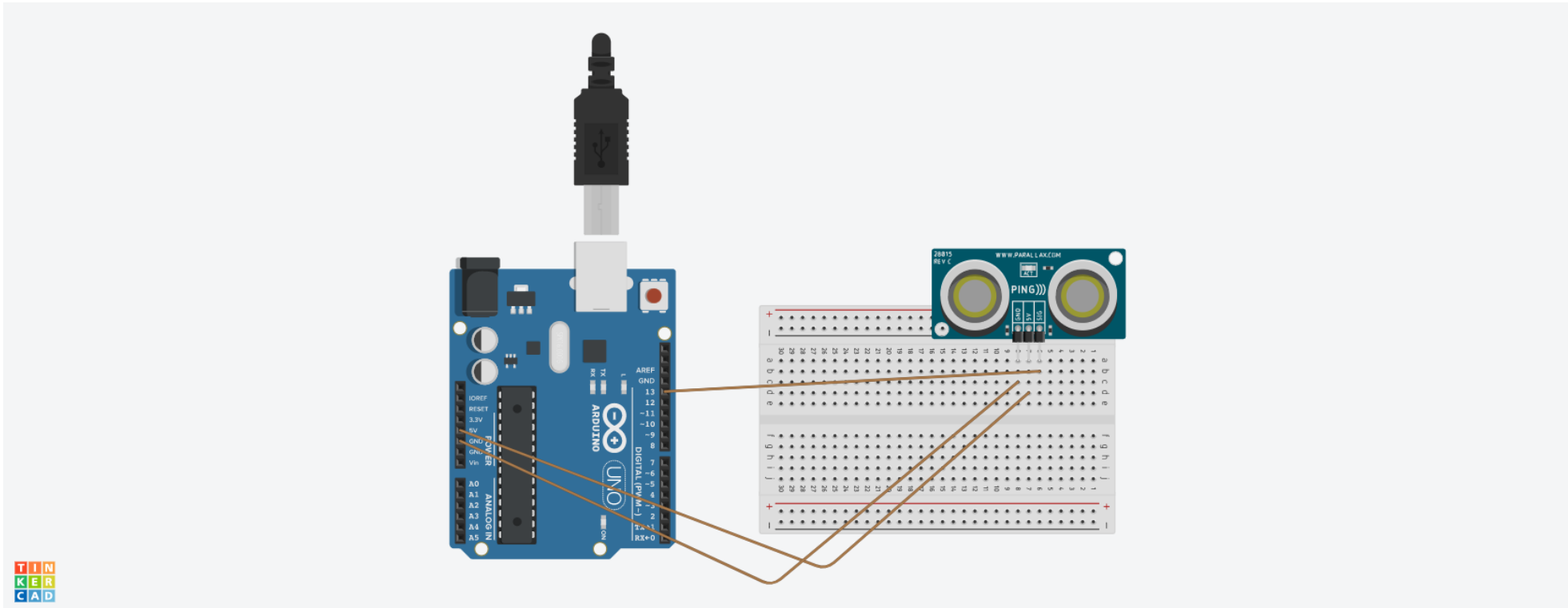
Project Plan:

	Week 1	Week 2	Week 3	Week 4	Week 5	Exam Preparation	Week 6	Week 7	Week 8
	04.06-11.06	12.06-17.06	18.06-24.06	25.06-01.07	02.07-08.07		26.07-01.08	02.08-08.08	09.08-15.08
Project Plan									
Requirement Analysis									
Requirement Gathering									
Arduino (Hardware and Software): Gather minimum knowledge for the project									
Hardware Implementation									
Programming Implementation									
Install, Configure and Test									
Final report, visual documention and submission									

The initial step of starting a project is to understand the requirements and explore their functionality and eventually collect the requirement. I'm going to spend the first 2 weeks doing those. Since Arduino is totally new to me, I need to understand the functionality of the Arduino hardware and software. For example, i need to gather all the knowledge I need to make my project. I will start installing the hardware from week 4, and software implementation from week 6. I will start the installation, setup and testing from week 7 and start the nal report and video documentation from week 8 and Finally the project will be submitted on August 15.

First Prototype: Since I don't have the physical requirements yet, I can't create a physical prototype. But using the Tinkercad web application, I make a simple diagram to show how ultrasonic sensors work. The limitation of the tinkercad and fritzing application is that they have no grove sensor. Following is my diagram and the Arduino code. I attached a video with this pdf.

Circuit Diagram:

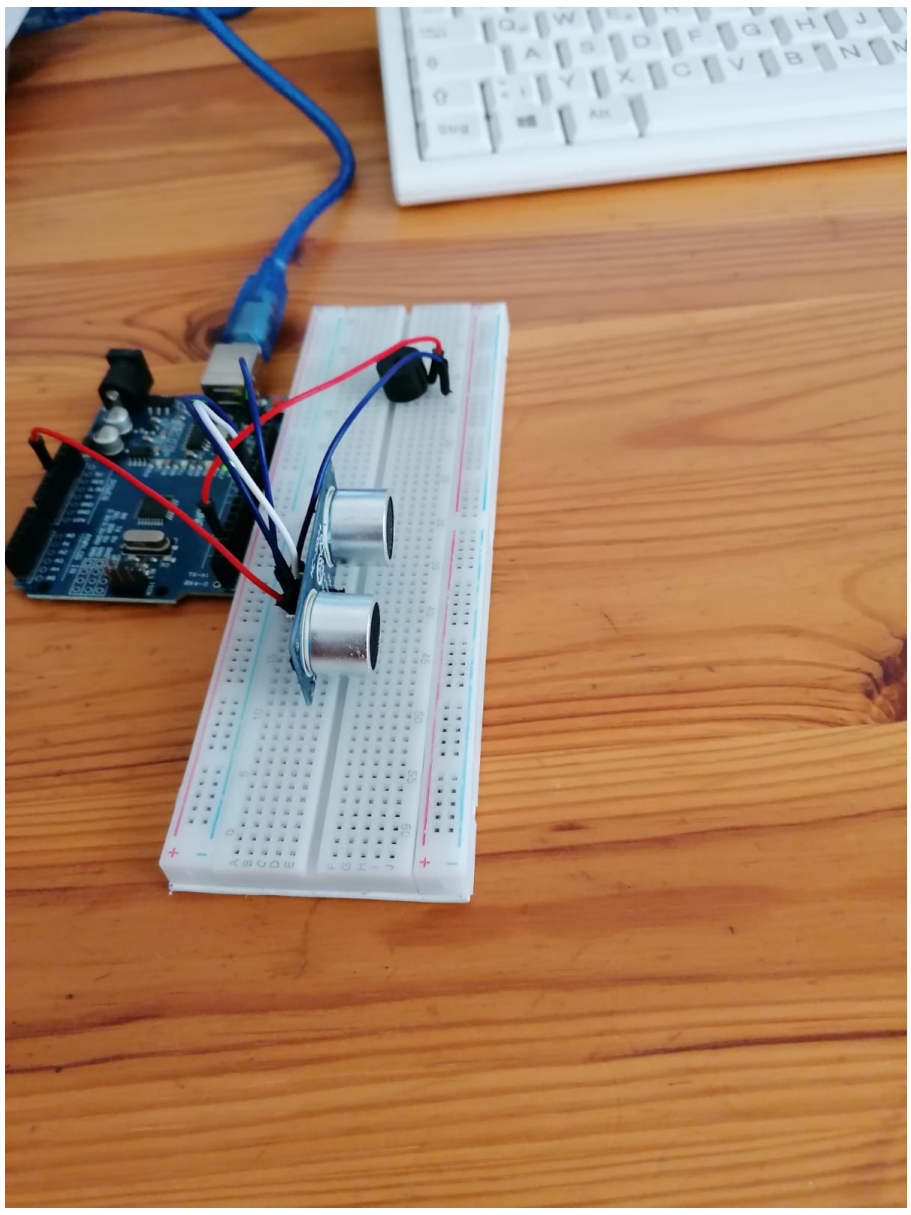


Code:

```
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;
}
```

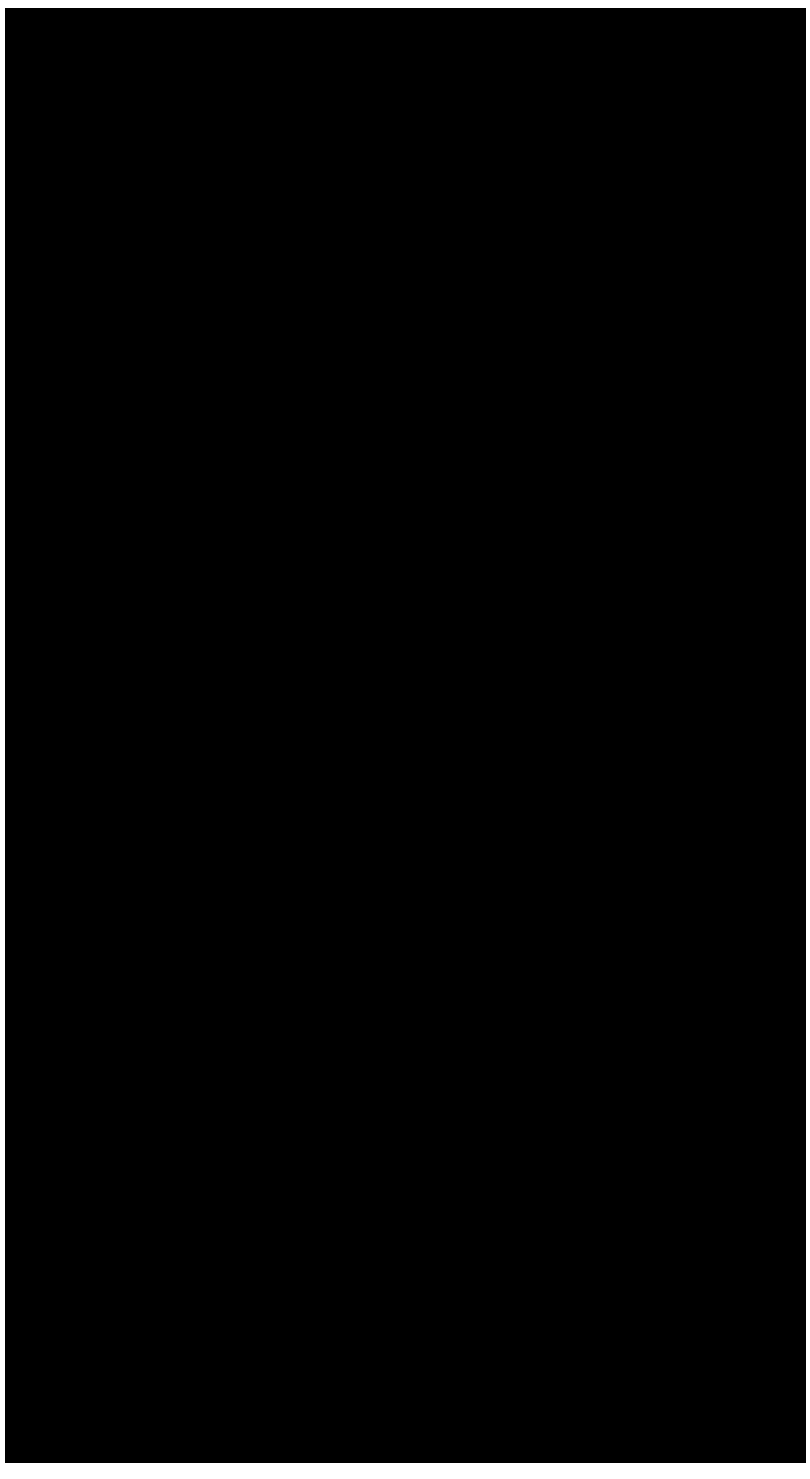
Assignment Submission 5: Week 2 & 3: 24.06

Prototype 2:



In the last submission, I used Tinkercad to visualize a basic prototype. This week I'm practically putting the idea into hardware. The illustration above 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 implement the circuit with a passive buzzer so that it generates so little noise. I'll fix this in the next submission with a 5V piezo sound buzzer. The demo video of this prototype is the following.

Demo Video:



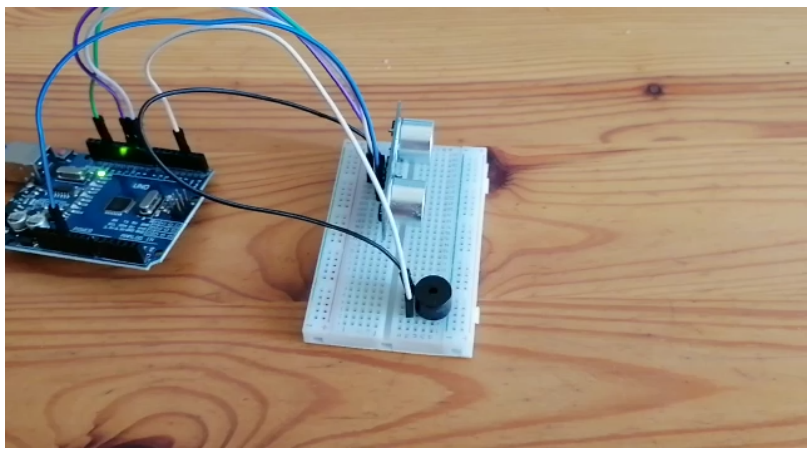
Code:

```
int const trigPin = 10, echoPin = 9, buzzPin = 2;
void setup()
{
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
pinMode(buzzPin, OUTPUT);
}
void loop()
{
int ms, range;
digitalWrite(trigPin, HIGH);
delay(1);
digitalWrite(trigPin, LOW);
ms = pulseIn(echoPin, HIGH);
range = (ms/2) / 29.1;
if (range <= 10 && range >= 0) {
digitalWrite(buzzPin, HIGH);
delay(10);
} else {
digitalWrite(buzzPin, LOW);
delay(10);
}
delay(60);
}
```

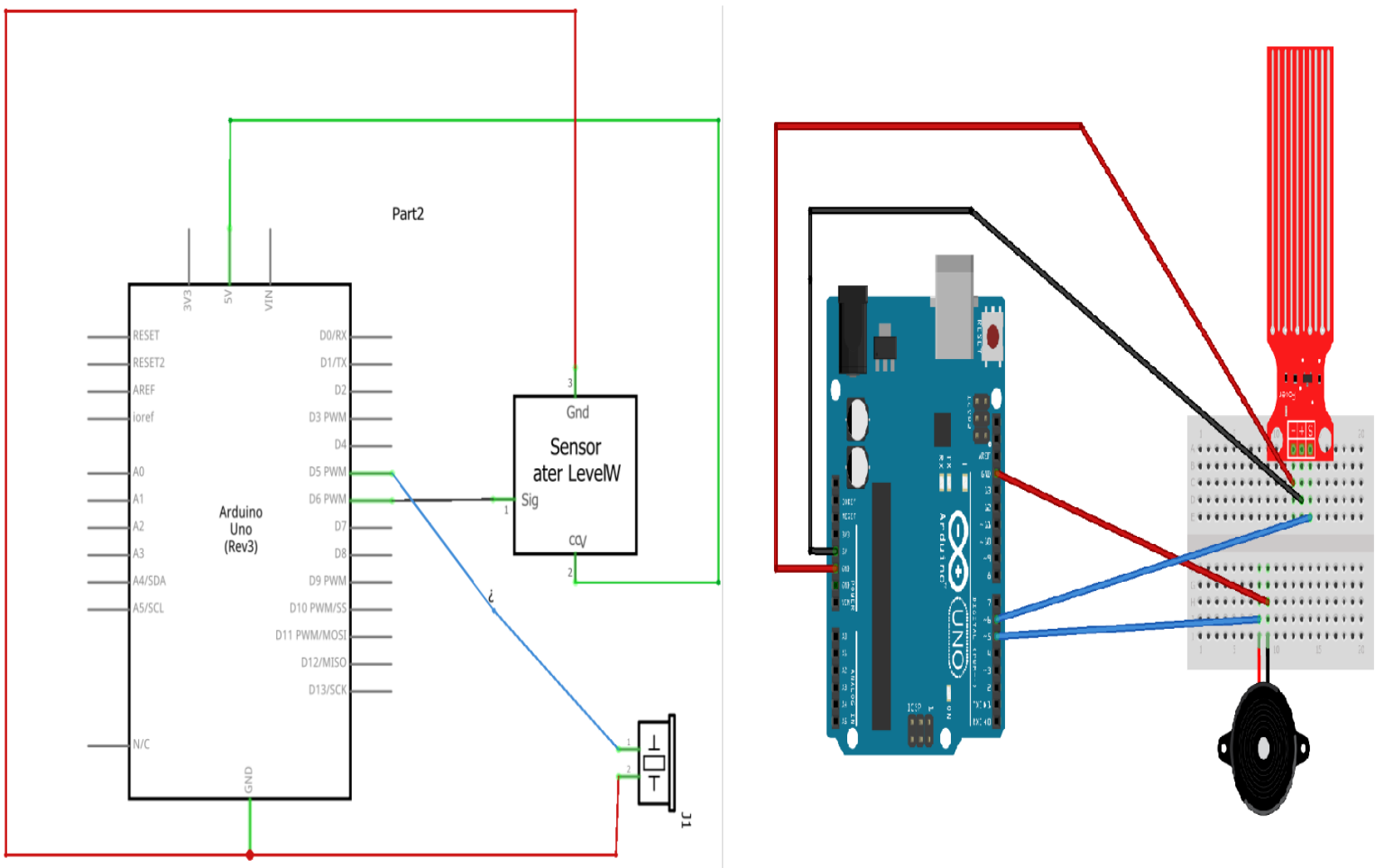
The reason for choosing the Arduino microcontroller is that it is the most commonly used and less expensive microcontroller for implementing a simple project. Since my concern is about obstacle detection, the ultrasonic sensor is the cheapest option. I also need a buzzer because I need something that makes noise. I make these decisions before implementing these materials in Prototype 2.

Assignment Submission 6:

Prototype 3A: In the last submission, 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. Now 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. The following video shows the situation with the active piezo buzzer.



Prototype 3B: The following 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.

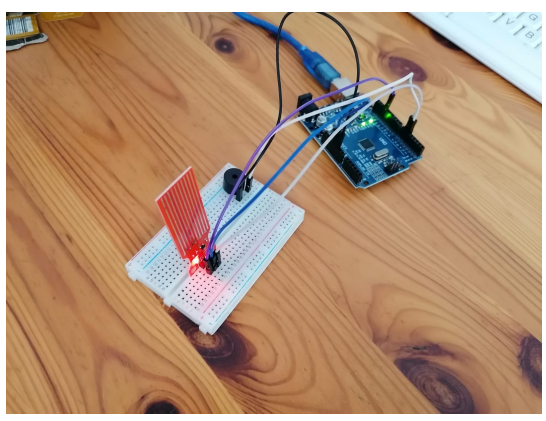


As mentioned earlier, this project is designed to help visually impaired people to find obstacles. This is the decision design reason for choosing the ultrasonic and water sensor. Since I have not yet received my water sensor, I cannot make a demo video with a water sensor this week. In the next week, I will build the circuit practically with the water sensor and also create a circuit diagram that contains both ultrasonic and water sensors.

Assignment Submission 7:

Prototype 4A:

The following prototype represents the hardware implementation of the prototype 3B. This is built using an Arduino microcontroller, a grove water sensor, and a buzzer. The buzzer reacts when the grove water sensor gets wet with water. The code for this hardware implementation is also given below.



Code:

```
int ip = 6, buzzer =5;
void setup() {
  Serial.begin(9600);
  pinMode(ip, INPUT);
  pinMode(LED_BUILTIN, OUTPUT);
  pinMode(buzzer, OUTPUT);
}
void loop() {
  while(digitalRead(ip)==HIGH)
   {
 digitalWrite(LED_BUILTIN, HIGH);
}while(digitalRead(ip)==LOW){
    digitalWrite(LED_BUILTIN, LOW);
     digitalWrite(buzzer, HIGH);
     delay(1);
     digitalWrite(buzzer, LOW);
     delay(1);
```

```
    }
   delay(1000);
}
```

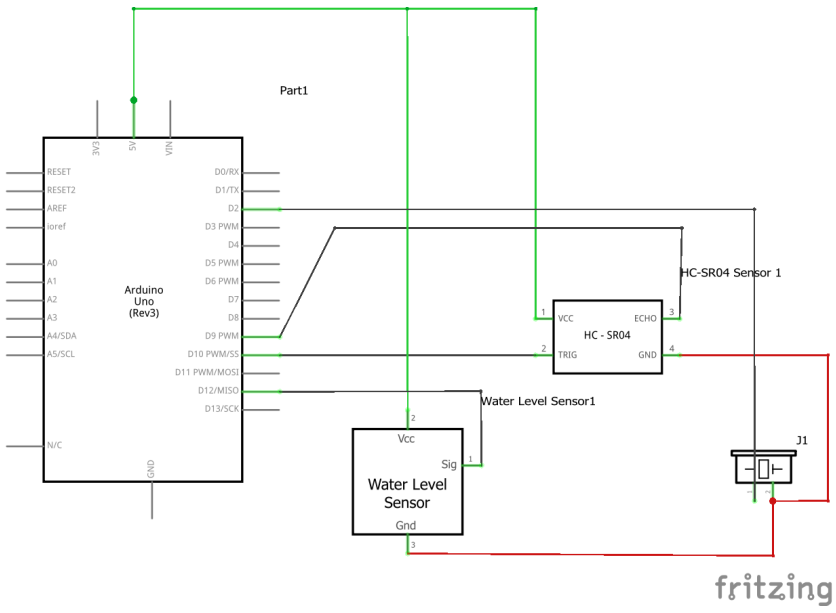
Prototype 4B:

The following 3 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 implements the design in hardware. This prototype was 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.

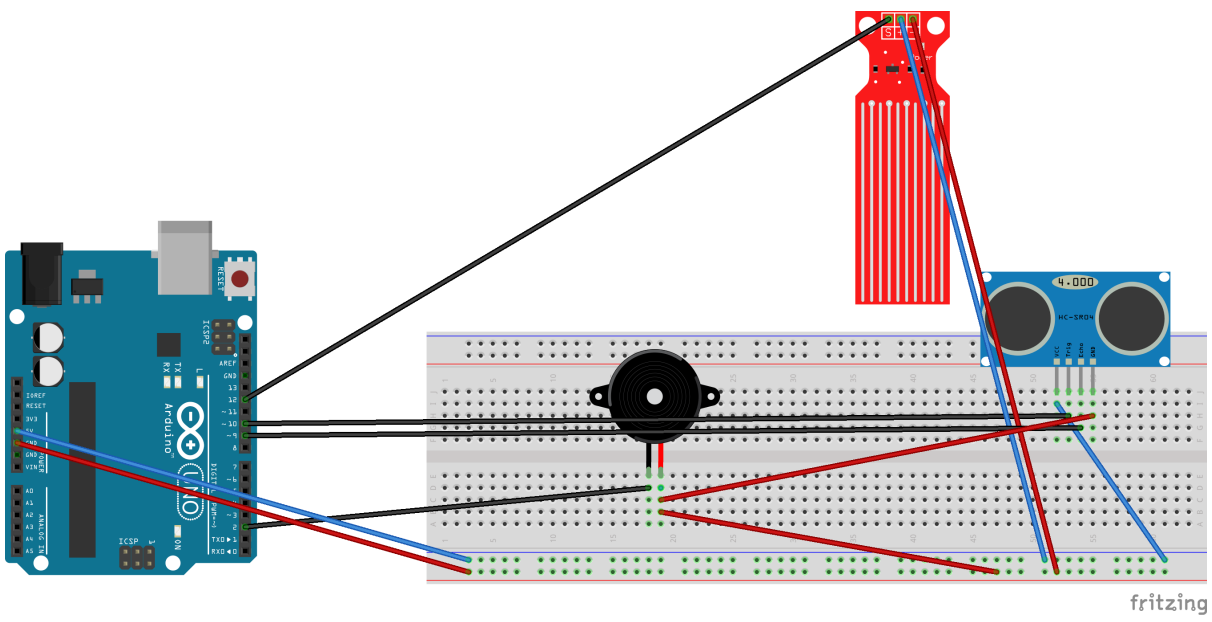
The ultrasound has 4 input pins, with 2 pins representing voltage and ground. The Grove water sensor has 3 pins, with 2 pins representing voltage and ground. Here I had made the circuit that way so that I could use a voltage pin and a ground pin for both the ultrasonic and water sensors. This is one 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 is integrated into a 15x15 frame, which is shown in the third image (prototype 4B hardware), which will be covered with textile fabric, and finally, the entire product will be integrated into the T-shirt shoulder.

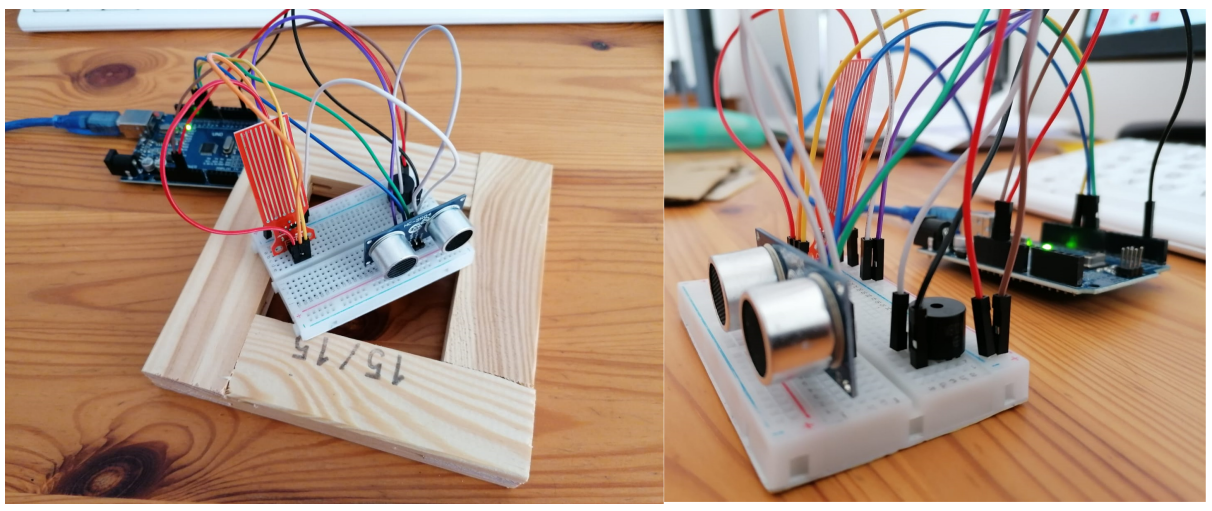
Prototype 4B Circuit:



Prototype 4B Circuit Visual:



Prototype 4B Hardware:



Assignment Submission 8:

Final Project:

5. 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.

6. References (existing scientific literature):

[1] Olanrewaju, Rashidah Funke, Muhammad Luqman Azzaki Mohd Radzi, and Mariam Rehab. "iWalk: Intelligent walking stick for visually impaired subjects." 2017 IEEE 4th International Conference on Smart Instrumentation, Measurement and Application (ICSIMA). IEEE, 2017.

[2] Gbenga, Dada Emmanuel, Arhyel Ibrahim Shani, and AdebimpeLateef Adekunle. "Smart Walking Stick for visually impaired people using ultrasonic sensors and Arduino." International Journal of Engineering and Technology 9.5 (2017): 3435-3447.

[3] Yutaka Tange, Tomohiro Konishi, and Hideaki Katayama. 2019. Development of Vertical Obstacle Detection System for Visually Impaired Individuals. In Proceedings of the 7th ACIS International Conference on Applied Computing and Information Technology (ACIT 2019). Association for Computing Machinery, New York, NY, USA, Article 17, 1–6. DOI:https://doi.org/10.1145/3325291.3325372

/