Adam Wilson

15013305

Design Documentation

DE0976 Experiential Design

Contents

Introduction

I decided that I was going to create a project based around option 2- Arduino. “Create a sensor-based interface to allow users to interact with an audio-visual environment. This could be based on **a physical-** computing model using tools such as the **Arduino system** or a motion-tracking experience using the Gesture and Media System “

From the outset I was fascinated with the endless possibilities that came with Arduino. Although my skills were limited when it came to using Arduino, I felt I needed to push my self for this project. In this document I will take you through my process, ideas and experiments and explain how my project has developed over time. From the start, I wanted to work with lights and sound but over time, I changed the idea to using a shoe.

The project

The project that I am creating is in hindsight ‘a shoe specifically created for the blind’. This shoe will allow individuals who are blind/have a visual disability to be able to walk around the streets knowing they are safe. Using an ‘ultrasonic range finder’ and a ‘3V Coin Vibrator Micro Motor’, the shoe will sensor when the individual is in close proximity to a curb, wall or any other object that might be in their way. The small coin vibrator will emit a small vibration as to the closeness of the object, giving the user enough notice.

Experience

The main experience that this project is trying to address is the idea that everyone should feel safe when they are walking around the street.

A lot of blind/visually impaired individuals get into a lot of accidents when they are crossing the road, walking up and down steps as well as every day wondering the streets.

The experience from this “shoe” will show how technology can be useful for everyone.

Research

Research- User

For the research, I began by looking deeper into the deaths and road accidents where blind people have been involved. I started conducting some research on road accidents where a blind person has been or nearly been injured. This led me to find an article where a man was hit by the same car twice because the engine was too quiet.

I also found that more blind people are walking into the middle of the roads because of bad parking or objects being in their way.

After further in depth research, I gathered some facts of deaths and injuries in the US where legally blind people have been involved from 2002-2006. Although the average number of blind people who have died from a traffic related accident is not that high each year, the number of average blind people who were injured is a lot higher.

Table 3: Type of Vehicle Involved in US Pedestrian Deaths, 2002-2006

Type of Vehicle	All Pedestrians	% of total	Not Legally Blind	% of total	Legally Blind	% of total
Car	11882	45%	11873	45%	9	32%
Pickup Truck	4628	17%	4618	17%	10	36%
SUV	3476	13%	3474	13%	2	7%
Minivan	1449	5%	1446	5%	3	11%
Subtotal, Passenger Vehicles	21435	80%	21411	80%	24	86%
Not passenger vehicle (Bus, Truck, Heavy Van, Motorcycle, Etc.)	5212	20%	5208	20%	4	14%
Total	26647	100%	26619	100%	28	100%
Memo: Toyota Prius	11		11		0	
Memo: Prius as % of pass. vehicles	0.05%					

Source: Analysis of FARS data files, 2002-2006.

The HCUP data show an average of about 40 legally blind pedestrians hospitalized for vehicle-related injuries every year (Table 6). This reported hospitalization rate for legally blind pedestrians is somewhat higher than the FARS reported death rate (Table 6). Where FARS showed an average of 0.11 percent of pedestrian deaths were legally blind individuals, the HCUP database shows 0.15 percent of pedestrian admissions were for persons coded as legally blind. Thus, the death experience in FARS may modestly understate the actual relative risk of death or serious injury for the legally blind.

Table 6: U.S. Hospitalizations for Pedestrians Involved in Motor Vehicle Accidents, 2001-2004

Year	Total	Any Blindness (Including Legally Blind)	Legally Blind	Not Blind or Legally Blind	Percent of Total: Any Blindness	Percent of Total: Legally Blind
Pedestrians in motor vehicle accidents						
2001	23237	52	*	23185	0.22%	0.02%
2002	27728	75	42	27653	0.27%	0.15%
2003	27866	53	48	27813	0.19%	0.17%
2004	26733	94	59	26639	0.35%	0.22%
Average	**26391**	**68**	**38**	**26323**	**0.26%**	**0.15%**

Research- Competitors

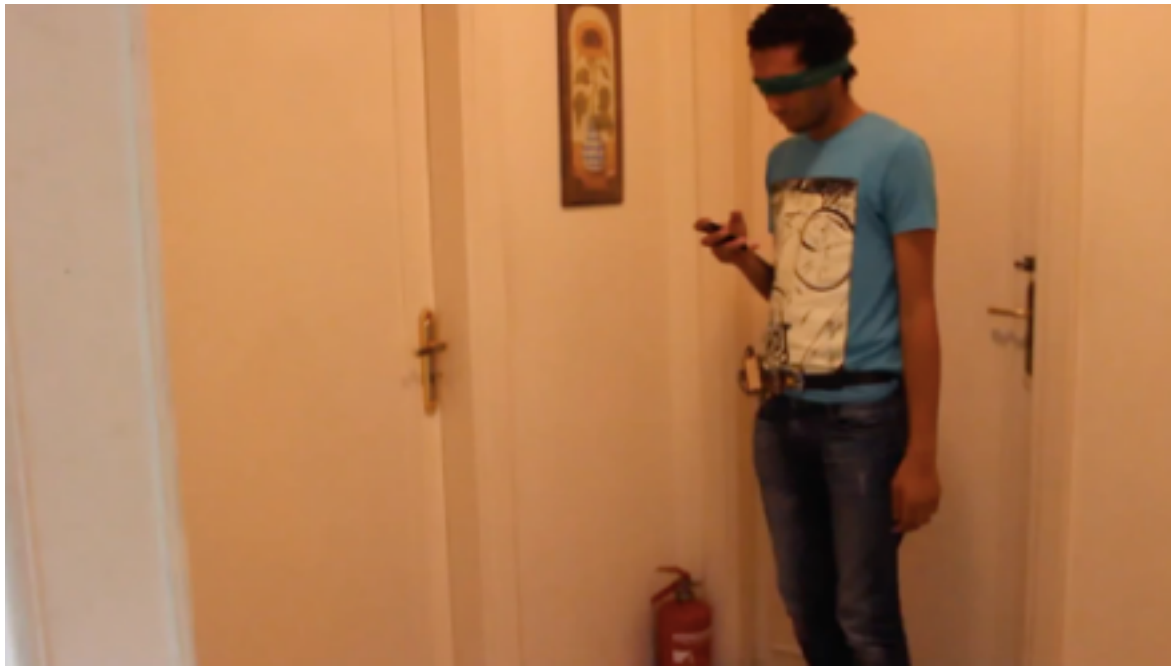
Once I had an understanding of the troubles that blind/partial sighted people have for when they are walking around, I then went onto looking at the competitors/ other products which will be similar to mine.

This would be a very hard task to complete because my idea is fresh thinking so the chances of other products being similar, was very small.

DIY Navigation Device

The "DIY Navigation Device" was a project created by tech guys. In this project, you cover your eyes and let your smartphone navigate you to avoid obstacles, the application is mainly a DIY navigation device for blind people.

- Basically, the ultrasonic sensors gets the distance in front of the user, if it is higher than 30 cm then there is no problem. However is it is less than 30cm, the sensor sends to the smart phone and it tells the user through the speaker to turn till the distance is over 30 again.
- Two sensors were used for better quality and wide range coverage, there is a function that compares between the 2 readings of the sensors and takes the decision based on that.



http://www.instructables.com/id/DIY-navigation-device-for-blind-people-using-Ardui/

Lechal- Smart shoes for the blind

An Indian company has come up with a sleek solution to wearable technology that is entirely useful and doesn't involve reading any tiny screens. The Bluetooth-enabled Lechal smart shoes vibrate to give people directions and tell them where to turn as they travel along.

The shoes sync with a user's phone, and an app that piggybacks on Google Maps allows the shoes to keep track of where they're going. Once you have input your destination and chosen a route, you can tuck your phone away and run or walk along with the left or right shoe buzzing to nudge you into turning.

http://www.lechal.com/#6

Research- Technology

After looking for the possible technology to use, I found 2 sensors and 1 micro motor vibrator.

These have the features that could possibly help the shoe function correctly, allowing my project to work in the way I'm expecting it should.

I will also be using the Arduino Uno.

Hc-sr04 Ultrasonic Range Finder Distance Measuring Module Sensor:

- Effectual angle: <15°
- Ranging distance: 2cm – 500 cm
- Resolution: 1cm
- Ultrasonic Frequency: 40k Hz

Adafruit Maxbotix Ultrasonic Rangefinder - LV-EZ1

- Detect objects from 0-inches to 254-inches (6.45-meters)
- Provides sonar range information from 6-inches out to 254-inches with 1-inch resolution
- Has a number of different outputs

3V Coin Vibrator Micro Motor

- DC motor capable of producing a vibration somewhat similar to a powerful mobile phone vibration
- Peel-able double sided sticker for easy attachment to all manner of surfaces
- 2.68g Weight
- 1.5 – 3V Input
- 275mW Output power

Initial Ideas

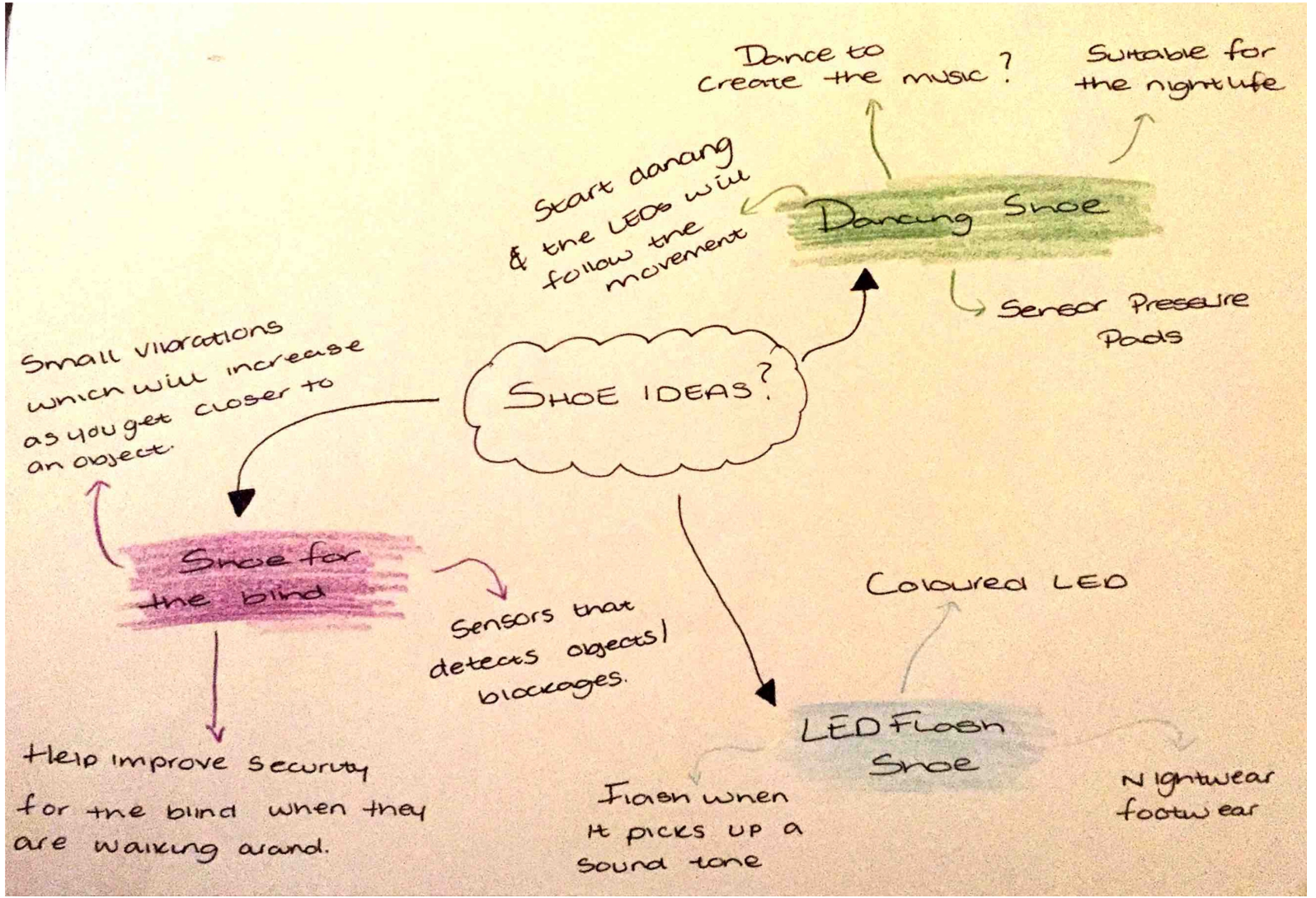
Initial Ideas

I came up with three different ideas which would incorporate a shoe.

-Shoe for the blind

-LED flash shoe

-Dancing Shoe



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The main concept

A shoe built for visually impaired people. This shoe will house a sensor which will pick up when an object is around 50 cm in front of the wearer. As the shoe gets closer to the object, a small vibration will be emitted through a micro, motor vibrator. This will be stored under the sole of the shoe.

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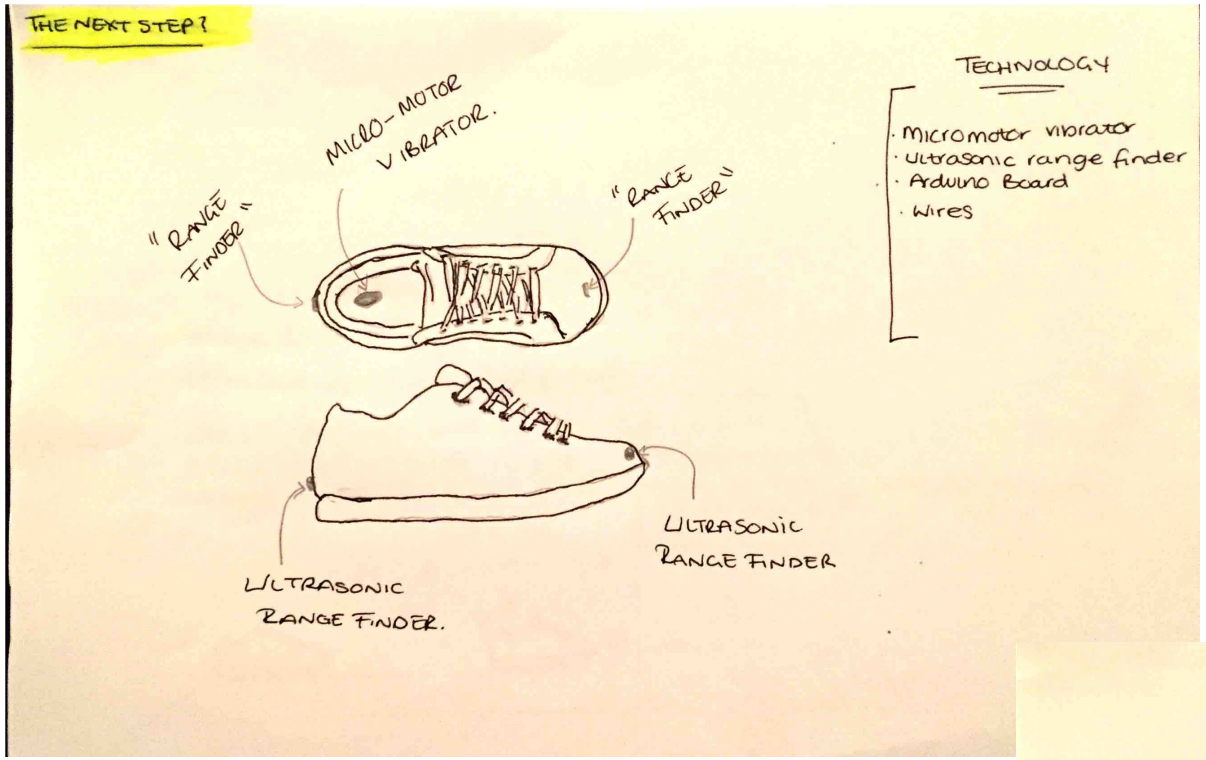

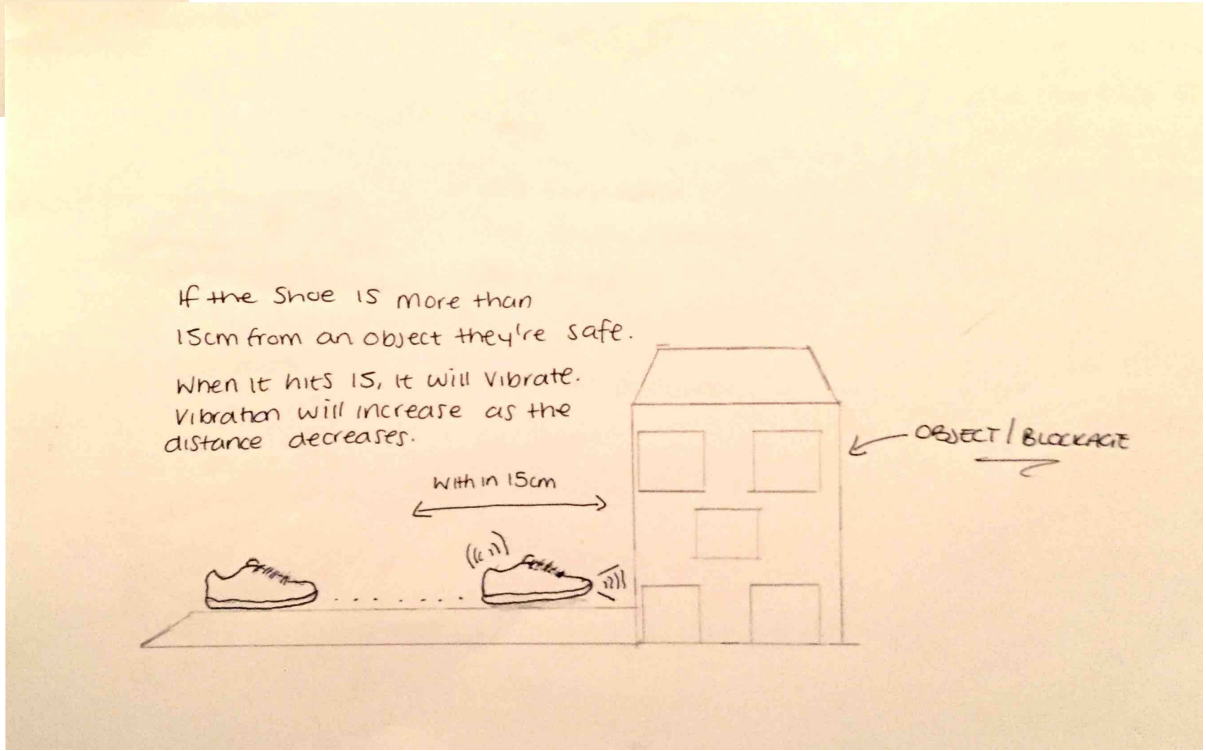

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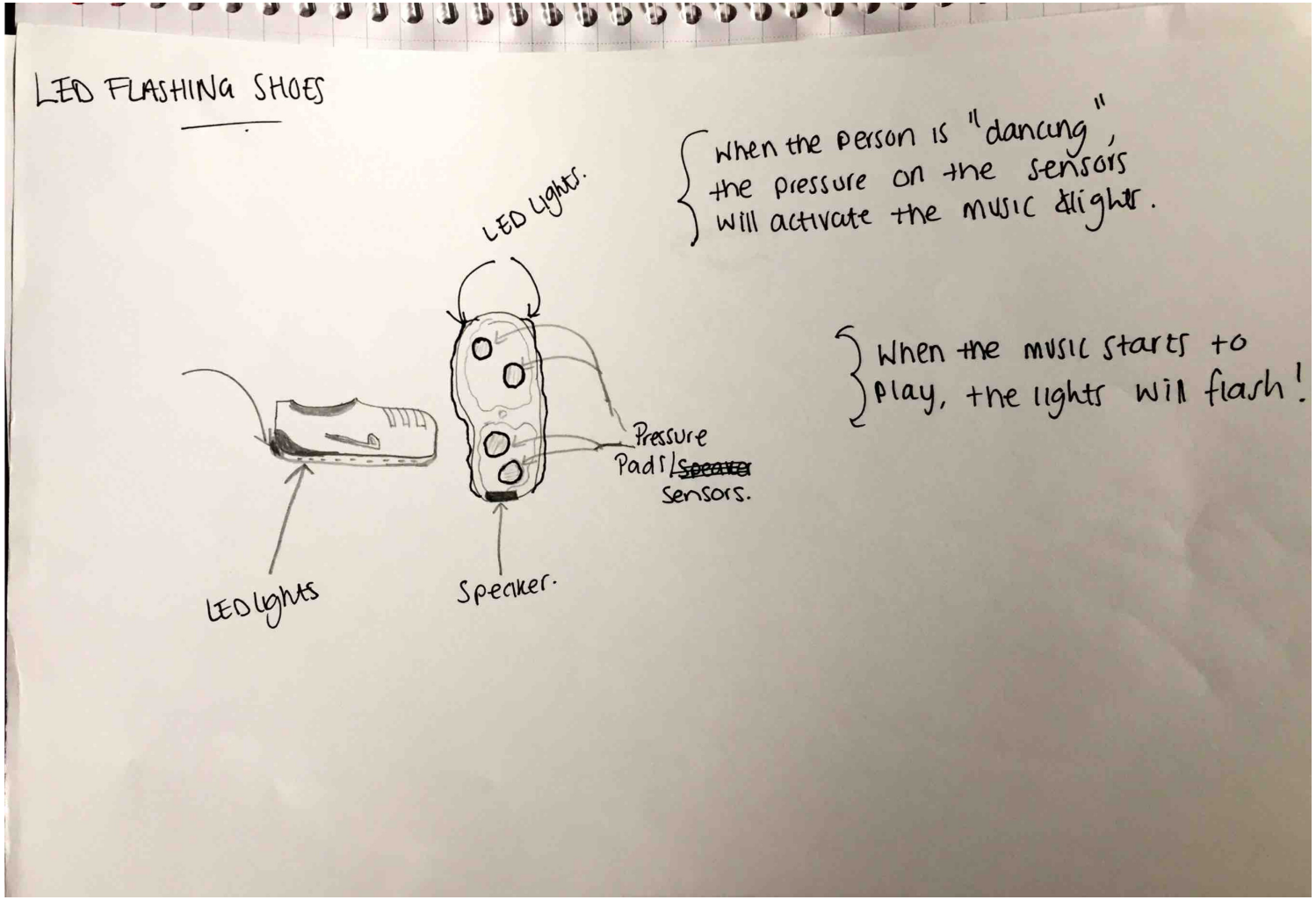
Features

- Comfortable footwear that will increase the public safety
- Sensors which will allow people to know when there is an object/blockage in their path
- Small vibrations which will increase if they get closer to an object/blockage
- Give a sense of security
- Using the latest technology in a fresh new way of thinking

I also came up with another 2 different concepts. They were still around the theme of using a show however I wont go into detail as I did not go with these designs.

Concept 2



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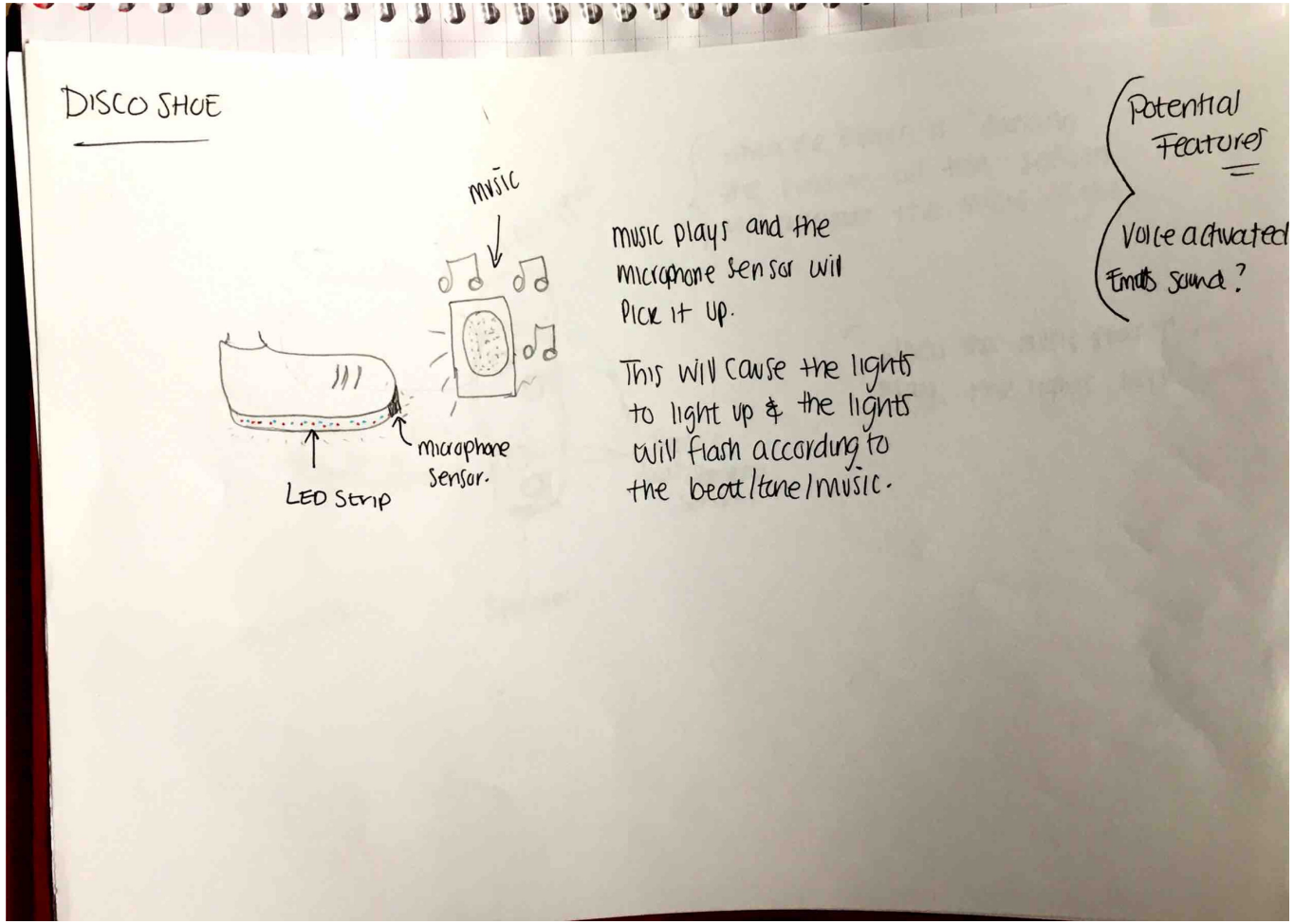
Concept 3



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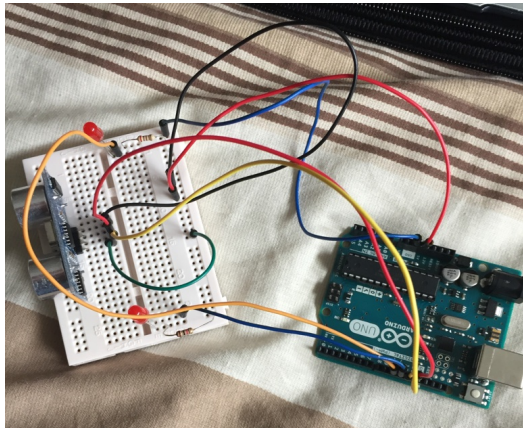
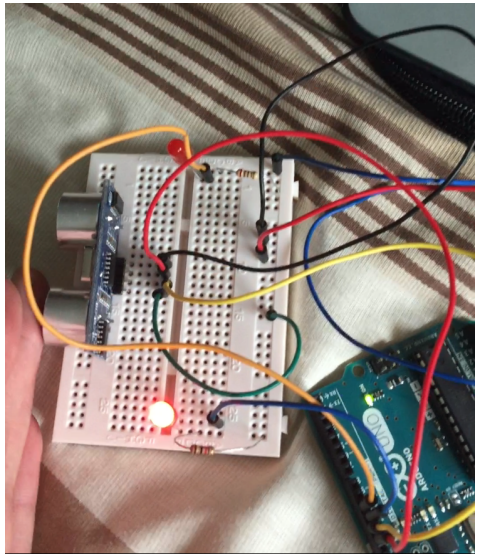
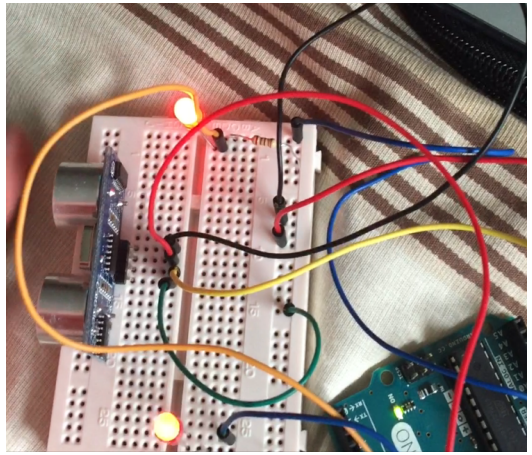
Concept Development

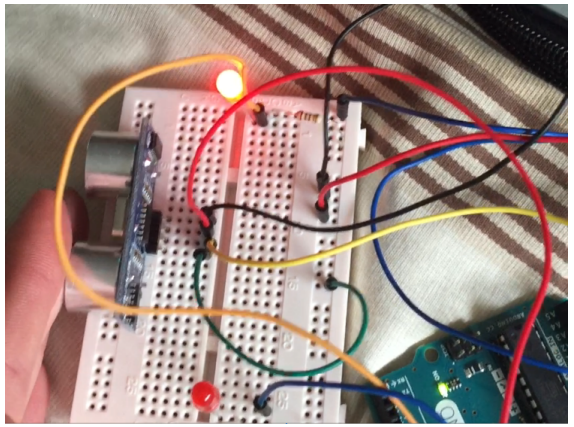
Getting to know Arduino

With having a limited number of skills when it came to using Arduino, I felt that I was going to find this project difficult to complete. I started off this project by doing some basic coding and system building. By using the Arduino website, I created a sensor and light system; to which the LED lights change from on and off as you get closer and further away from the sensor.

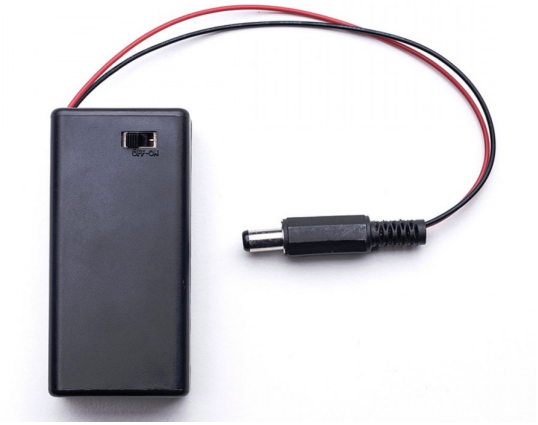








After I was getting to know how Arduino works, I went onto purchasing the main equipment that I needed. This included ordering a couple of the range finder sensors and the micro-motor vibrators. I also bought some extra wires, diodes, resisotrs and a battery 9v pack.



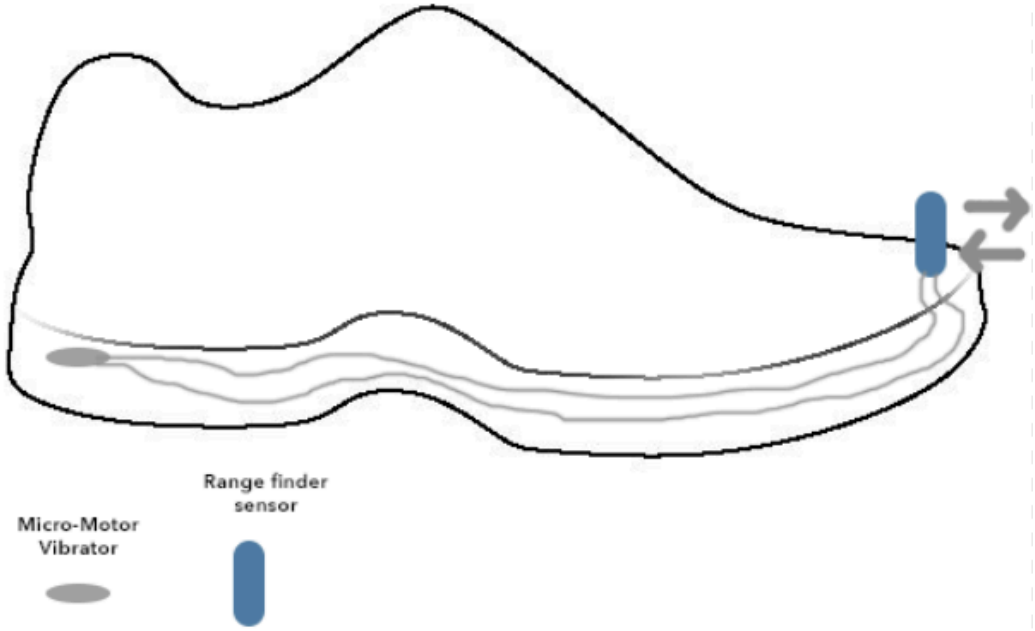
How it works

So how will it work? The range finder sensor will be used to track the distance between the shoe and any object that is in front of it. If there is an object less that 50cm away, the motor will vibrate until the path is clear again.

If the object is…

>50cm away, No vibration, user is fine

<50cm, Vibration will start and user will know to move.



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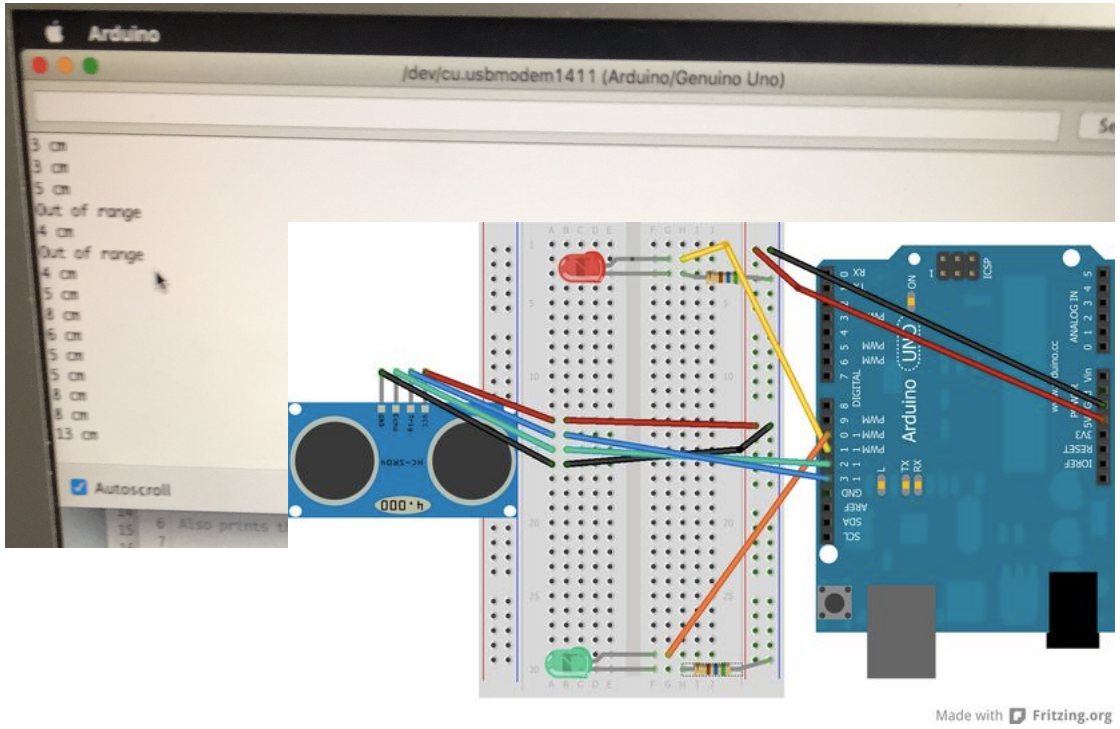
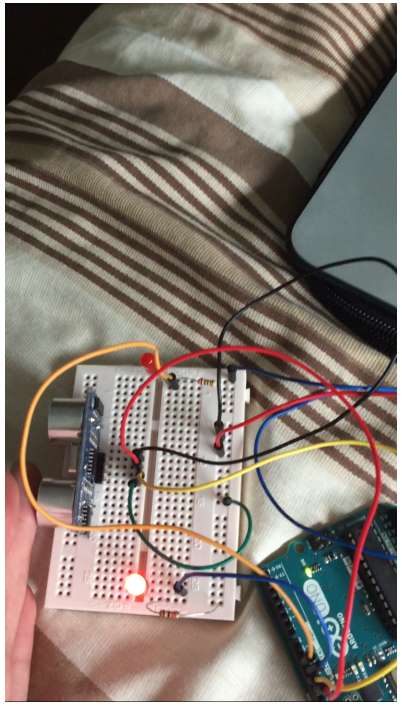
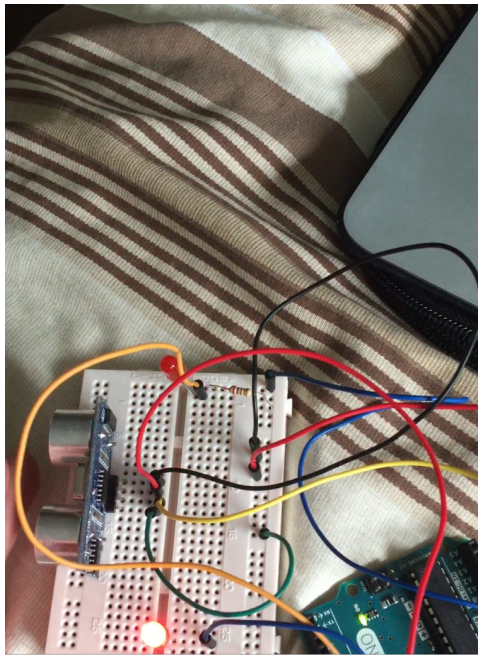
Testing the components

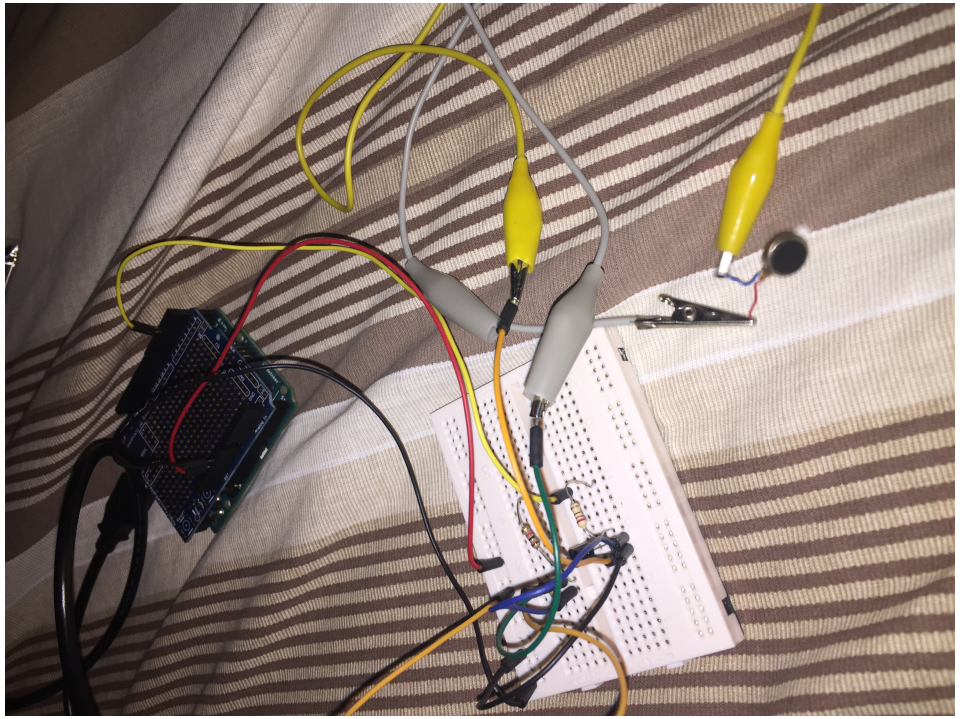
Before I began the build, I needed to make sure that the components worked correctly. With Arduino, there are some built in examples of circuits and codes. I needed to make sure that the sensor would pick up the distance range. I found an example which included making LEDS change from one colour to another when a certain distances is reached.

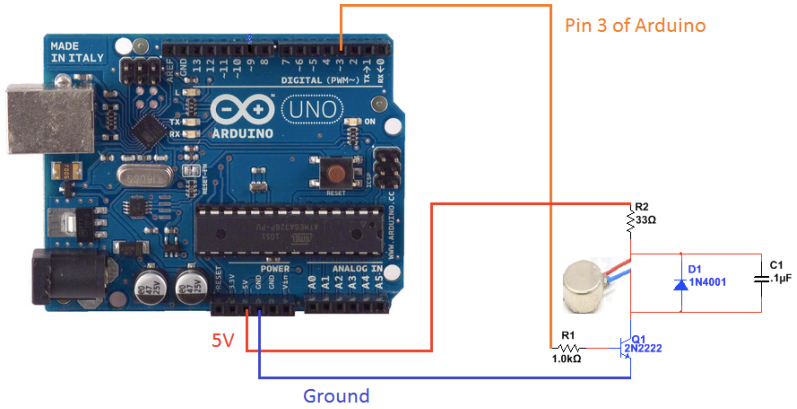






I wanted to make sure that the micro motor vibrator worked correctly. I could not find an example of a code and circuit set up on Arduino, so I conducted a Google research and found an example to use. Good thing was that my components worked.





Now that I knew they worked, I needed to begin creating the set up incorporating the shoe.

```
const int motorPin = 3;

void setup()
{
pinMode(motorPin,OUTPUT);
}

void loop()
{
digitalWrite(motorPin, HIGH);
delay(1000);

digitalWrite(motorPin,LOW);
delay(10000);
}

// End
```

Shoe

I was using this shoe because it has a comfortable sole and there was a deep inside to which I plan on housing the components.

Design Development

The circuit

Since I had the two different codes for the sensor and the micro motor pin, my task was to try and combine these together to make one main piece of code. I wanted the micro motor to vibrate when the distance was below 50cm.

I was going to remove the LED pins because I was not using these but replace them with the motor pin.

vibration_motor

```
const int motorPin = 3;

void setup()
{
pinMode(motorPin,OUTPUT);
}

void loop()
{
digitalWrite(motorPin, HIGH);
delay(1000);

digitalWrite(motorPin,LOW);
delay(10000);
}
```

Done compiling.

sketch_apr03a §

```
void setup() {
  Serial.begin (9600);
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(led, OUTPUT);
  pinMode(led2, OUTPUT);
}

void loop() {
  long duration, distance;
  digitalWrite(trigPin, LOW);  // Added this line
  delayMicroseconds(2); // Added this line
  digitalWrite(trigPin, HIGH);
//  delayMicroseconds(1000); - Removed this line
  delayMicroseconds(10); // Added this line
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance = (duration/2) / 29.1;
  if (distance < 4) {  // This is where the LED On/Off happens
    digitalWrite(led,HIGH); // When the Red condition is met, the Green LED should turn off
  digitalWrite(led2,LOW);
}
  else {
    digitalWrite(led,LOW);
    digitalWrite(led2,HIGH);
  }
  if (distance >= 200 || distance <= 0){
    Serial.println("Out of range");
  }
  else {
    Serial.print(distance);
    Serial.println(" cm");
  }
```

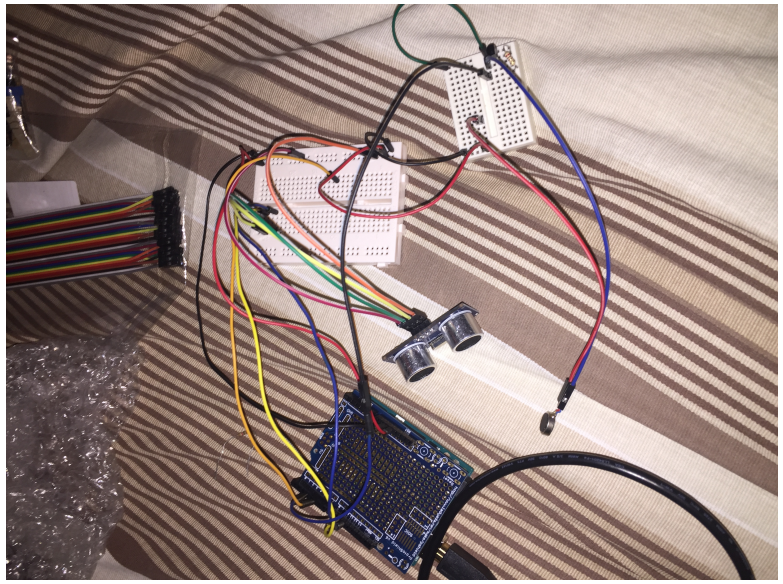
Arduino_Code

```
/*
  This code should work to get warning cross the buzzer when something be closer than 0.17 meter
  Circuit is ultrasonic sensor and micro motor vibrator and Arduino uno is used
*/
// Define pins for ultrasonic and buzzer
int const trigPin = 10;
int const echoPin = 9;
int const buzzPin = 2;

void setup()
{
  pinMode(trigPin, OUTPUT); // trig pin will have pulses output
  pinMode(echoPin, INPUT); // echo pin should be input to get pulse width
  pinMode(buzzPin, OUTPUT); // buzz pin is output to control buzzering
  Serial.begin(9600);
}

void loop()
{
  // Duration will be the input pulse width and distance will be the distance to the obstacle in centimeters
  int duration, distance;
  // Output pulse with 1ms width on trigPin
  digitalWrite(trigPin, HIGH);
  delay(1);
  digitalWrite(trigPin, LOW);
  // Measure the pulse input in echo pin
  duration = pulseIn(echoPin, HIGH);
  // Distance is half the duration devided by 29.1 (from datasheet)
  distance = (duration/2) / 29.1;
  // if distance less than 0.1 meter and more than 0 (0 or less means over range)
    if (distance <= 50&& distance >= 0) {
      // Buzz
      digitalWrite(buzzPin, HIGH);
      Serial.println(distance);
    } else {
      // Don't buzz
      digitalWrite(buzzPin, LOW);
      Serial.println(distance);
    }
    // Waiting 60 ms won't hurt any one
    delay(60);
}
```

Done uploading.

I added the motor pin onto the sensor code and made a few iterations to the void setup and the void loop.

I was “messing around” with the distance to see what would be better. I started with 50 then went down to 17.



I wrote some rules so that when the distance was less than a certain value, the buzzer will vibrate.

Once I had the code working and the set up complete, I started to play around with the idea of delaying the time the buzzer vibrated. Initially I wanted to make the motor vibrate in a way in which was similar to that of a parking sensor. I added in the tempMapping feature but after I completed it, I felt it would not work very well.

```
/*
  This code should work to get warning cross the b
  Circuit is ultrasonic sensor and micro motor vib
*/
// Define pins for ultrasonic and buzzer
int const trigPin = 10;
int const echoPin = 9;
int const buzzPin = 2;

int delayTime = 0;

int tempMapping = map(distance, 0, 50, 1, 50);

if(distance < 0)
{
  // do nothing
   Serial.print("Error");
}
else if(distance > 50)
{
  distance = 50;
  digitalWrite(buzzPin, HIGH);
delay(tempMapping);
digitalWrite(buzzPin, LOW);
delay(tempMapping);
}
else
{
digitalWrite(buzzPin, HIGH);
delay(tempMapping);
digitalWrite(buzzPin, LOW);
delay(tempMapping);
}

Serial.print(distance);
Serial.print(" , ");
Serial.println(tempMapping);
```

Constructing the shoe

Once I was happy with the set and the code, I needed to transfer the circuit from being on the table, to being in the shoe. I began by trying to construct in the way that I wanted. I wanted all the Arduino and the bread board to be placed under the foot, so in the sole of the shoe.

I removed the inner parts of the shoe.

I then began the construction on the holes for the sensor placement and placed the sensor into this.

However doing this, I found the sensor would not pick anything in front of it, so I needed to start again.

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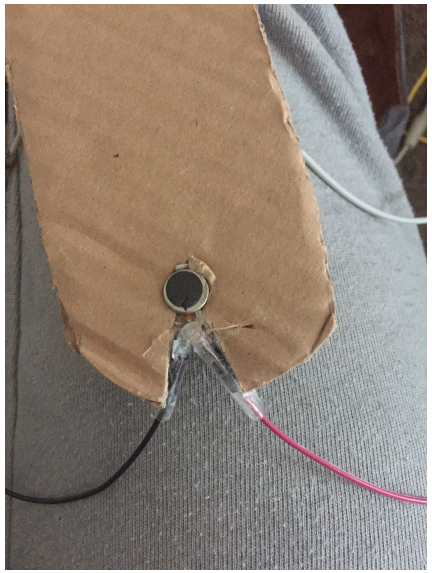
I then placed the technical bits and pieces into the shoe and connect the wires in place.

However once I had done this, there was little room available for the foot to go. I realised that I was un able to do what I initially intended to do, so I needed to find another solution for the placement of the wires etc.…

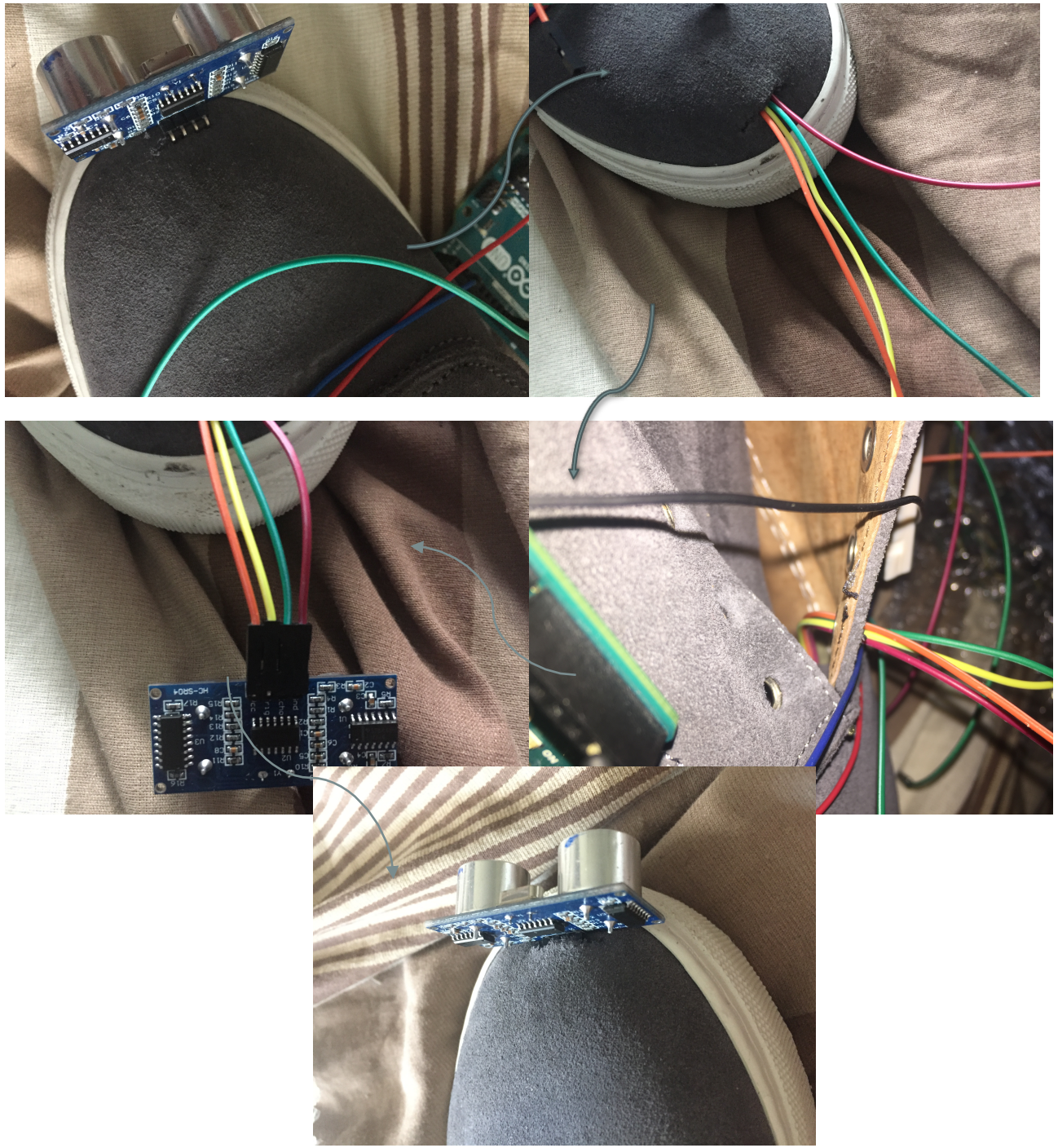


Using the main form sole as a guide, I created a false sole out of cardboard. I was going to put this into the shoe as a place to hold the motor vibrator. The pictures above show how I went about doing this.

Next I needed to place the wires and the board onto the shoe. Since I was using a battery pack, I knew that the shoe was going to be compact, so there was no need to connect the Arduino board to a computer or a mains plug.

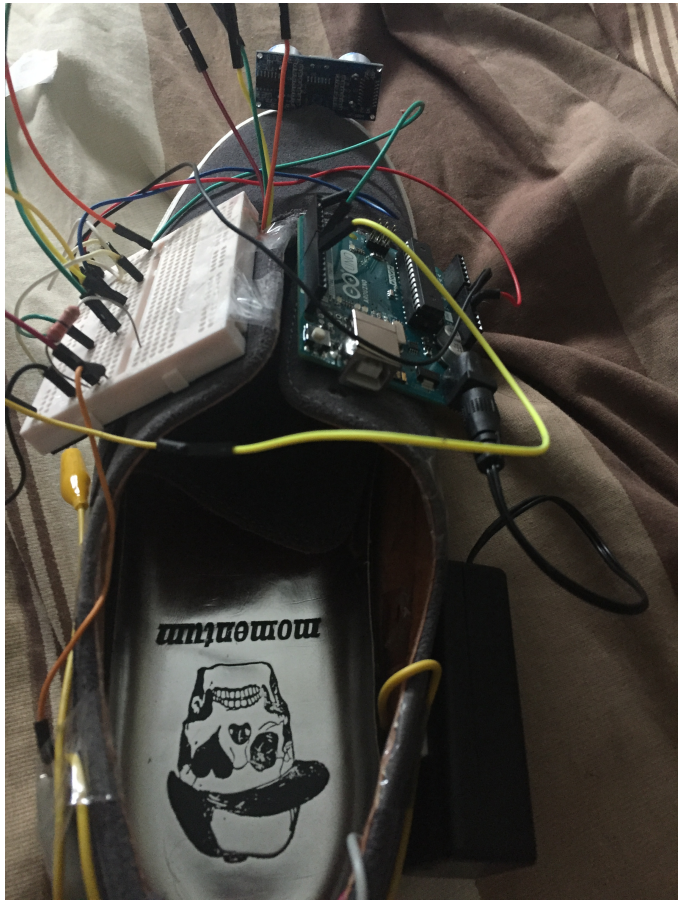
Just to test out how it would work, I decided that I was going to place the components on the top of the shoe.

I started with placing the sensor. I found that if I put the sensor on the top tip of the shoe, it would pick up everything. So I made some holes and threaded the wires through and connected the sensor. I used the holes for the laces, for threading the wires through.



Once I had connected the sensor, I placed the rest of the components onto the top of the shoe (as shown in the picture). I used double sided tape to do this, which allowed the components to be secure.

I tested the shoe and everything worked.



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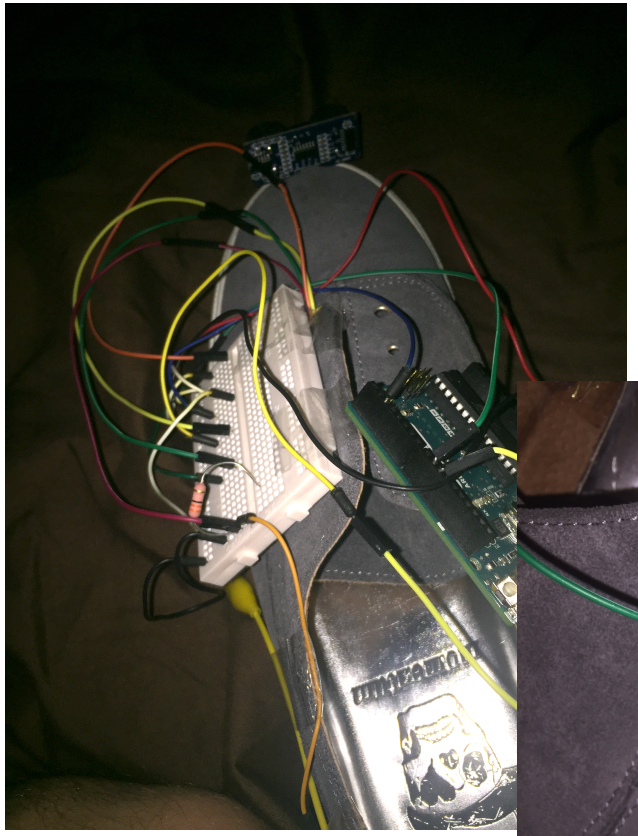
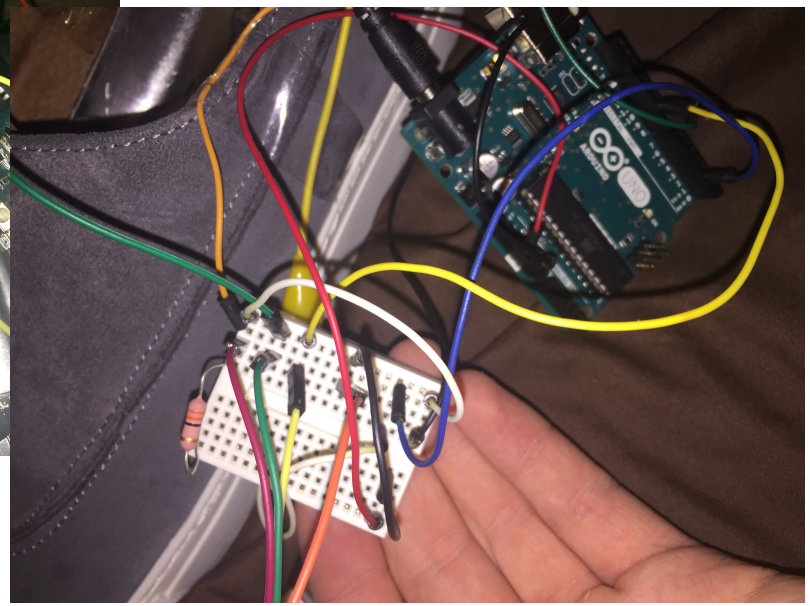
Testing and feedback

After the testing of the shoe, I showed other people. They were impressed with how the shoe worked and the fact the vibrations were very relaxing on the foot. After discussing, they felt the wires were too much on shoe so I should try to figure out a way in which I could move all these to present the design a bit better.

Design Changes

I went back to the shoe to make a start on the recommended changes. I looked at how I could possibly remove the wires out of outside of the shoe. I noticed that there was not many pins being used on the breadboard so I decided that the could just use a smaller bread board.





The bread board I used had a removable sticky back. I peeled this off and it was smaller enough the fit on the inside of the tongue of the shoe. This therefore meant that the wires were inside of the shoe and will be covered over.

I carried on with the changing by moving the placement of the Arduino board and the battery pack. I placed these to the side of the shoe and it made an improvement on the design.

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Branding

I felt that since I needed to create a video, I should have a name for the shoe. In order to make it as minimal and simple as possible, I decided that I was going to called the product, “Step”, the smart shoe. It seems perfect for what the shoe is offering people.

I created a logo which incorporated the icon of a foot into the S of the name of the shoe.

I wanted the logo to have some colour to it so I decided to make it green. There was no particular reason for this but I felt that it would work well.

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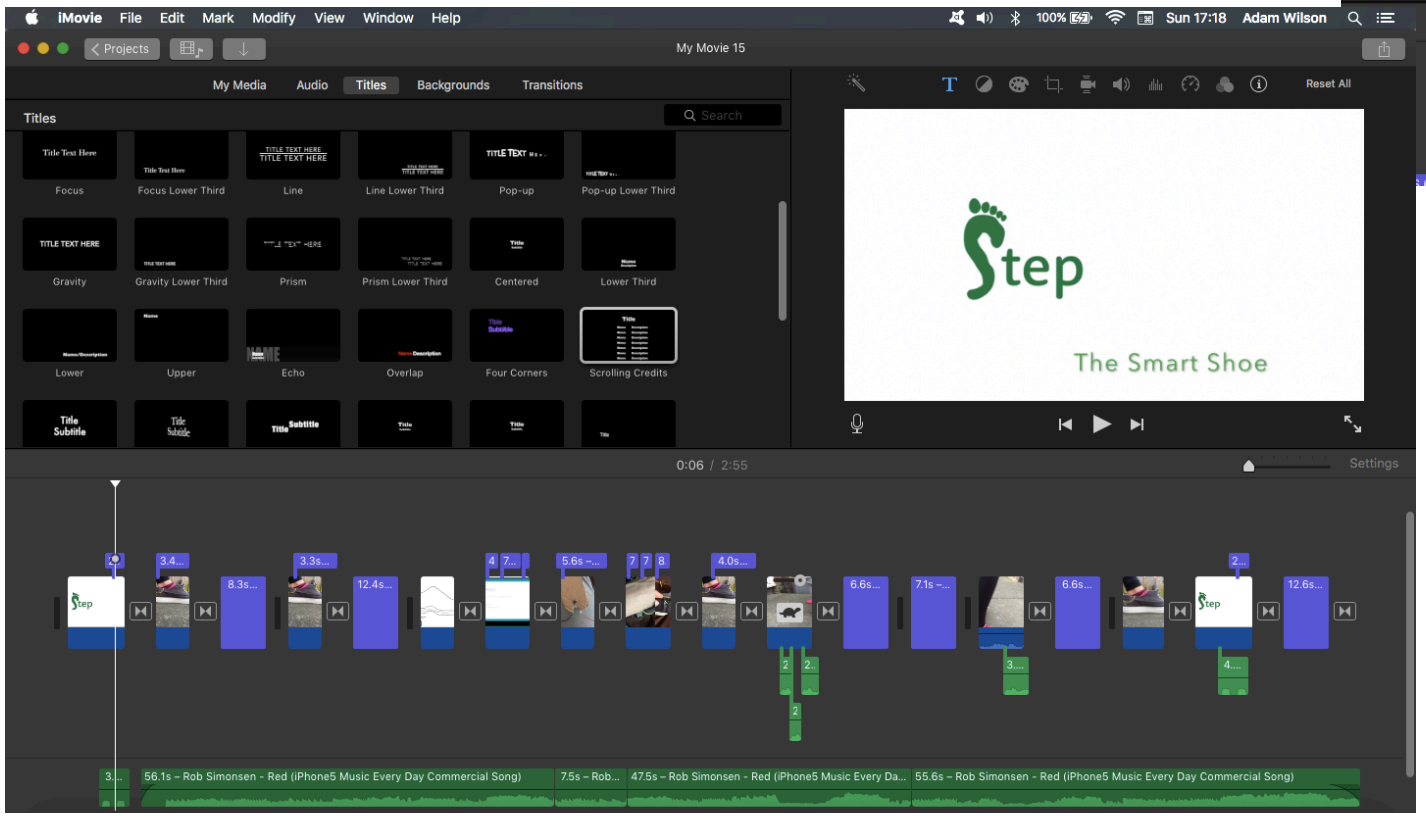
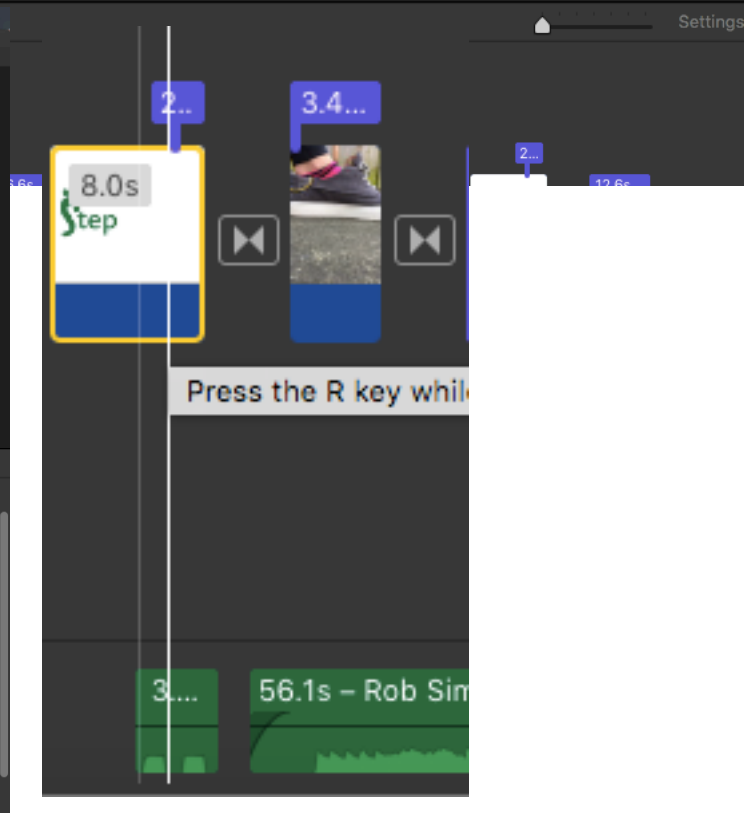
When it came to creating the video, I wanted to have a small animation of the logo. I wanted there to be some geometric shapes at the start, then for this to transition into the S. I also wanted to have the S move slightly, to symbolise it vibrating. This would bring in the relevance of what the shoe does.

Once I had the animation created, I began making the movie. When the S appears on the animation, I added a vibration sound effect. This went well with the video, giving it some originality and making it different from usual shoe logos.

I added in some information about the shoe, what it does, how it works as well as a demonstration.



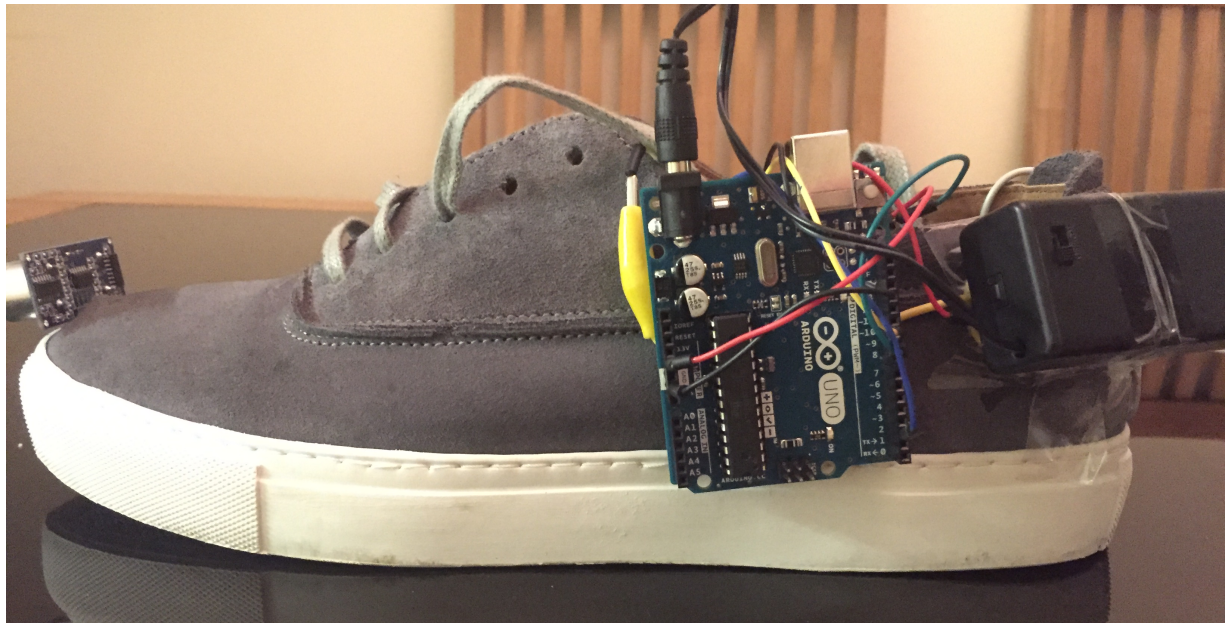


Final Prototype

This is the final design of the shoe. From the side you can see that there is very limited wires on show, giving the impression of an ordinary, normal shoe.

I am really please with the fact there are limited wires visible on the outside of the shoe.

From the other side of the shoe, you can see that the Arduino board and battery pack are on shoe. The switch on the battery pack allows the user to turn the shoe on or off when ever they want to use it.



I got a user to test the shoe whilst I filmed, as this was going to be part of the video. The user stated how she thought the idea was really good and the vibration was a lot smoother than she initially thought it would be. The vibration emits a sound while it is vibration which will help with the acknowledgement of an object in the way.

Conclusion

To summarise, my goal at the start of the project was to create a shoe in which would help the visual impaired feel safer when they are walking in the streets. I feel that I have successfully met my goal because the final product, "Step", allows any user to walk around in the street, knowing full well they are safe. The sensor tracks any object that is within 50cm in front of the user, giving the micro motor enough time to vibrate and making the user aware.

Throughout this project, I have pushed my self into working with software's to which I have limited skills and knowledge about. With such a small time frame, I was able to get a working final product, which is somewhat visually pleasing. Along the way, there were some troubles with the code and the building of the shoe, but I was able to pull through and resolve these.

If I was able to do this project again, I would try and push my self further, in terms of using Arduino. I have been able to build my skills a lot more when it comes to using Arduino, so I would like to maybe incorporate other features within the show, such as a sensor in the back.

Overall I am really pleased with what I have achieved. Even with some problems along the way, I have enjoyed working on this module. I have surprised myself with how much I have managed to achieve and build within the time limit, allowing me to explore my capabilities.

The video can be found at the following link……

https://youtu.be/RQiGeu0zcIk