Chapter 1

ABSTRACT

There are nearly 250 million people who suffer from blindness across the world. Either some have birth defect or suffer from acquired old age loss of vision. Every human being needs mobility and locomotion, that needs visual stimuli to locate the pathways and the navigate to the destination. Even moving across the house needs certain navigation to carry daily activities in this modern era. Every blind person either has to depend on someone to move, or accept the fact he just can't have a normal life.

Several technologies have been developed to aid navigation to blind people using smart assistive sticks and computer assistant aided speaker. But we are going to develop a simpler and effective navigation tool that can assist a person without much complication or involvement. Our Project is a Halo Head-Band Navigator that uses ultrasonic sensors to detect objects and calculate a pathway and instructs the user with vibrations on his head directly with haptic feedback technology(Vibration Integrations). The most important goal of this project was to increase the response time for the user. It is assumed to be far more better, simplistic, more effective and far cheaper compared to other existing technologies in the market.

INTRODUCTION

Globally, an estimated 285 million people are suffering visually impaired worldwide: 39 million are blind and 246 million have low vision [8]. Demographics of the blindness vary significantly in different parts of the world. In developing countries, about 0.4% of the population is blind while in the rest part this rate rises up to 1%. Consequently, 90%

of the visually impaired population are living in developing countries. About 82% of the blind are over the age of 50 [8]. Despite the medical revolution in the last 20 years has greatly reduced the blindness caused by diseases, it is surprising to note that the blindness is predicted to slowly decrease, if not increase, in the near future. Hollins [9] reasons the fact that the number of blind children is going to increase because “medical advances have made it possible for many premature infants, who in the past would have died, to survive”. In addition, longer life span trend also causes of concern.

Of all the senses, vision plays a vital role in everyday life situations and perception. Vision combined with other sense, usually hearing, offer most of the information needed to perceive the world and perform actions upon it. Losing sight is then the cause of numerous challenges in life: obstacle avoidance, navigation, information access, interaction with the environment and people. Despite efforts, it is obvious that most schools and employers can not accommodate blind people. In fact, working-age blind suffers a very high unemployment rate, about 65% in the United States [10]. The issue then becomes serious in terms of health care and social welfare, which evidently means significant high cost to be covered by the families and states. Therefore along with medical treatment revolutionary assistive technology for this population is very appreciated.

Blind people can easily comprehend speech in a far beyond maximum rate that sighted people can understand. Normal conversations are spoken at about 6 syllables per second and the absolute limit of comprehension for sighted people is 10 syllables per second. Blind people, however, can comprehend speech sped up to 25 syllables per second which sighted people consider as impossible-to-understand-noise. Comparing the brain regions activated by the blind and the sighted people while they listened to ultra-fast speech, brain scanner revealed that the cortex part of the blind that normally responds to vision was responding to speech [11]. The phenomena is called brain plasticity - the ability to reorganize brain functions in order to adapt to a certain life condition. Normally the brain region at the back of the skull, called V1, is only stimulated by light.

Vision is such an important sense of human that a huge portion of the brain is devoted to visual processing. Also, most of our senses have interacts with each other, which is

called cross-modality. Some connections exist between the brain's visual and auditory regions since they must corporate. Seeing a person's lips move helps to understand the speech. In general the information exchange between vision, auditory and other senses let people confirm a life's event. These connections become strengthened after losing sight. In addition, the regions in other cortex gradually expand their territory to make use of the idle power in the visual cortex. Brain plasticity of the blind depends on a critical period when people loses sight. Indeed, to be rerouted the connections need to preexist. In early blind's brain, the visual cortex is functionally disconnected and therefore is completely unresponsive to any auditory or visual stimulation. Experiments on animals have shown that early blind ones has no response to stimuli once vision is restored [12]. They behave as if they were blind. However the late blind whose connections formed are able to reroute the brain in order to process auditory information.

Obstacle avoidance is the most basic but crucial task for the blind. Although the blind can apply echolocation to detect obstacles, it is not practical in daily life since they are usually surrounded by people and ambient noise. Hearing is then occupied to sense moving objects and indeed the blind are quite good in this regard. When it comes to still objects, the task is almost impossible. Hence obstacle avoidance is in the interest of most makers. One of the earliest ETAs in 1970s is Mowat sensor [13], a handheld flashlight like device that use ultrasonic signals to sense obstacles and vibrates when obstacles are found. There are a few levels of vibrations depending on the measured distance. The shorter the distance, the higher frequency the vibrations.

SonicGuide [14] also adopts ultrasonic sensors to scan the space in front of the user but output via stereo audio signal that varies in pitch. The device fits in the frame of a pair of glasses. Although the rich information provided, learning how to decode this signal requires a lot of effort. Downie, an experienced ETA user, reviews: "At the end of training, I could do some very useful things with the aid. However, and of extreme importance for members of this list, I was still developing skills for a couple of years" [15].

The HeadNav takes in input from four ultrasonic sensors, each collecting from different direction, and process the vision through two detection algorithm, combinational detection and Sensory Detection. Combinational Detection is an advance differential classification algorithm that can detect big obstacles in front of the user. The algorithm then enroutes the information to proper directing routines corresponding to the motor patterns with multi rate modulating algorithm based on the distance.

The vibrations produced are multi-frequency multi pattern, that is calculated by an algorithm, which tells faster and more intense vibrations if the object is very close.

This project hopes to produce quick detections without utilizing heavy processing and aims to produce more RESPONSE TIME than other navigational assistance. We used general engineering and diploma development tools to implement this project. The idea if implemented could reduce the cost and production much lower than incurred here.

Chapter 2

LITERATURE SURVEY

One of the most extensive and still in-progress study on vision substitution through tactile feedback is the Tactile-Video-Substitution System (TVSS) by Bach-y-Rita since 1963. The system captures video and converts to vibrations or direct electrical stimulation. The tactile feedback is applied to the abdomen, the back or the thigh with arrays of 100 to 1032 points. In a recent effort, direct electrical stimulation on the tongue is also tested [12]. VideoTact, the commercial TVSS version, costs $40000 [21].

NAVIG (Navigation Assisted by artificial VIsion and GNSS) [22] is a multidisciplinary project aiming at assisting navigation and object localization via virtual augmented reality system. The system consists of stereoscopic cameras, adapted GIS (Geographic Information System) and a integrated database of important geolocated objects. The information is then displayed in 3D sounds to increase perceptual position accuracy. A prototype of NAVIG is shown in Figure 1.

Figure 1 : NAVIG prototype

Mejer [23] came up with a basic argument that human brain is capable enough to process and interpret complicated and rapidly changing sound patterns. The vOICe [24] is thus built of a digital camera attached on a pair of eyeglasses, headphone and a portable computer. The working principle is quite simple: images captured by the camera is processed by computer to create a direct one-to-one image-to-sound map. Then the sound is output via headphones. No filter was applied as the main idea is to keep as much information as possible and let the human brain pick up what it needs. Hence the system is simple, compact and lightweight. The expense is however the extensive training required, as the author acknowledge: “just like in learning a foreign language, or mastering a musical instrument, or learning to read Braille by touch, at least months of training effort should be expected before it begins to feel second nature” [24]. The system is sold at $2500.

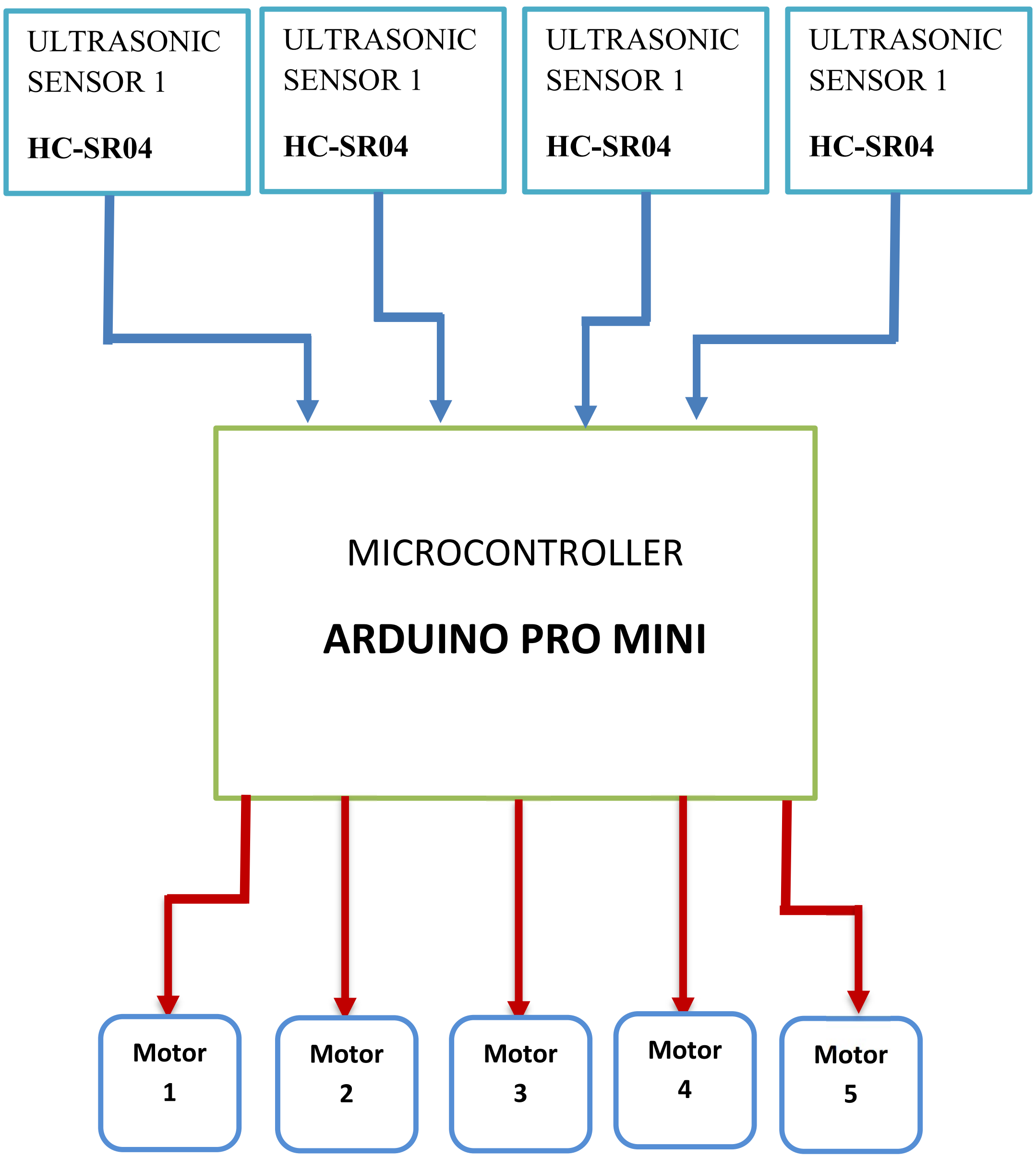
In stead of learning how to interpret raw sound, OrCam [25] customer can listen to verbal messages. OrCam is a $3500 assistance device looks like a a pair of eyeglasses with miniature camera attached, and a pocket-size controller as seen in Figure 1.6. OrCam can read, recognize faces, identify objects, products and places, locate bus numbers and monitor traffic lights. The user place a finger on top of what he would like to “see”, and OrCam will read it loud.

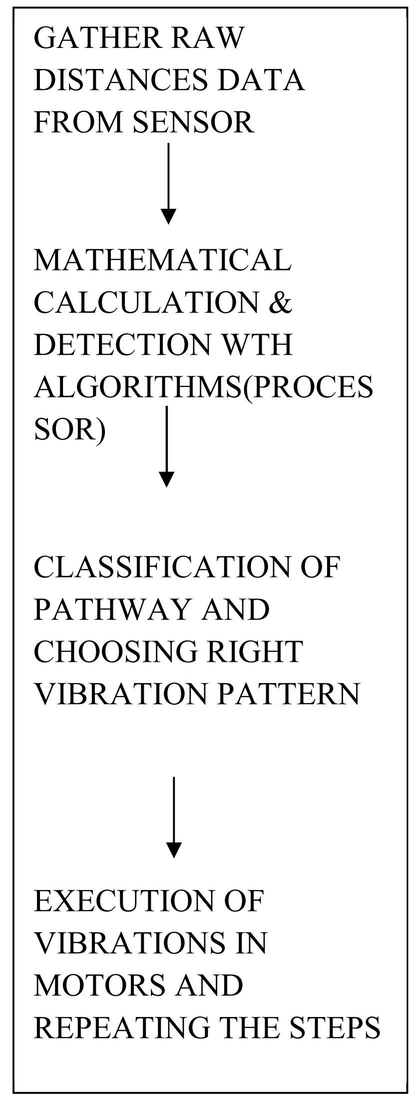
OrCam system

Chapter 3

METHODOLOGY

3.1 Block diagram





3.2 Working

The system has three categorical modules, as follows-

1. VISION CROWN
2. HAPTIC BAND
3. ELECTRONIC CONTROLLER

3.2.1 VISION CROWN:

Vision Crown is the sensing unit, that detects obstacles in the user's frontal navigation field. The field is a 160 Degree angle field with 3 meters range field.

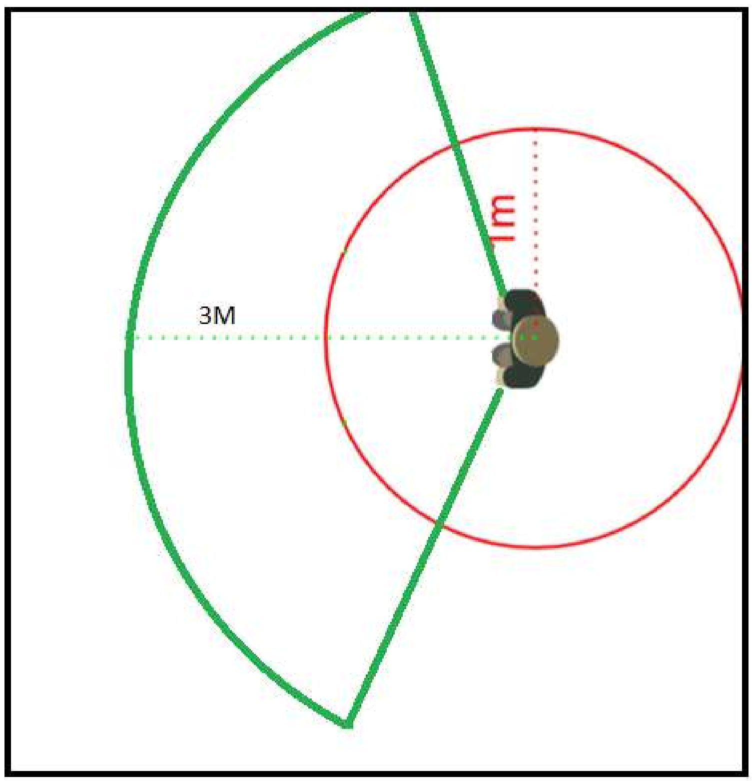


Figure: Object Detection Range

The detection schema is divided into four divided areas with each area of 40 Degrees. Each area consists of a sensor that detects objects in that 40-degree 3-meter area sector. That way, we divide the vision aka the object detection to 4 different sensors.

The ultrasonic sensor in each sector detects objects in its area and sends the distances of them to the algorithm. The distances are measured in cms with smallest unit measured is 1 cm. That way the algorithm receives 4 measured distance integers as inputs per instant of time from the sensors in the program. This is the input data of the program.

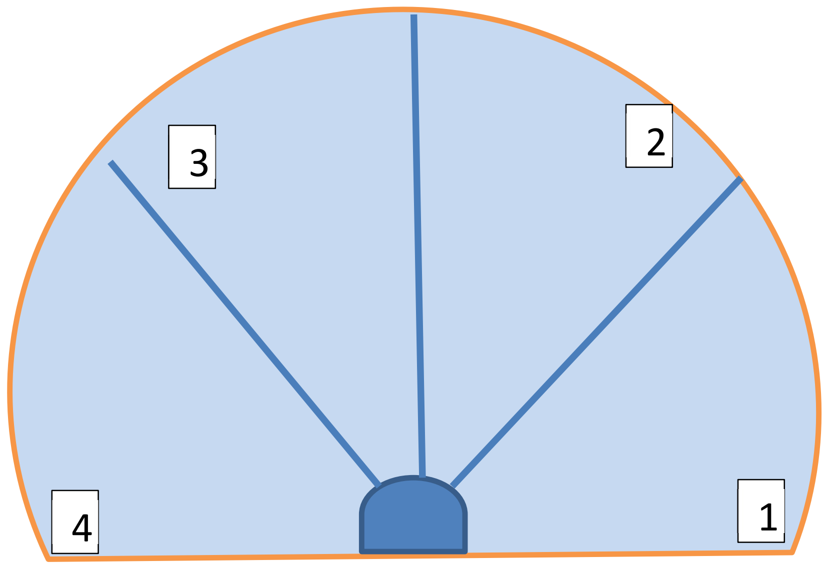
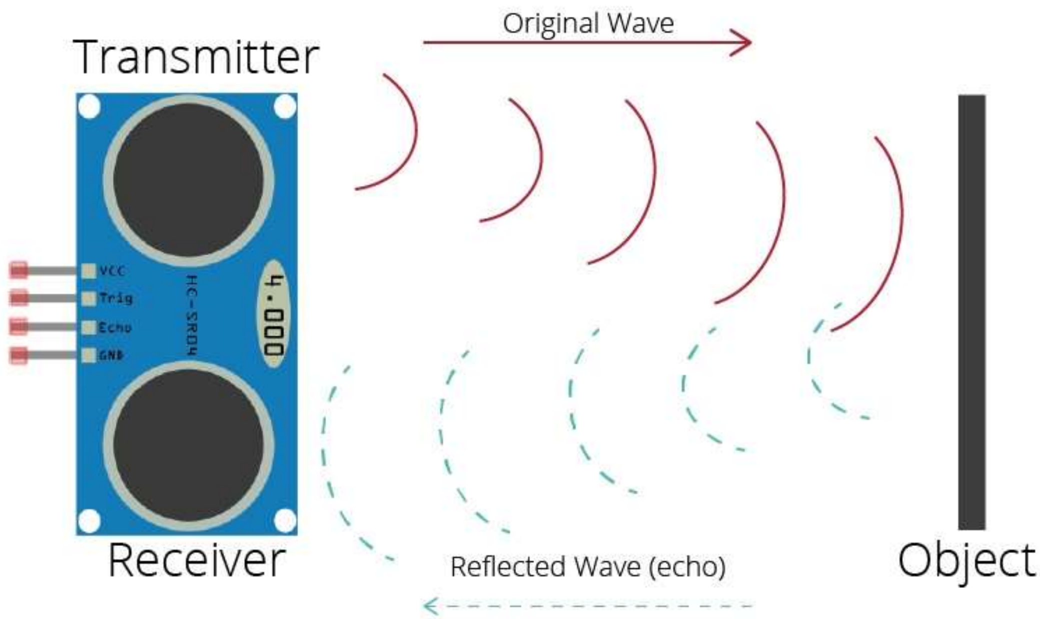


Figure: Sensor Sectors of the Vision Crown

3.2.1.1WORKING OF ULTRASONIC SENSOR:

An HC-SR04 ultrasonic distance sensor actually consists of two ultrasonic transducers. One acts as a transmitter that converts the electrical signal into 40 KHz ultrasonic sound pulses. The other acts as a receiver and listens for the transmitted pulses.

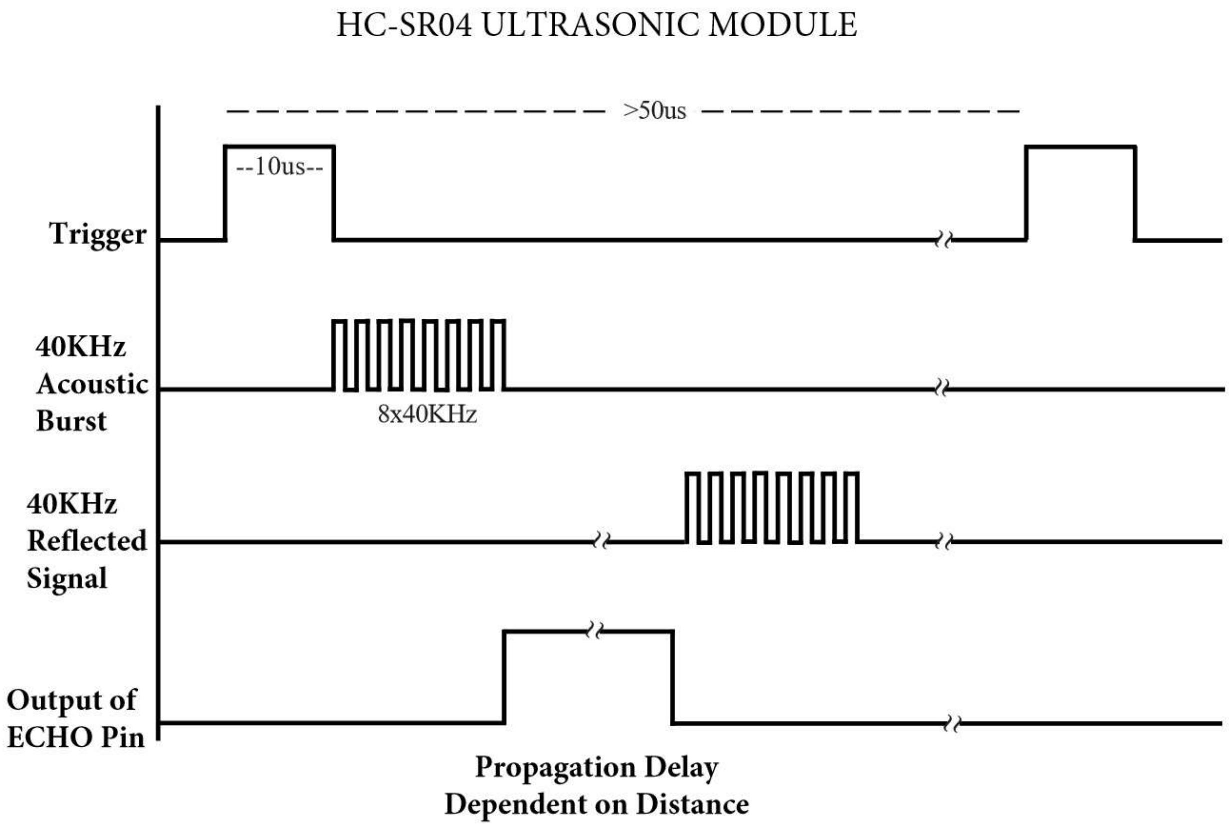
When the receiver receives these pulses, it produces an output pulse whose width is proportional to the distance of the object in front. This sensor provides excellent non-contact range detection between 2 cm to 400 cm (~13 feet) with an accuracy of 3 mm. Since it operates on 5 volts, it can be connected directly to an Arduino or any other 5V logic microcontroller.



It all starts when the trigger pin is set HIGH for 10µs. In response, the sensor transmits an ultrasonic burst of eight pulses at 40 kHz. This 8-pulse pattern is specially designed so that the receiver can distinguish the transmitted pulses from ambient ultrasonic noise.

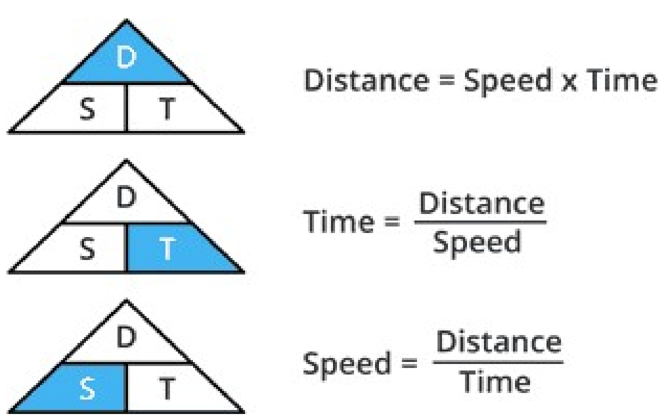
These eight ultrasonic pulses travel through the air away from the transmitter. Meanwhile the echo pin goes HIGH to initiate the echo-back signal.

If those pulses are reflected back, the echo pin goes low as soon as the signal is received. This generates a pulse on the echo pin whose width varies from 150 µs to 25 ms depending on the time taken to receive the signal.



3.2.1.2 Calculating the Distance

The width of the received pulse is used to calculate the distance from the reflected object. This can be worked out using the simple distance-speed-time equation we learned in high school. An easy way to remember the equation is to put the letters in a triangle.



Let us take an example to make it more clear. Suppose we have an object in front of the sensor at an unknown distance and we receive a pulse of 500µs width on the echo pin. Now let's calculate how far the object is from the sensor. For this we will use the below equation.

Distance = Speed x Time

Here we have the value of time i.e. 500 µs and we know the speed. Of course it's the speed of sound! It is 340 m/s. To calculate the distance we need to convert the speed of sound into cm/µs. It is 0.034 cm/µs. With that information we can now calculate the distance!

Distance = 0.034 cm/µs x 500 µs

But we're not done yet! Remember that the echo pulse indicates the time it takes for the signal to be sent and reflected back. So to get the distance, you have to divide your result by two.

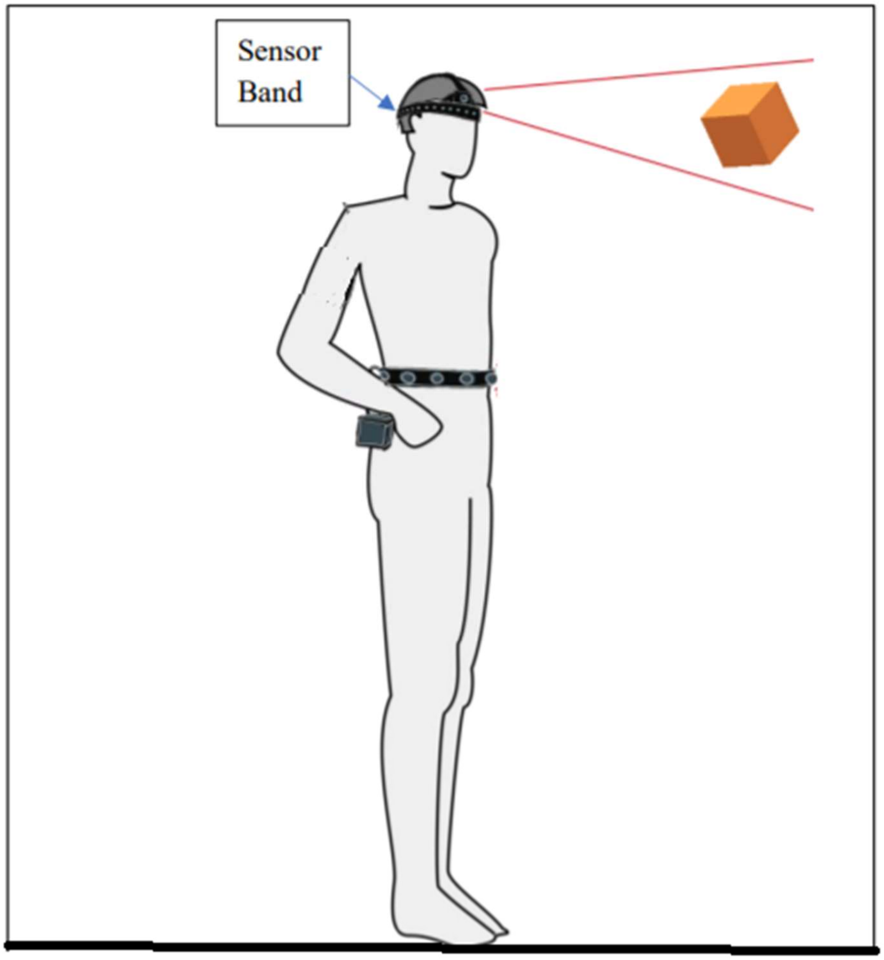
Distance = (0.034 cm/µs x 500 µs) / 2

Distance = 8.5 cm

Now we know that the object is 8.5 cm away from the sensor.

CHAPTER 3.5

SYSTEM ANALYSIS



- The design consists of a microcontroller chip (Arduino mini pro) that is interfaced with the sensor.
- The sensor is programmed in such a way that it, if there is an obstacle in the circumference of 10feet then the sensor senses and intimates the microcontroller chip.
- The code is written in such a way that if the obstacle appears from front then the vibrator vibrates once, if it appears from back then it vibrates twice hence in a similar manner according to the direction the vibrator intimates the visually impaired accordingly with the programmed number of vibrations, which is shown in the flowchart.

1. **Ultrasonic sensor**

Ultra sonic sensor suit the best for this project as it can detect any object that lies on the ground, situated a distance of certain meters from the user. The sensor will then detect the presence of any object that lies within that meters by detecting the reflected sound beam. The time intervals at which the transmitter will transmit ultrasound depend on the walking speed of the user. Also it is low cost, and efficient. Here we use HC-SR04 series ultrasonic sensor.

2. **Microcontroller chip**

Both the sensors and the vibration interface would be controlled through microcontroller. One of the biggest microcontroller names in the market is the Arduino family, with over 20 different board models. To meet the design spec of being lightweight and portable, the Arduino Mini Pro was chosen. This model is small and lightweight, while still operating at a frequency of 16 MHz to provide timely feedback to the user. CMOS batteries of 5v are used in the system; all the components require 5v supply for the working of the system. They are portable, light, and less expensive.

3. **Vibrating motor**

To determine how the device would alert the user the proximity of objects first, audio signals were considered. However, an audio signal would be difficult to hear in a loud area and cause confusion to the user. A good alternative to audio signals would be a vibrating interface. The vibration interface would indicate to the user the proximity of an object with different vibration intensities and speeds. In addition to being a much more discrete way to notify the user, it is also much more cost effective.

4. **Software**

   Arduino IDE is the software that is used to develop the source code of the microcontroller. It is chosen because it is widely used and the language is easy to understand. It is compatible for various kinds of microchip development system tools. FTDI DRIVER is used for connecting Arduino software to the system.

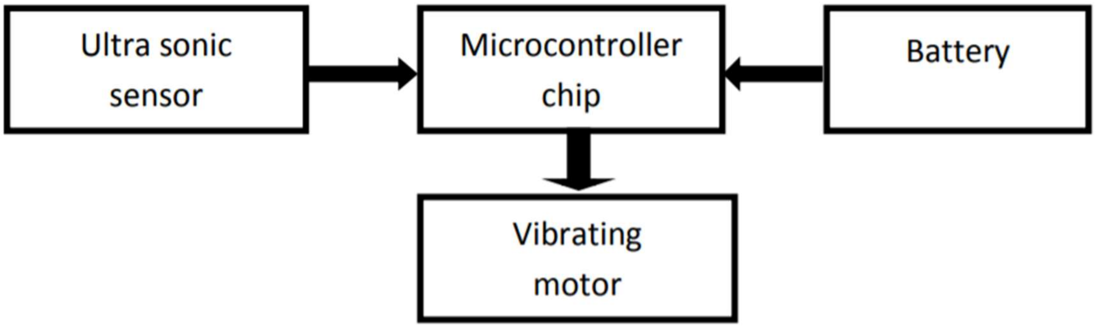


Fig1: Basic block diagram

Case Analyis:

When the data is above 500cm, it is to understood that there is noobject.

Our requirement:
A sensor for 300 cms.
The sensor should be light
Visual data-□numbers-□read by the code(microcontroller)

In our algorithm
Input: 4 sensor data(distance)
Out: generate motor signals(which motor to vibrate) + At what speed each motor should vibrate(rate)

```
Void algorithm(int sensor1, int sensor2, int sensor3, int sensor4){
If(sensor1<=300 || sensor2<=300 || sensor3<=300 || sensor4 <=300){
//We have an object
}
```

We use vibrating motors that will be placed on the persons forehead on different places.

By pulsing different motors we can tell which direction the object is.

By changing the pulsing rate we tell how near the object is.

Algorithm(inputs){

Return Which motor to vibrate;

Return how fast the motor should vibrate;

}

1) **Calculate the vibration rate**
2) **Decide which motor to vibrate**

Vision:

Vision detects the objects

To detect, we use multiple US sensor on different angles

To detect the exact location:

1) **Which sensor the object is detected(angle)**
2) **Distance of the object(distance)**

Study A Case:

Sensor 2 reports there is an object infront of it in 3 meters

Data:

Sensor number: 2

Distance : 3

The object is at the left front of the person.

The object is 3 meters far.

We vibrate the left front vibrating motors

We have to vibrate the motors slowly

Chapter 4

COMPONENTS DESCRIPTION

4.1 ARDINO PRO MINI

- **Arduino Pro Mini** is a microcontroller board developed by Arduino.cc and comes with Atmega328 microcontroller incorporated inside the board.
- This board comes with 14 digital I/O out of which 6 pins are used for providing PWM output. There are 8 analog pins available on the board.
- It is very small as compared to Arduino Uno i.e. 1/6 of the total size of the Arduino Uno.
- There is only one voltage regulator incorporated on the board i.e 3.3V or 5V based on the version of the board.
- The Pro Mini runs at 8 MHz for the 3.3V version which is half than Arduino Uno board that runs at 16MHz.
- There is no USB port available on the board and it also lacks built-in programmer.

Figure 4: Arduino pro mini

4.2 HC SR-04 ULTRASONIC SENSOR

- The HC-SR04 Ultrasonic Distance Sensor is a sensor used for detecting the distance to an object using sonar.

- It's ideal for any robotics projects your have which require you to avoid objects, by detecting how close they are you can steer away from them!

- The HC-SR04 uses non-contact ultrasound sonar to measure the distance to an object, and consists of two ultrasonic transmitters (basically speakers), a receiver, and a control circuit.

- This time can subsequently be used, along with some clever math, to calculate the distance between the sensor and the reflecting object!

- The HC-SR04 is great, as it's low cost, can be powered via the Raspberry Pi's 5V output, and is relatively accurate! Please Note. The HC-SR04 has a 5V output (which needs to be reduced to 3.3V to work with the Raspberry Pi).

- The HC-SR04 sensor works best between 2cm – 400 cm (1" - 13ft) within a 30 degree cone, and is accurate to the nearest 0.3cm.

- The HC-SR04 Ultrasonic Range Sensor Features:

Input Voltage: 5V

Current Draw: 20mA (Max)

Digital Output: 5V

Digital Output: 0V (Low)

Working Temperature: -15°C to 70°C

Sensing Angle: 30° Cone

Angle of Effect: 15° Cone

Ultrasonic Frequency: 40kHz

Range: 2cm - 400cm

Dimensions

Length: 43mm

Width: 20mm

Height (with transmitters): 15mm

Centre screw hole distance: 40mm x 15mm

Screw hole diameter: 1mm (M1)Transmitter diameter: 8mm

Figure 5: HC-SR-04 Ultrasonic Sensor

4.2.1 Pin Description of HC SR-04 Ultrasonic module:

HC-SR04 Ultrasonic Sensor Pin Configuration

This sensor includes four pins and the pin configuration of this sensor is discussed below.

Pin1 (Vcc): This pin provides a +5V power supply to the sensor.

Pin2 (Trigger): This is an input pin, used to initialize measurement by transmitting ultrasonic waves by keeping this pin high for 10us.

Pin3 (Echo): This is an output pin, which goes high for a specific time period and it will be equivalent to the duration of the time for the wave to return back to the sensor.

Pin4 (Ground): This is a GND pin used to connect to the GND of the system.

4.3 Vibrating Motors

- Two wires are used to control/power the vibe. Simply provide power from a battery or microcontroller pin (red is positive, blue is negative) and it will buzz away.

- The rated voltage is 2.5 to 3.8V and for many projects, we found it vibrates from 2V up to 5V, higher voltages result in more current draw but also a stronger vibration.

Dimension: 10mm diameter, 2.7mm thick

Voltage: 2V - 5V

5V current draw: 100mA,

4V current draw: 80mA,

3V current draw: 60mA,

2V current draw: 40mA

11000 RPM at 5V

Figure 7: Vibrating Motor

1.4 Active Electrical Components

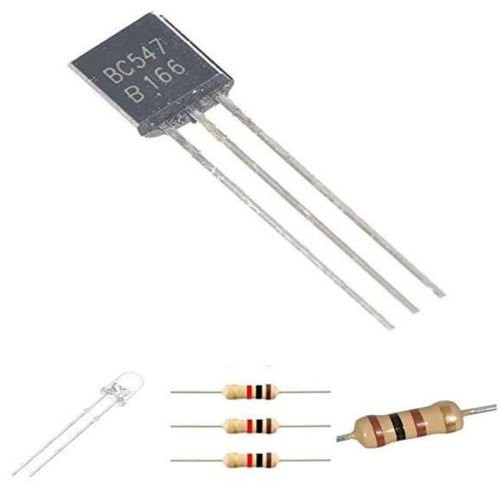


Figure: Transistors and Resistors

- The electronic controller needs some of the foundation electronic gates and active components in order to properly drive the vibrational motors off the system.
- The microcontroller’s

- We used NPN transistors BC547 for each motor as an amplification transistor, which acts as a switch between microcontroller input pin and motor supply output pin.
- We used 1K ohm resistors to bridge the microcontroller and transistors drive circuit, protecting the microcontroller from over flow.
- All the system together forms a amplification circuit for motors.

1.5 Vero Prototyping Board

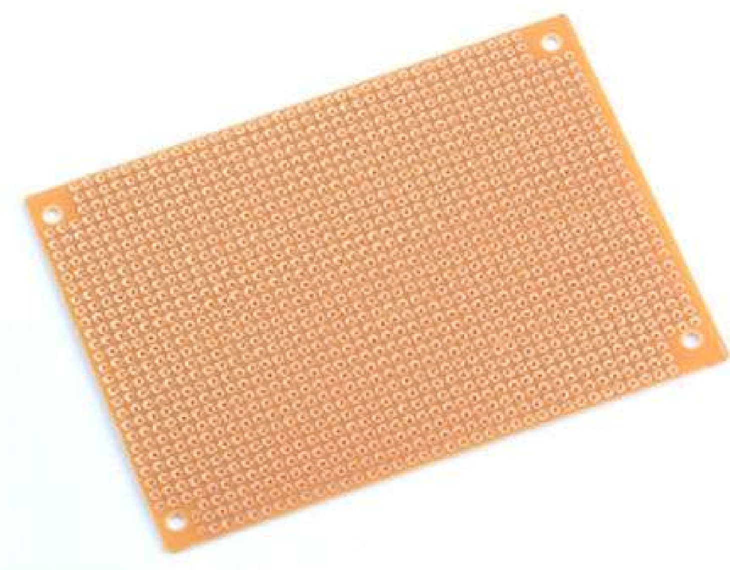


Figure: Vero Prototyping board

- The circuit of electronic controller was chosed to be assembled and formed or an simple prototyping board called Vero Board.
- It's a 10cm X 10 cms board with ceramic material and Slotted copper points.
- The Circuit could be designed from top with markers and then soldered and connections could be made from the bottom copper pins.

1.6 The HeadBand

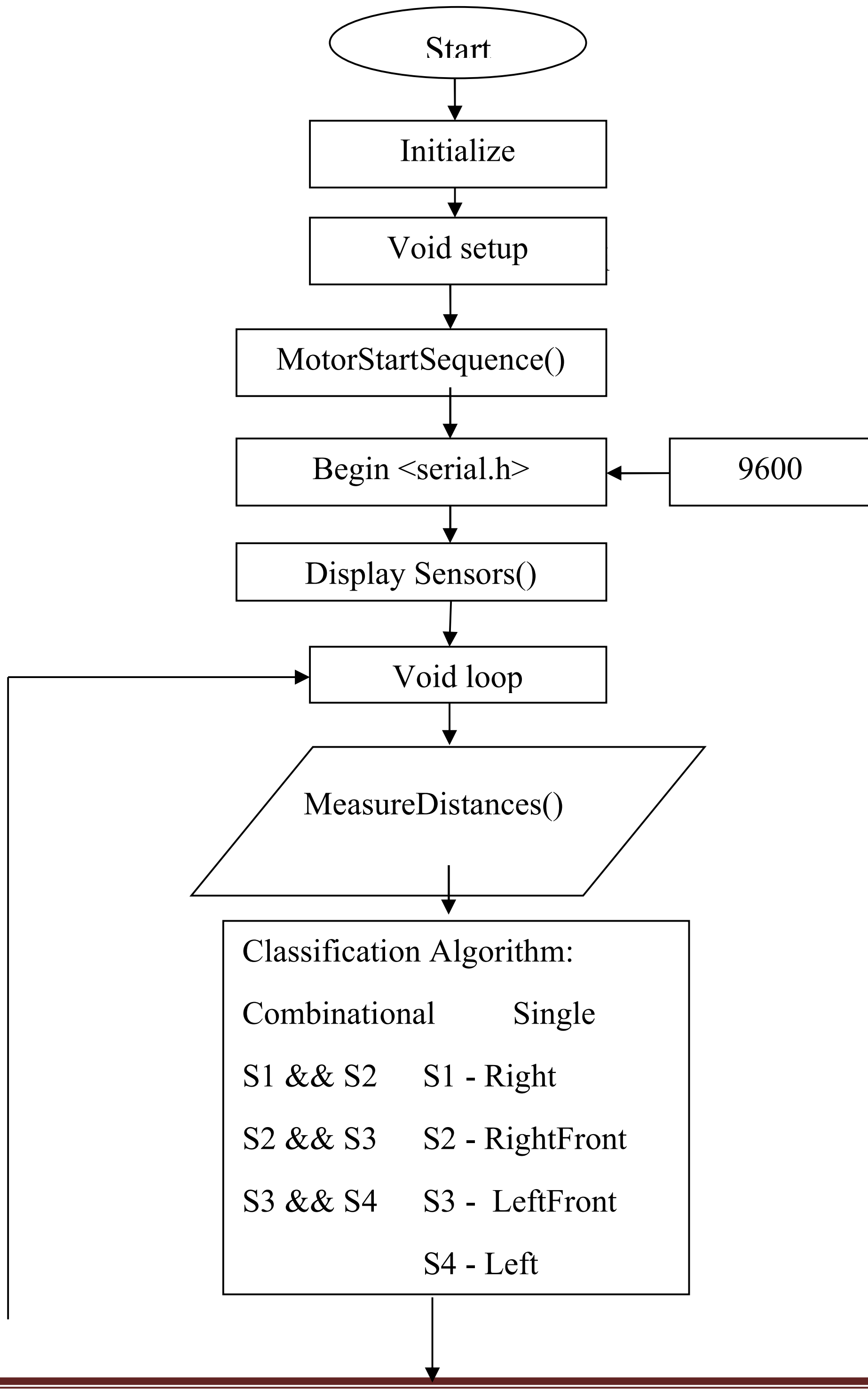
- Vinyl upholstery is made from two separate synthetic materials. The fibers of the upholstery are constructed from strong polyester fibers.
- The fibers are then coated with vinyl, made from polyvinyl chloride (PVC) and plasticizers (phthalic acid). This vinyl is melted onto the surface of the fibers, sealing them closed and making a virtually waterproof surface that is still flexible and tough.
- Vinyl upholstery is easy to clean and maintain. This makes it ideal for situations where cleanliness is a top priority, such as in hospitals and restaurants. Vinyl also does not require any special care or conditioning.
- We chose this material to make the headband because of its comfortable and Suitable material for headband.
- We needed material that can hold of printed plastic fibre structure and motors elastic bands and then easily stitch the fabric into the head band.
- This material also has a good aesthetic Profile.

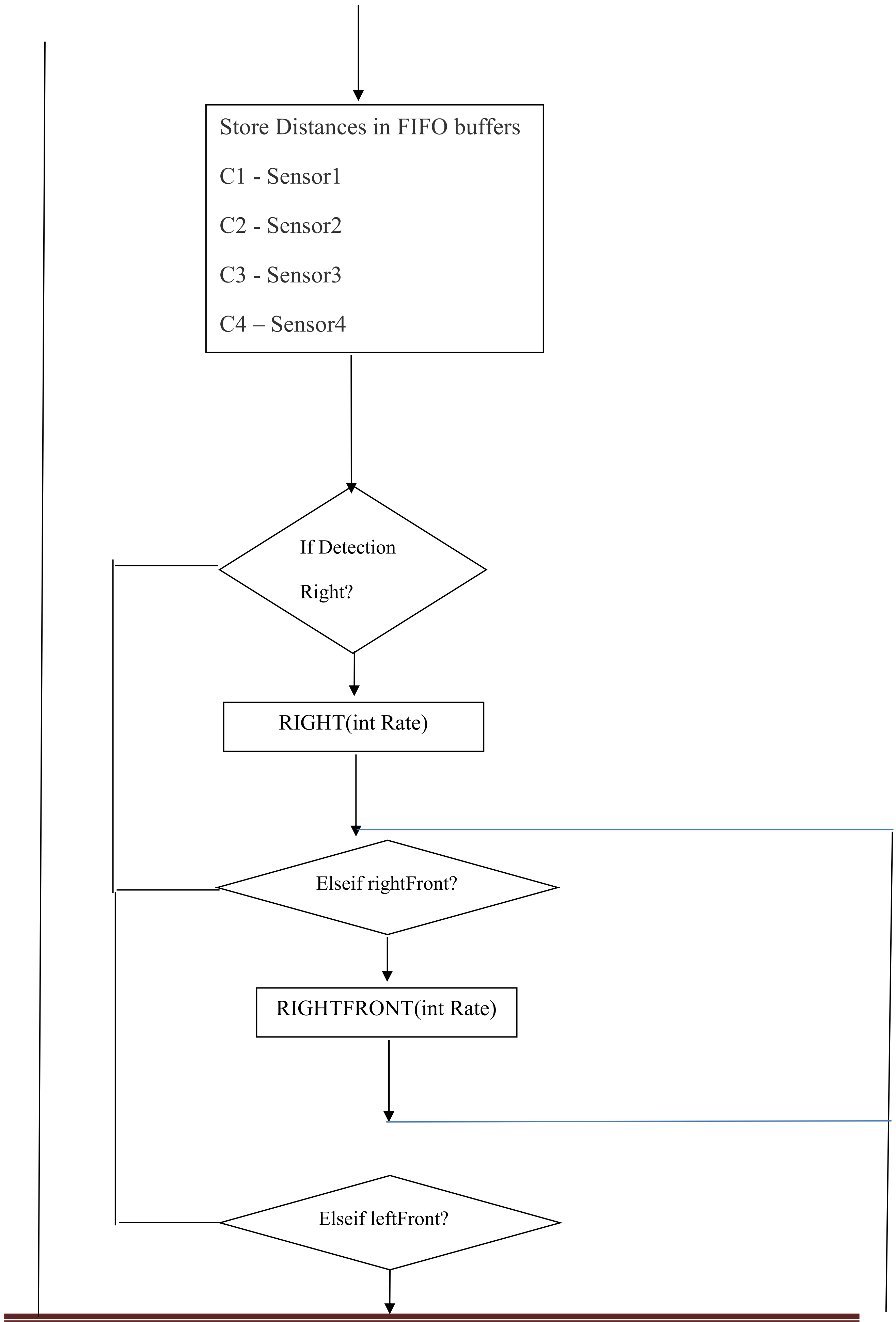
Figure: Vinyl upholstery

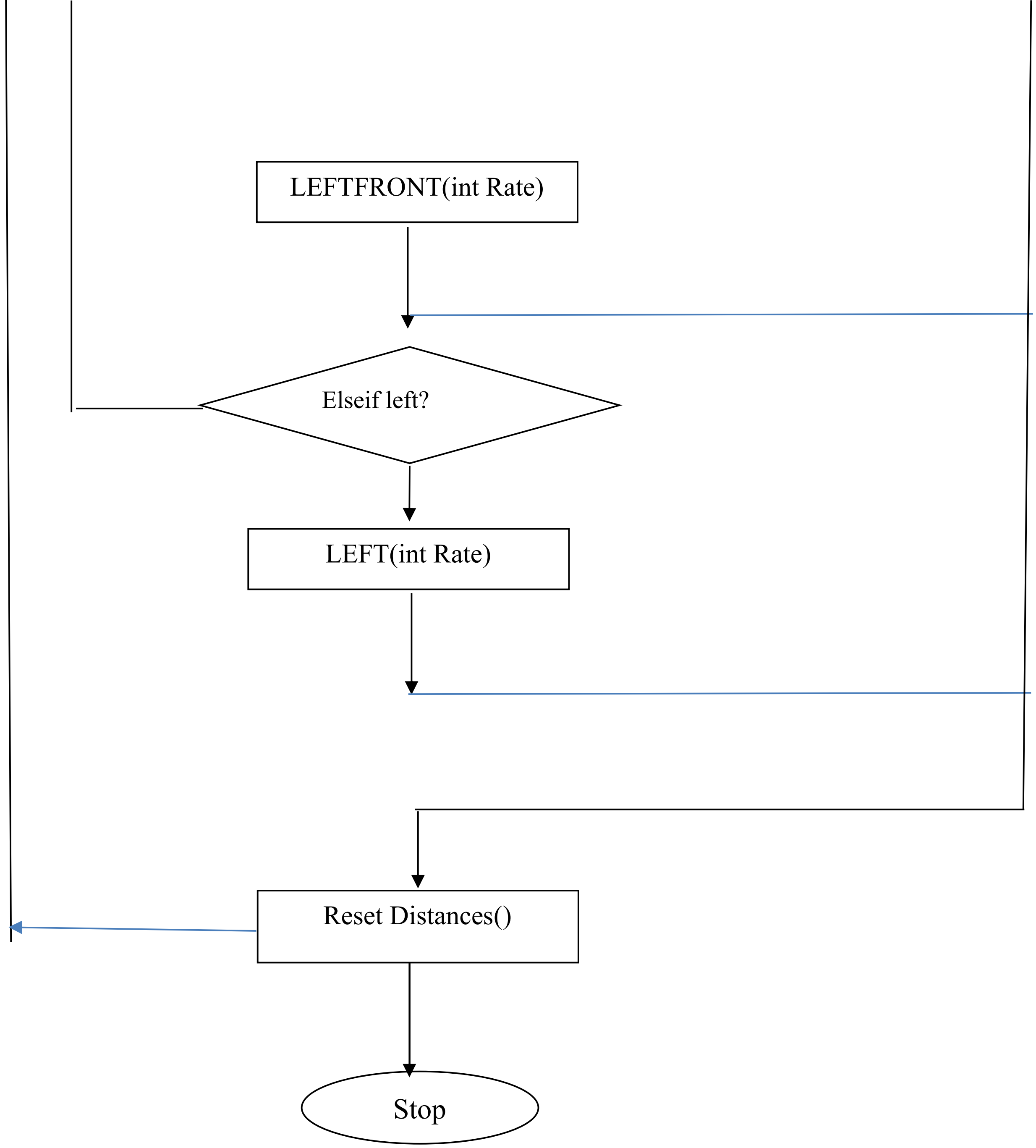
Chapter 5

FLOW CHART

5.1 Program flow chart




Store Distances in FIFO buffers
C1 - Sensor1
C2 - Sensor2
C3 - Sensor3
C4 – Sensor4
If Detection
Right?
RIGHT(int Rate)
Elseif rightFront?
RIGHTFRONT(int Rate)
Elseif leftFront?


LEFTFRONT(int Rate)
Elseif left?
LEFT(int Rate)
Reset Distances()
Stop

Chapter 6

PROGRAM

```
const int frontEchoPin = 7;
const int frontTriggerPin = 6;
const int leftEchoPin = 11;
const int leftTriggerPin = 10;
const int rightEchoPin = 9;
const int rightTriggerPin = 8;

const int motorL1 = 2;
const int motorL2 = 3;
const int motorR1 = 4;
const int motorR2 = 5;

volatile float maxFrontDistance = 25.00;

volatile float frontDuration, frontDistanceCm, leftDuration, leftDistanceCm,

rightDuration, rightDistanceCm;

volatile float maxLeftDistance, maxRightDistance = 20.00;

void setup() {
  // serial
  Serial.begin(9600);
  // ultrasonic
  pinMode(frontTriggerPin, OUTPUT);
  pinMode(frontEchoPin, INPUT);
  pinMode(leftTriggerPin, OUTPUT);
  pinMode(leftEchoPin, INPUT);
  pinMode(rightTriggerPin, OUTPUT);
  pinMode(rightEchoPin, INPUT);
  // motors
  pinMode(motorL1, OUTPUT);
  pinMode(motorL2, OUTPUT);
  pinMode(motorR1, OUTPUT);
  pinMode(motorR2, OUTPUT);
}

void loop() {
  // front distance check
  checkFrontDistance();
```

```
if (frontDistanceCm < maxFrontDistance) {
  Serial.println("Too close");
  checkLeftDistance();
  delay(20);
  checkRightDistance();
  delay(20);
  if (leftDistanceCm < rightDistanceCm)
    moveRight();
  else if (leftDistanceCm > rightDistanceCm) {
    moveLeft();
  }
}

else {
  Serial.println("OK");
  moveForward();
}

// left distance check
checkLeftDistance();
if (leftDistanceCm < maxLeftDistance) {
  Serial.println("Left too close");
  delay(20);
  checkLeftDistance();
  delay(20);
  checkRightDistance();
  delay(20);
  if (leftDistanceCm > rightDistanceCm)
    moveForward();
  else if (leftDistanceCm < rightDistanceCm) {
    moveRight();
  }
}

// right distance check
checkRightDistance();
if (rightDistanceCm < maxRightDistance) {
  Serial.println("Right too close");
  delay(20);
  checkRightDistance();
  delay(20);
  checkLeftDistance();
  delay(20);
  if (rightDistanceCm > leftDistanceCm)
    moveForward();
  else if (rightDistanceCm < leftDistanceCm) {
```

```
      moveLeft();
    }
  }
}

void checkFrontDistance() {
  digitalWrite(frontTriggerPin, LOW);  //para generar un pulso limpio ponemos a
LOW 4us
  delayMicroseconds(4);
  digitalWrite(frontTriggerPin, HIGH);  //generamos Trigger (disparo) de 10us
  delayMicroseconds(10);
  digitalWrite(frontTriggerPin, LOW);
  frontDuration = pulseIn(frontEchoPin, HIGH);  //medimos el tiempo entre pulsos,
en microsegundos
  frontDistanceCm = frontDuration * 10 / 292 / 2;  //convertimos a distancia, en cm
  Serial.print("Distance: ");
  Serial.print(frontDistanceCm);
  Serial.println(" cm");
}

void checkLeftDistance() {
  digitalWrite(leftTriggerPin, LOW);  //para generar un pulso limpio ponemos a
LOW 4us
  delayMicroseconds(4);
  digitalWrite(leftTriggerPin, HIGH);  //generamos Trigger (disparo) de 10us
  delayMicroseconds(10);
  digitalWrite(leftTriggerPin, LOW);
  leftDuration = pulseIn(leftEchoPin, HIGH);  //medimos el tiempo entre pulsos, en
microsegundos
  leftDistanceCm = leftDuration * 10 / 292 / 2;  //convertimos a distancia, en cm
  Serial.print("Left distance: ");
  Serial.print(leftDistanceCm);
  Serial.println(" cm");
}

void checkRightDistance() {
  digitalWrite(rightTriggerPin, LOW);  //para generar un pulso limpio ponemos a
LOW 4us
  delayMicroseconds(4);
  digitalWrite(rightTriggerPin, HIGH);  //generamos Trigger (disparo) de 10us
  delayMicroseconds(10);
  digitalWrite(rightTriggerPin, LOW);
  rightDuration = pulseIn(rightEchoPin, HIGH);  //medimos el tiempo entre pulsos,
en microsegundos
  rightDistanceCm = rightDuration * 10 / 292 / 2;  //convertimos a distancia, en cm
  Serial.print("Right distance: ");
```

```
  Serial.print(rightDistanceCm);
  Serial.println(" cm");
}

void moveBackward() {
  Serial.println("Backward.");
  digitalWrite(motorL1, HIGH);
  digitalWrite(motorL2, LOW);
  digitalWrite(motorR1, HIGH);
  digitalWrite(motorR2, LOW);
}

void moveForward() {
  Serial.println("Forward.");
  digitalWrite(motorL1, LOW);
  digitalWrite(motorL2, HIGH);
  digitalWrite(motorR1, LOW);
  digitalWrite(motorR2, HIGH);
}

void moveLeft() {
  Serial.println("Left.");
  digitalWrite(motorL1, LOW);
  digitalWrite(motorL2, HIGH);
  digitalWrite(motorR1, HIGH);
  digitalWrite(motorR2, LOW);
}

void moveRight() {
  Serial.println("Right.");
  digitalWrite(motorL1, HIGH);
  digitalWrite(motorL2, LOW);
  digitalWrite(motorR1, LOW);
  digitalWrite(motorR2, HIGH);
}
```

Chapter 7

FINAL PROJECT

Construction:

PART A: Assigning Microcontroller pins on board: The all sensors and modules i.e Four Ultrasonic Sensors, Motors, Transistors were needed to assigned all the communications lines on the microcontroller and programmed accordingly. We chose pins that fit the physical design and connection of wires and that suited for optimal communication software wise.

Connection Details:

2------>Echo 1

3------>Trig 1

4------>Echo 2

5------>Trig 2

6------>Echo 3

7------>Trig 3

8------>Echo 4

9------>Trig 4

10------>Motor1

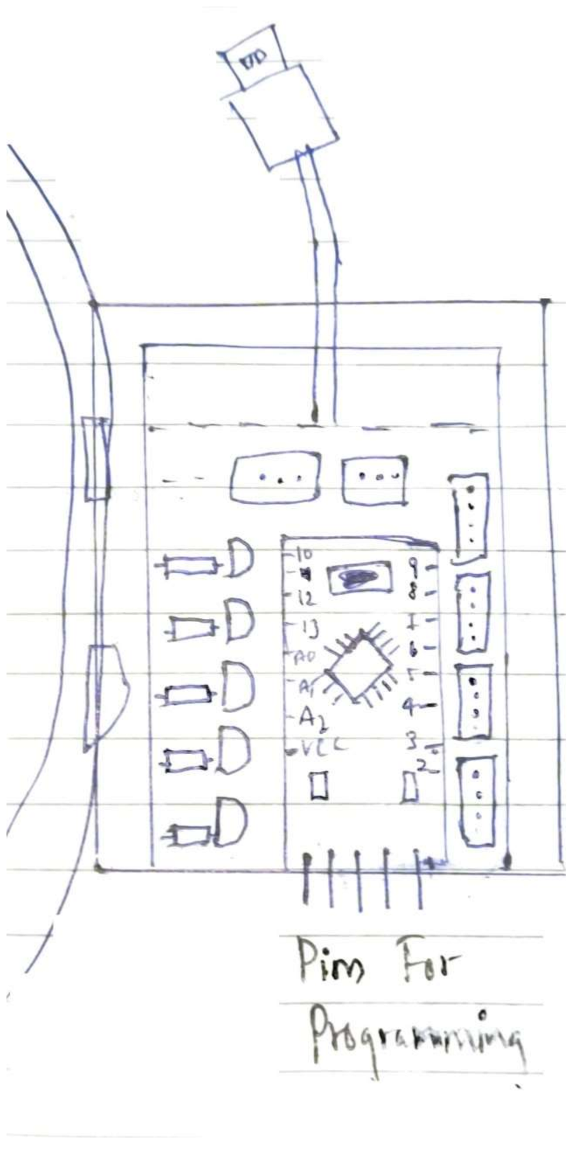
11------>Motor2

12------>Motor3

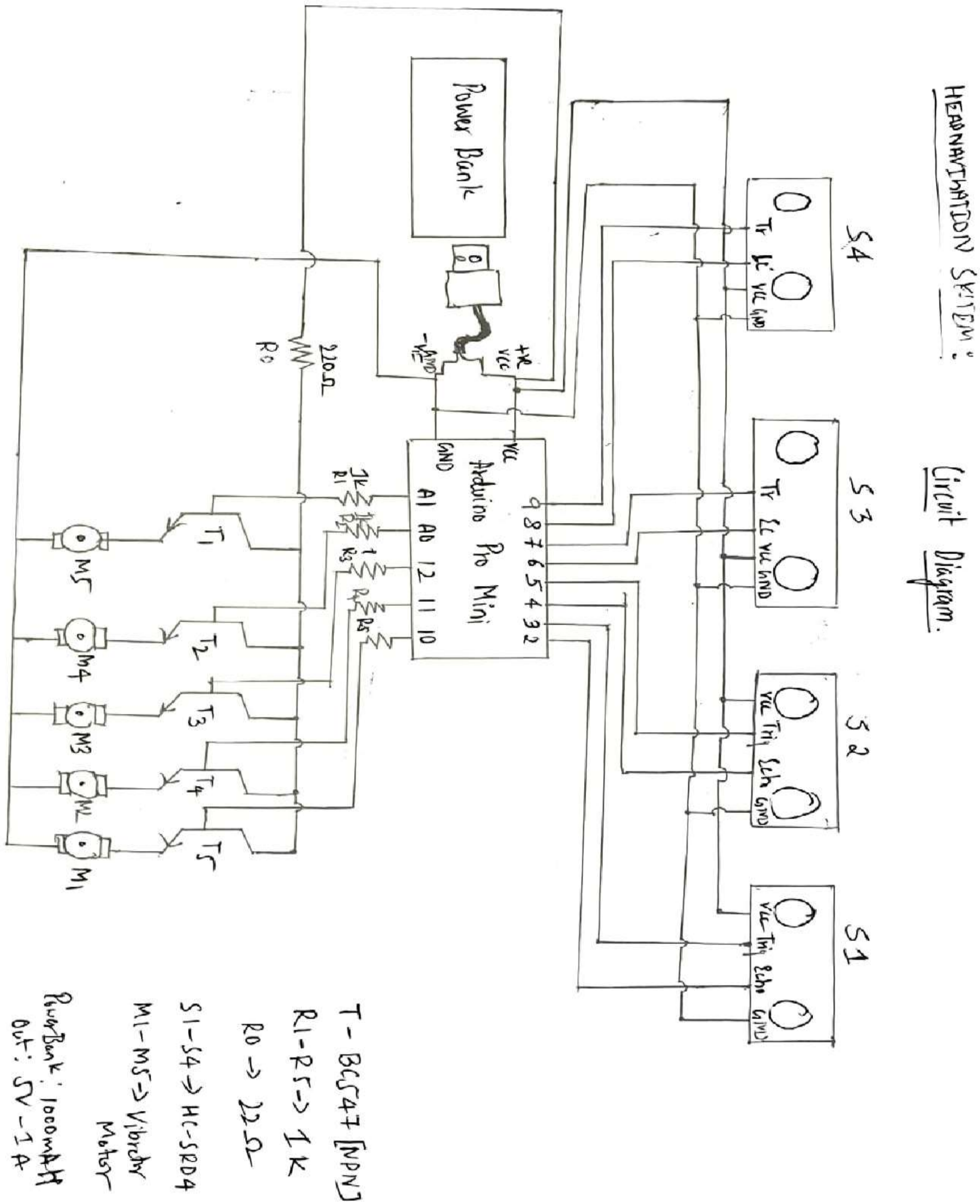
A0------>Motor4

A1------>Motor5

-We Built the PCB Veroboard Design

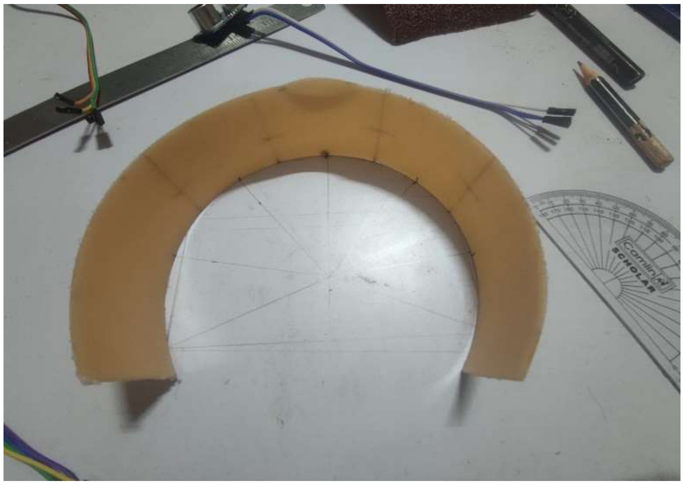
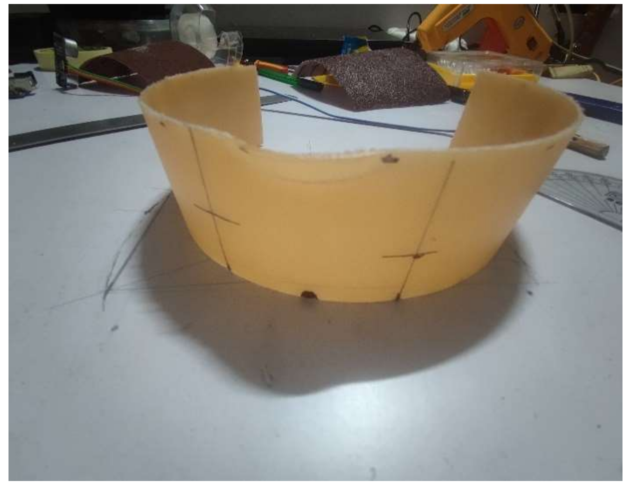


We build the final Circuit Diagram of the project.

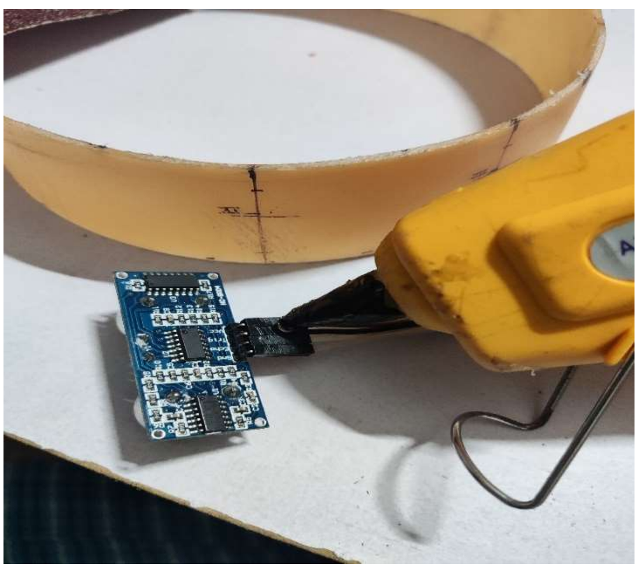
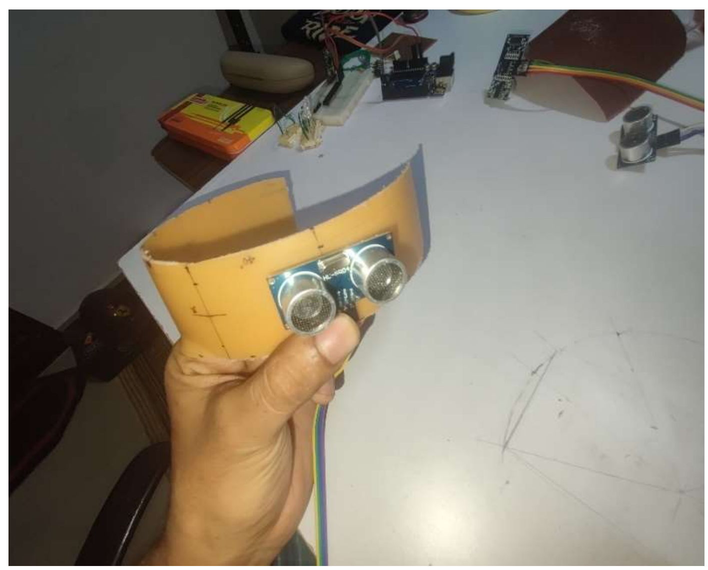


PART A: VISION CROWN

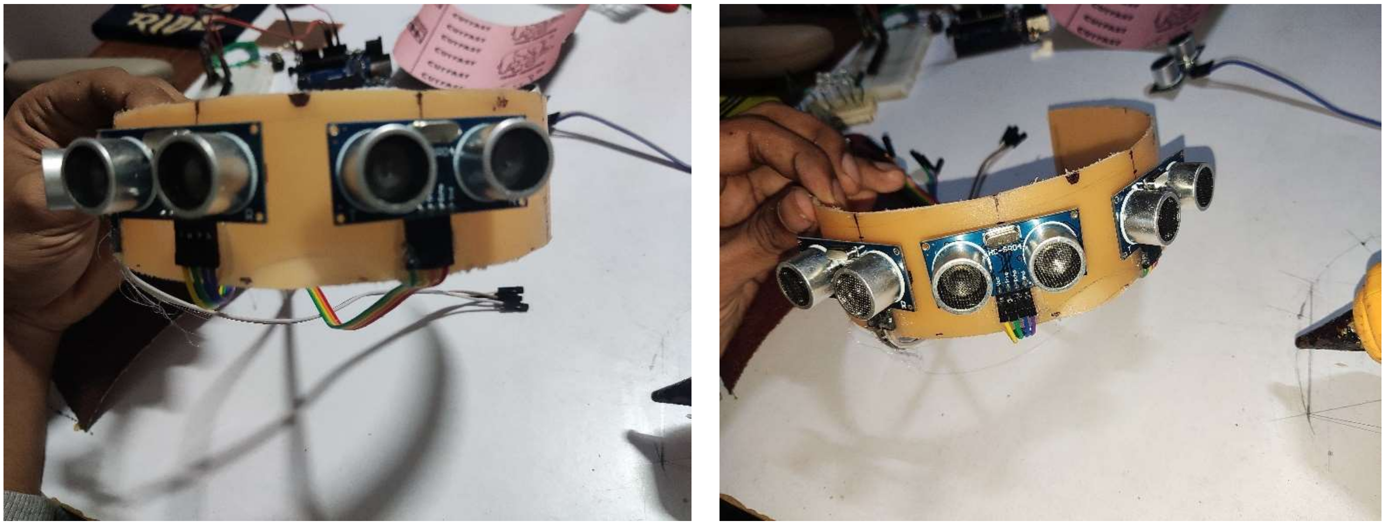
- We 3D printed the fiber Crown with dimensions that fit the human head. The fiber was light and rigid that could hold up the 4 ultrasonic sensors with proper angle markings.
- Sanding of the edges of the fiber after printing was necessary for smooth edges to avoid any cuts.
- All the sensors we were marked with 40Degree mark difference from each position: right, rightfront, leftfront and Left.

b. Marking the Crown with positions of 4 ultrasonic sensors with center of circle method

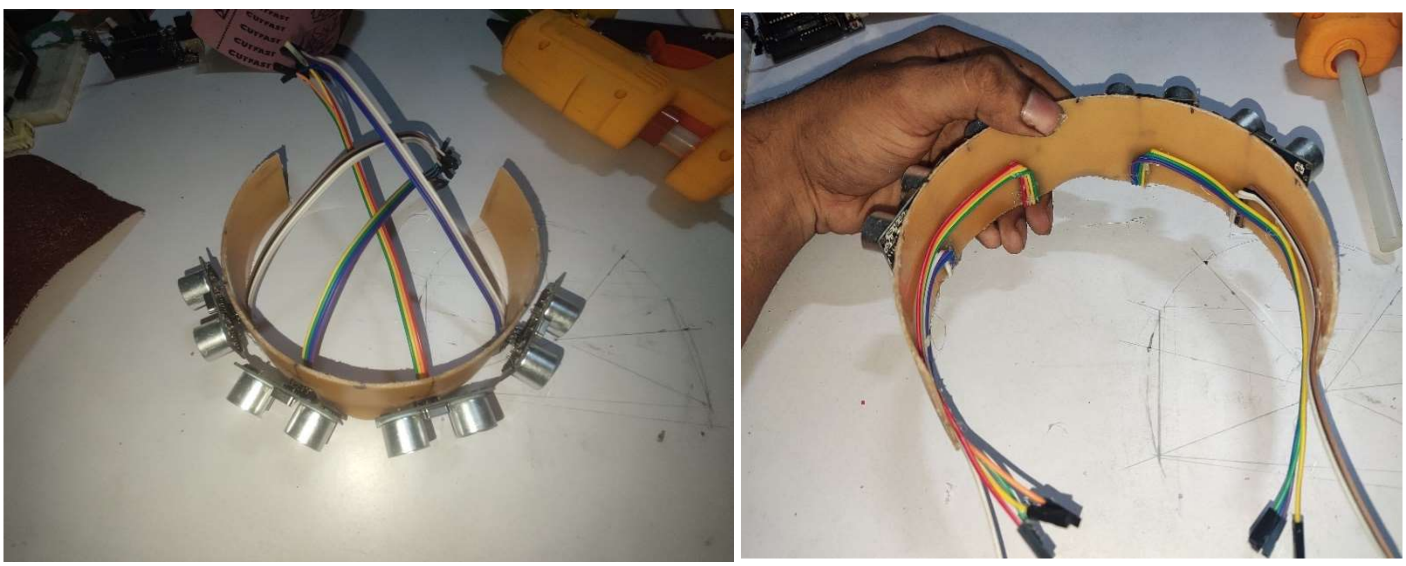



c. HOTGLUE: The sensors were Hot glued at the connected terminals and assembled on the fiber one by one.

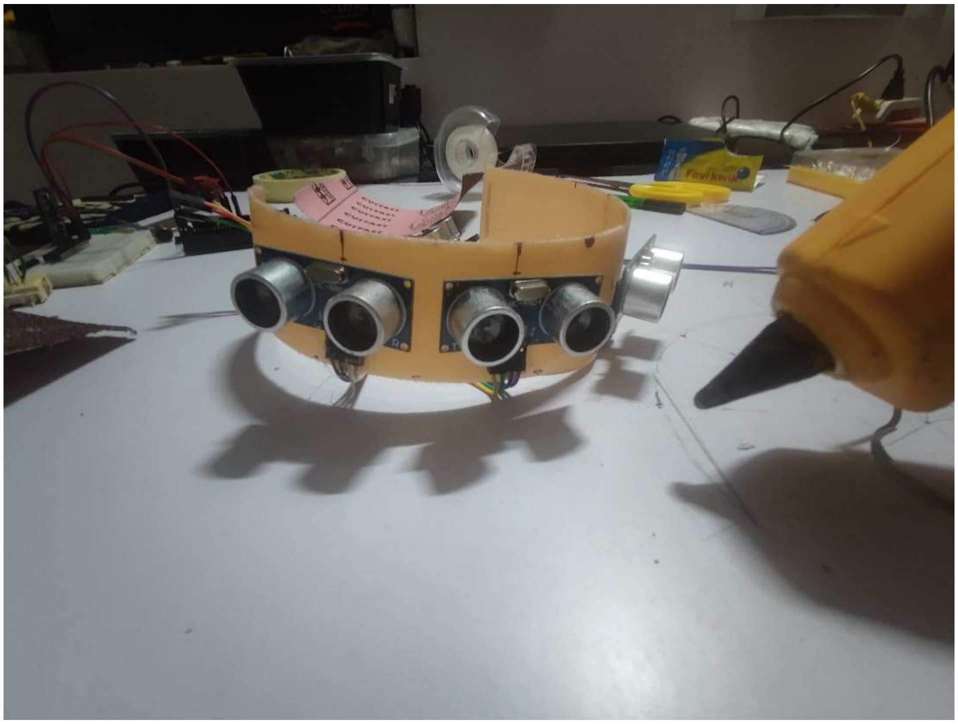


d. Assembled. The angles were reverified after assembly and

any corrections were made.

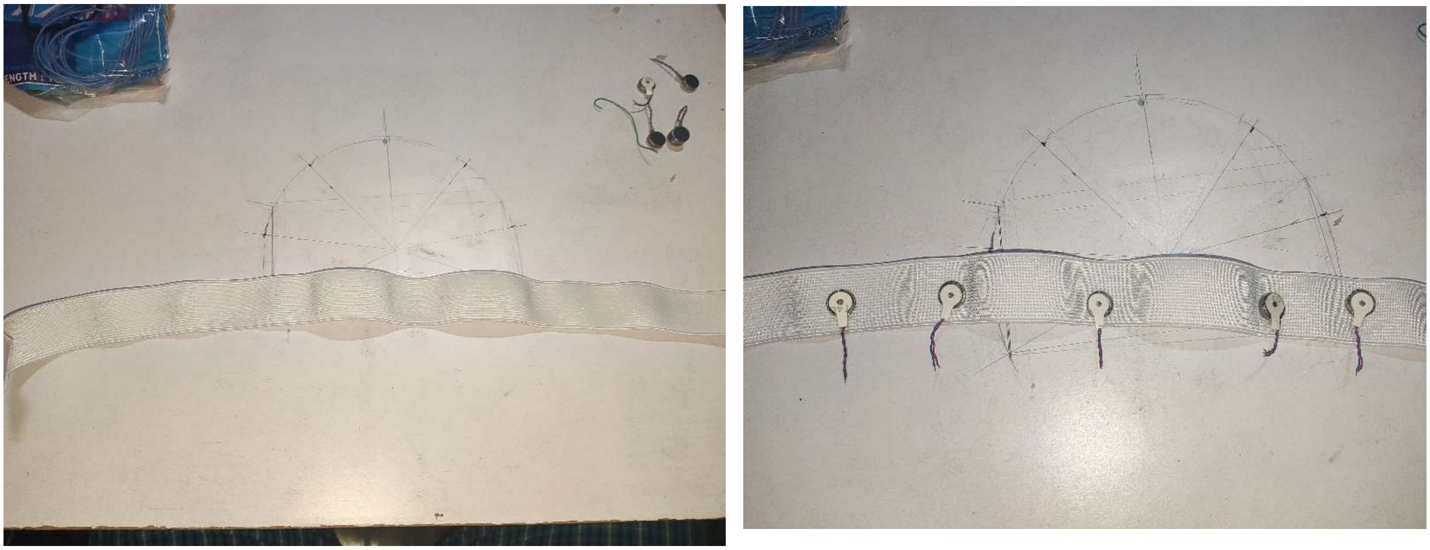


e. Glue the Back cables. The sensor cables were passed from backside of the crown to go through sideways and pass through the band stitching later to the controller directly.

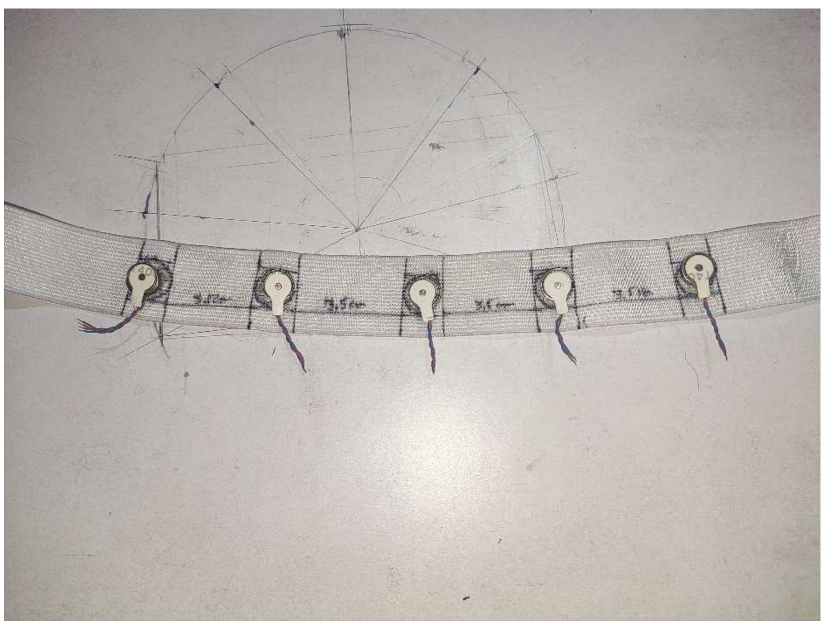


Finished With VISION CROWN.

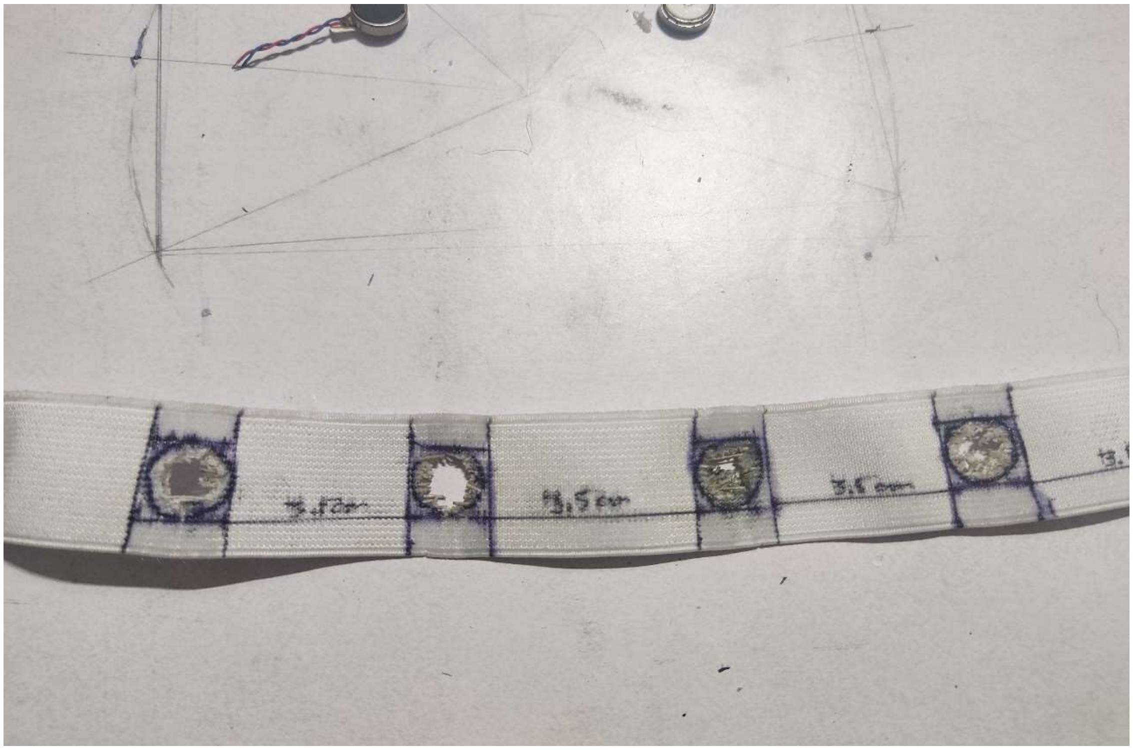
PART B: HAPTIC BAND



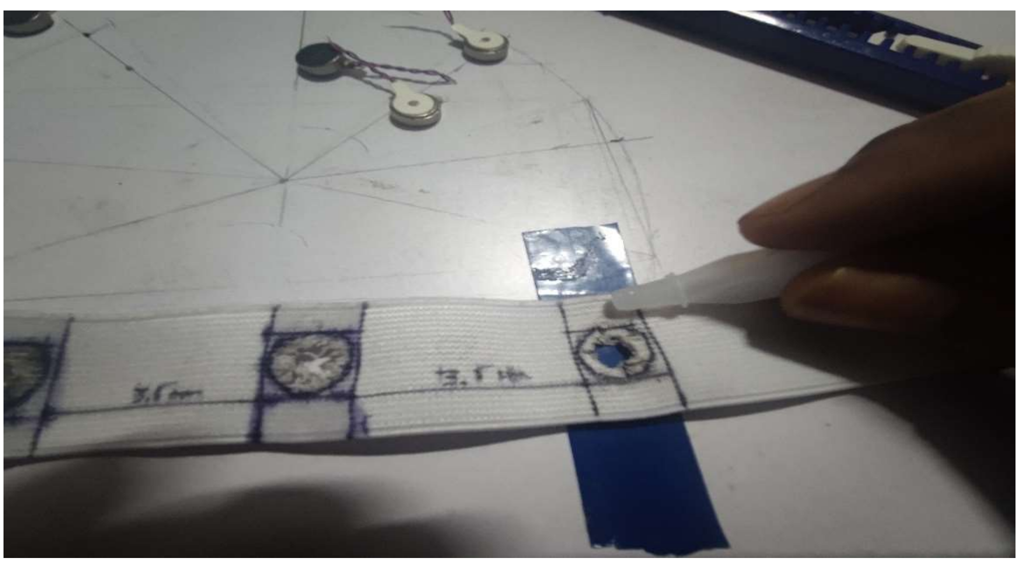
a. Measurement of motors on the elastic Band by scaling on the head with approx 4 cms difference each



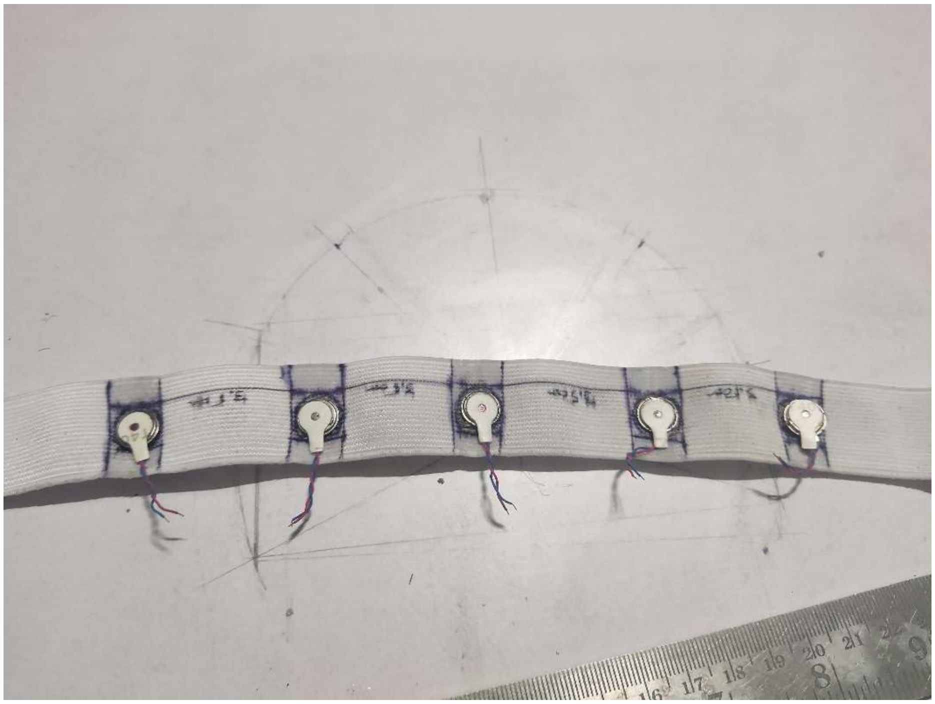
b. Marked with marker, and ready for making holes in the fiber. The drilling was achieved with a heating element of solder gun.



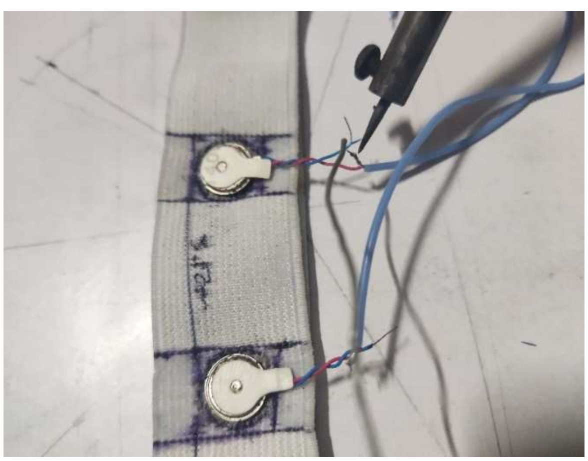
c. Finished Job of Drilling. Some threads were left as a better grip for motor glueing.

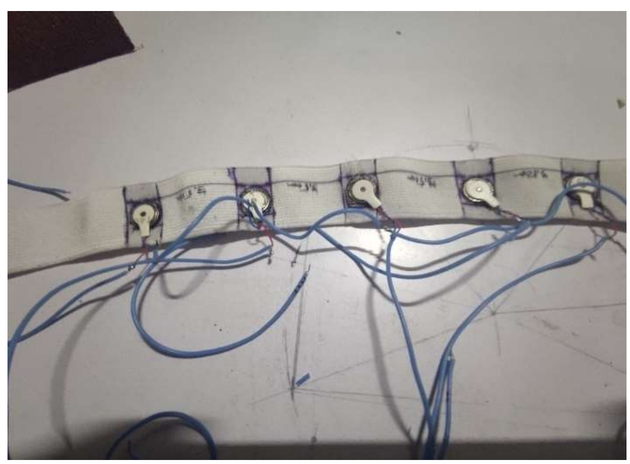


d. The Glueing was done systematically with feviquick to freeze the stretching capabilities of motors area and then Hot Glued to motors after that.

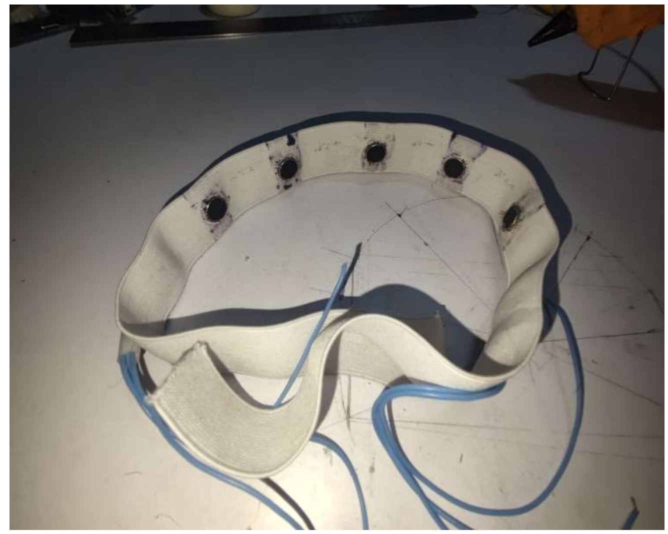


e. The Motors were glued with hot Glue Gun and carefully checked if the fit properly. The Frontal region was examined for over stretching or any sharp points in the fiber.

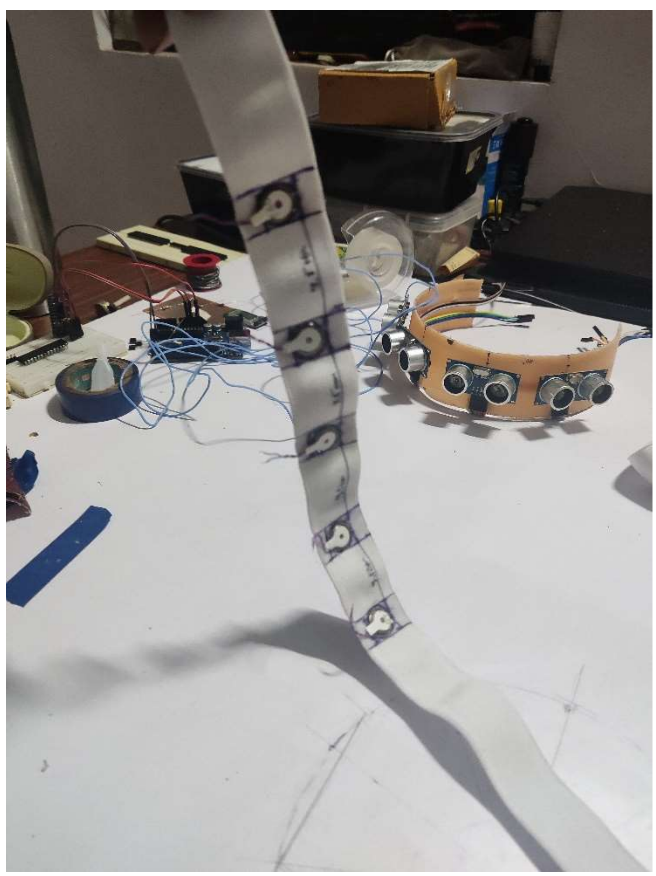




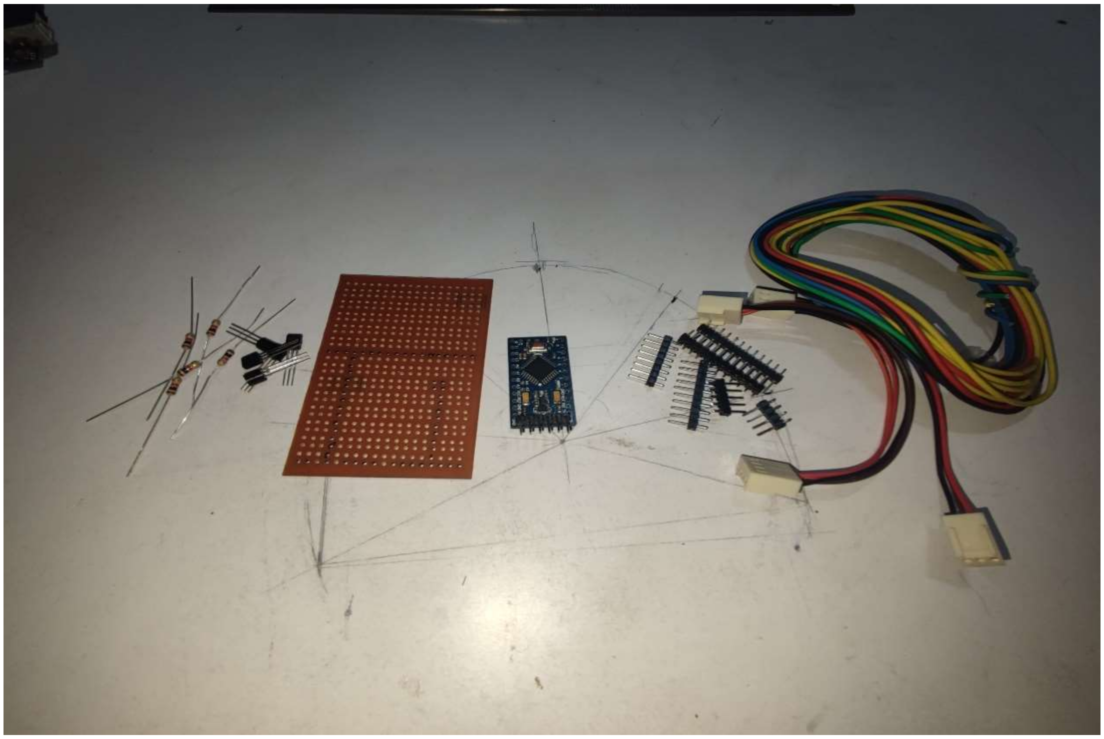
f. Soldering of Wires: All the motors were soldered with soft silicon wires with extra lengths In the void to support stretching of the haptic band. Total 6 wires with **5 wires being control and 1 being common ground.**

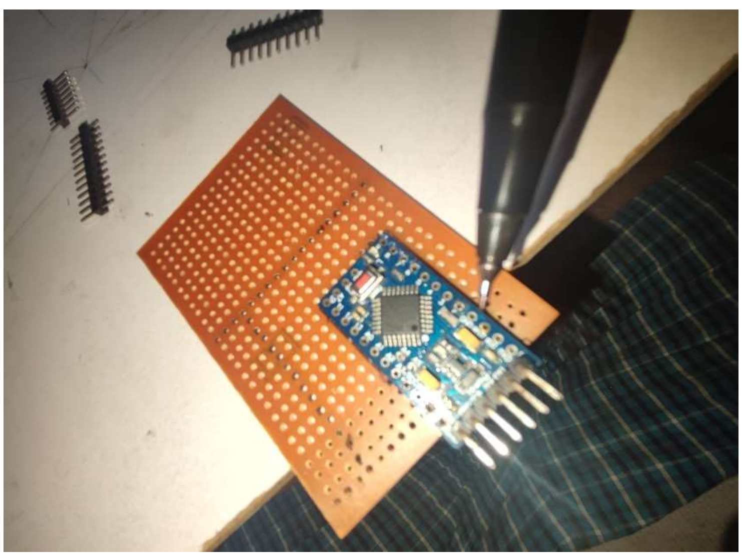


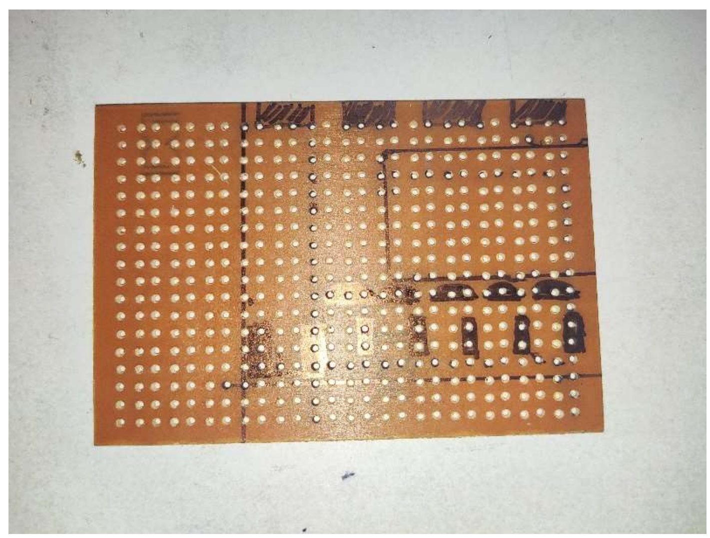
g. Finished. This is the haptic Band looks like



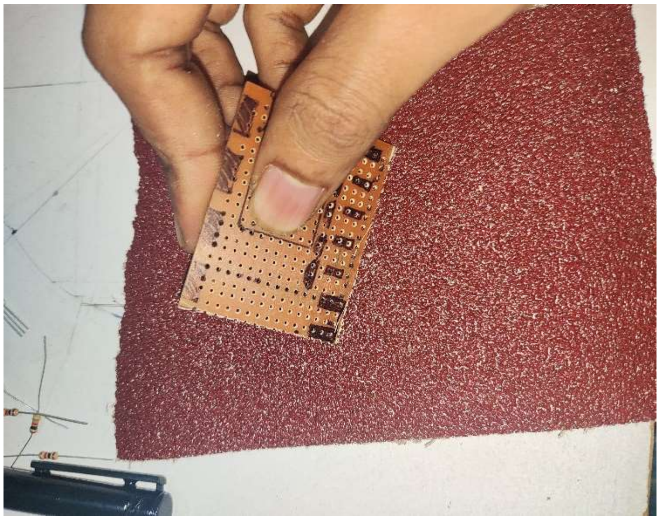
Part C: Electronic Controller

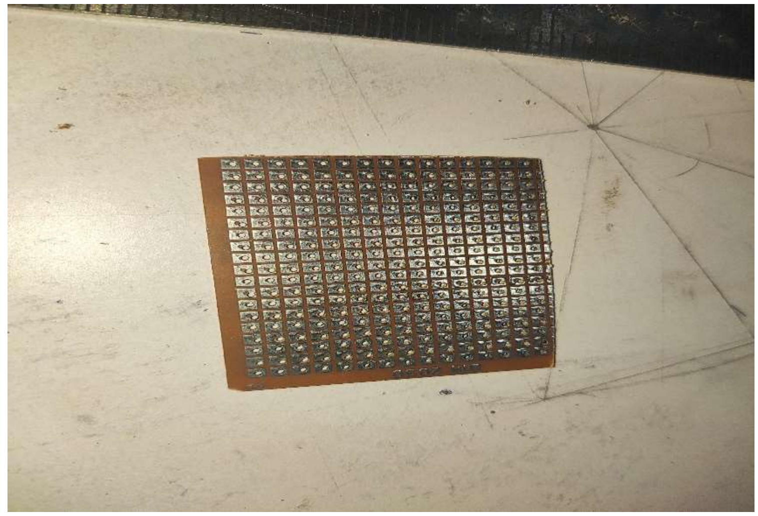




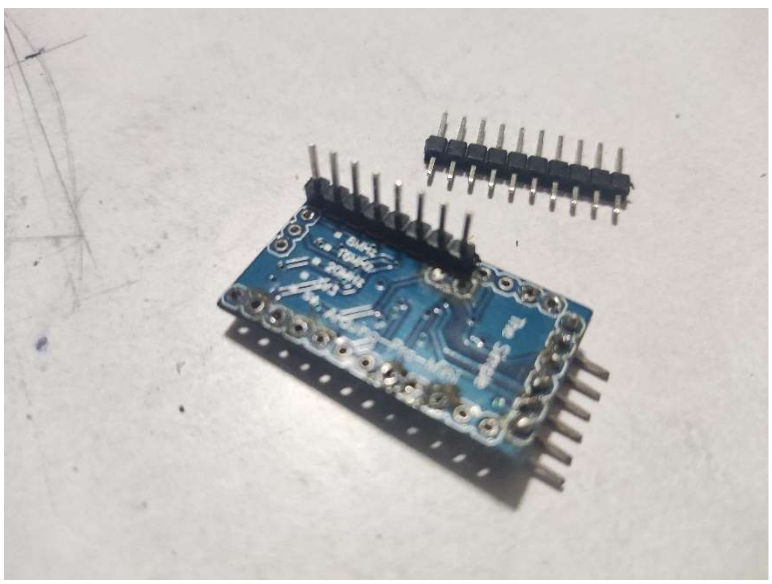


a. Marking and Designing The VeroBoard: The Veroboard was designed according to the mentioned in previous section. It was scaled and then cutted to remove extras.

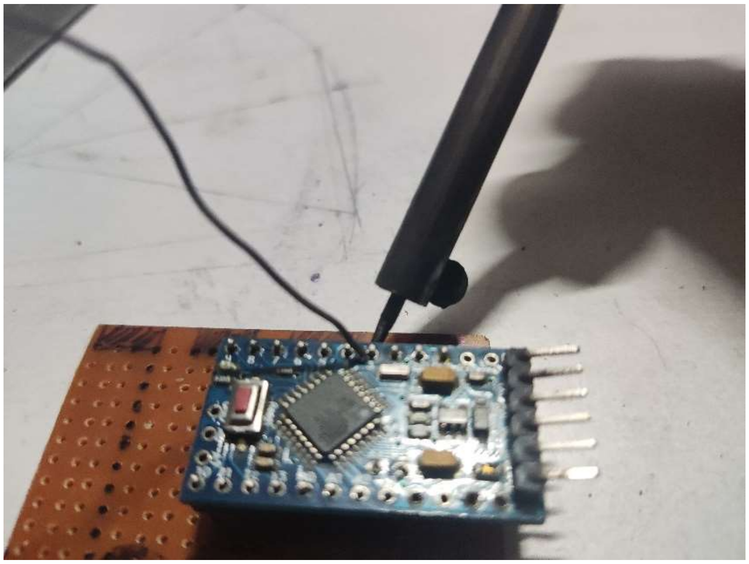


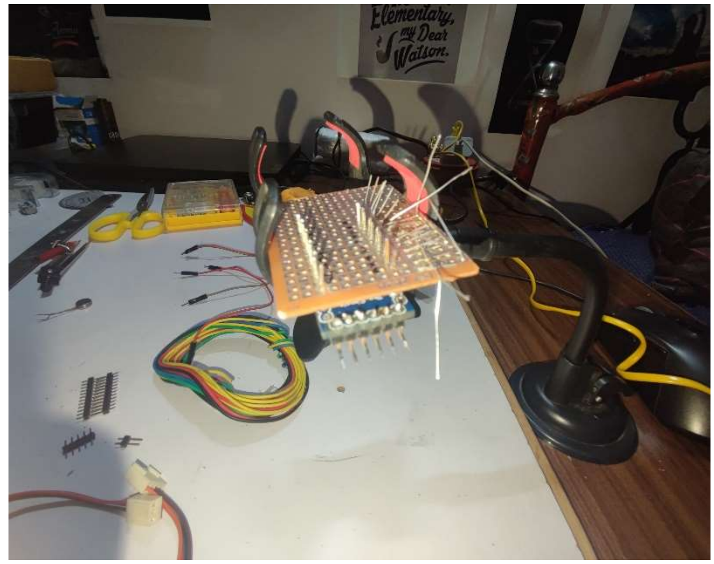


b. Front and Back of End Vero Board with 8 X 7 cms dimensions. With component markings.

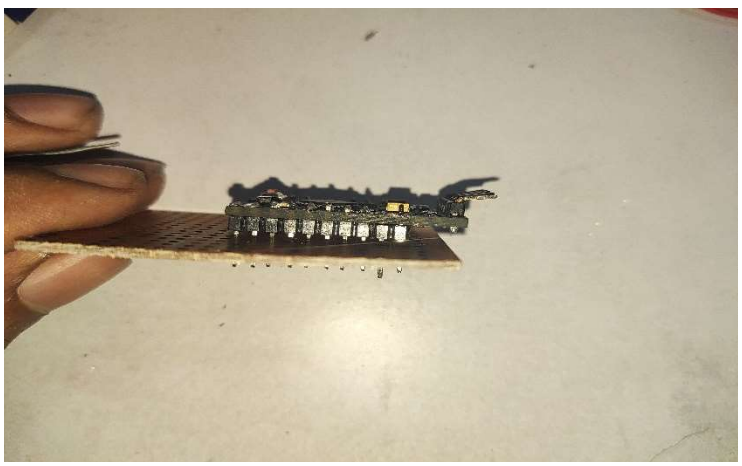


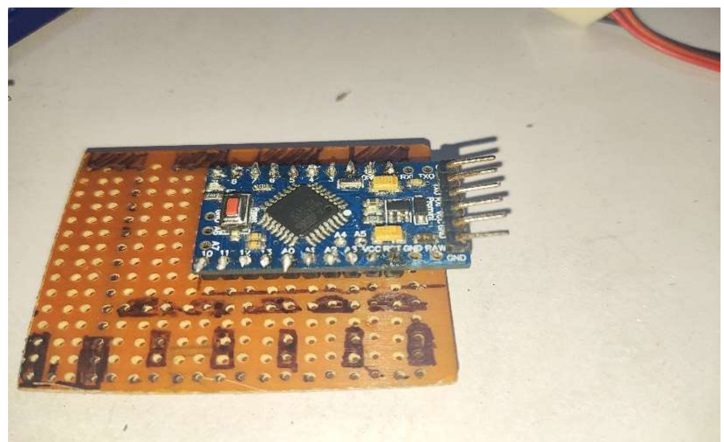
c. Soldering the Arduino: The board was soldered with jump pins and then was ready to be soldered on the Veroboard.

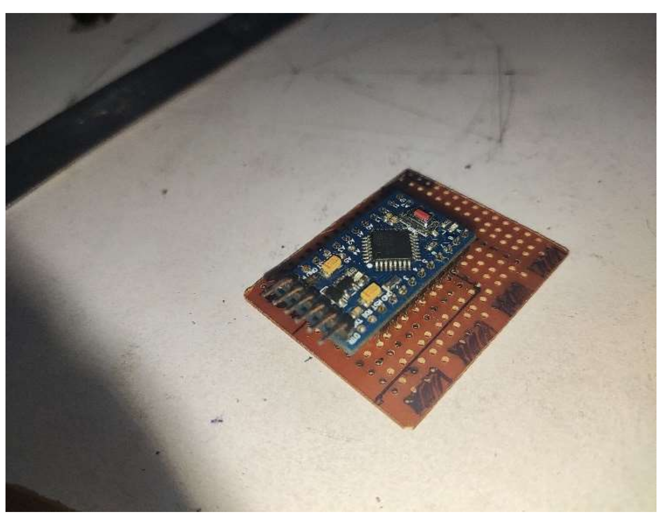


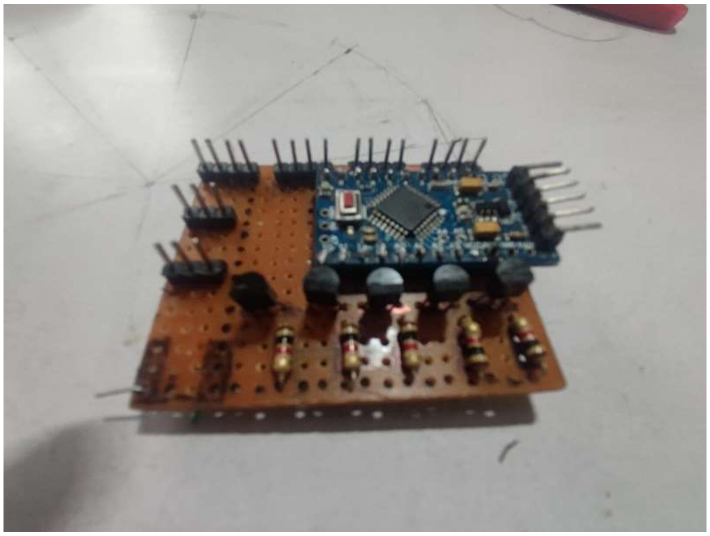


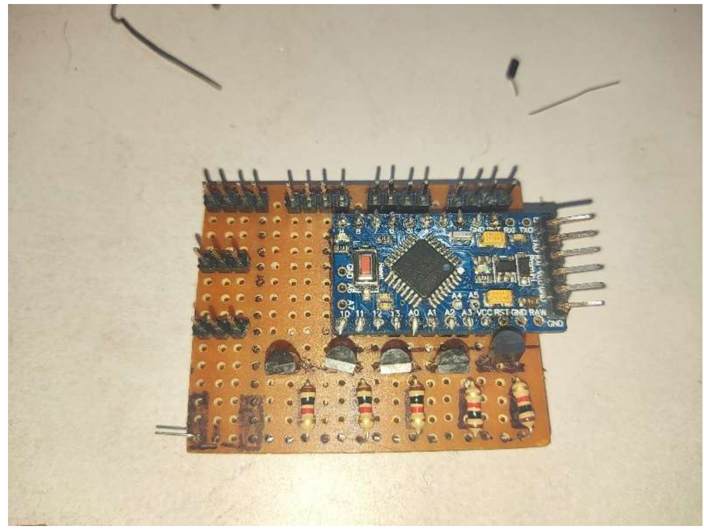
d. The Board was soldered on the board at the centre.





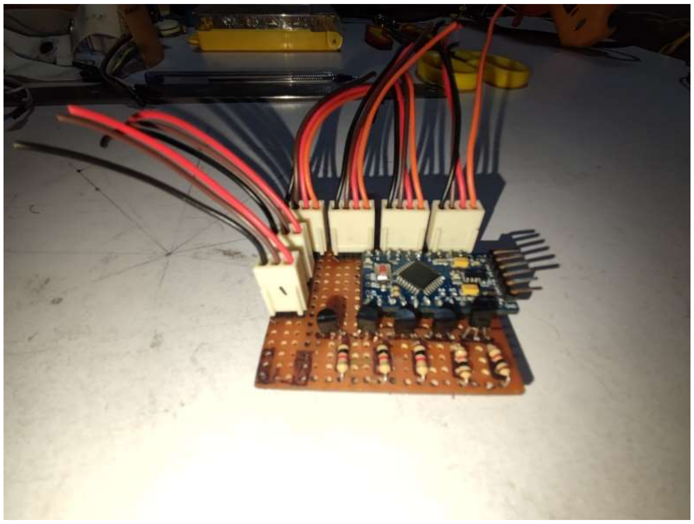


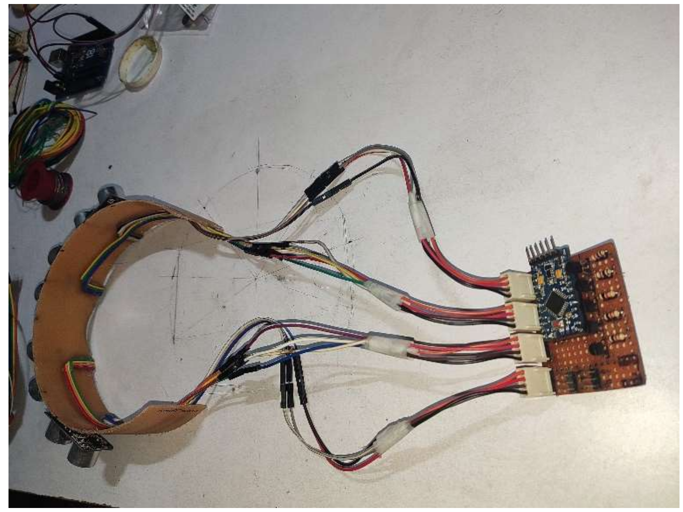




e. Soldering the Rest of the Components & finishing: The

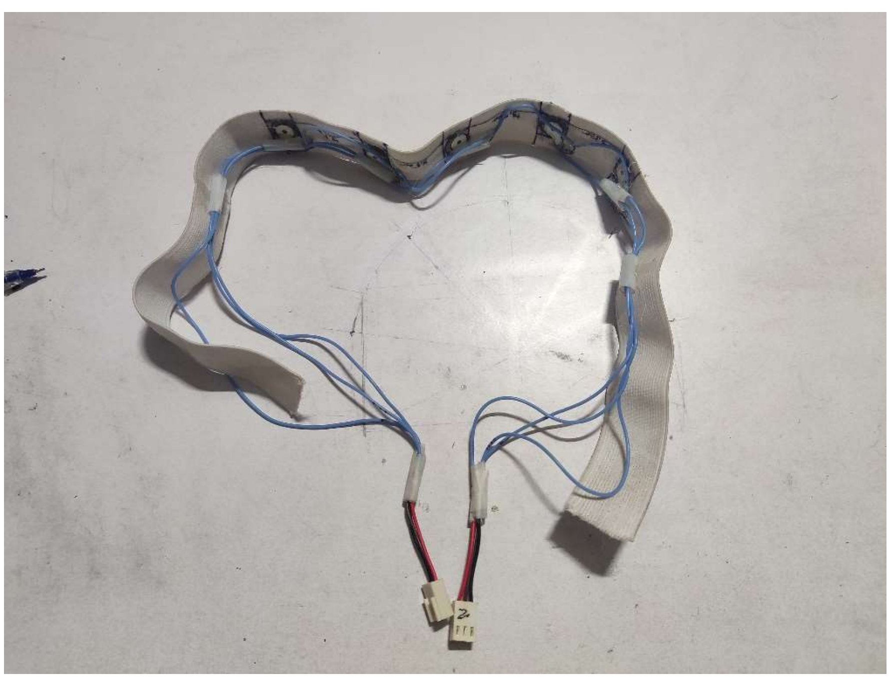
PART D: soldering all the Cables of All Modules





a. All the cables from crown and haptic band and controller were soldered with portables jump cables for final assembly.

b. The connections were tested with multimeters for any loose connections and shortcircuits

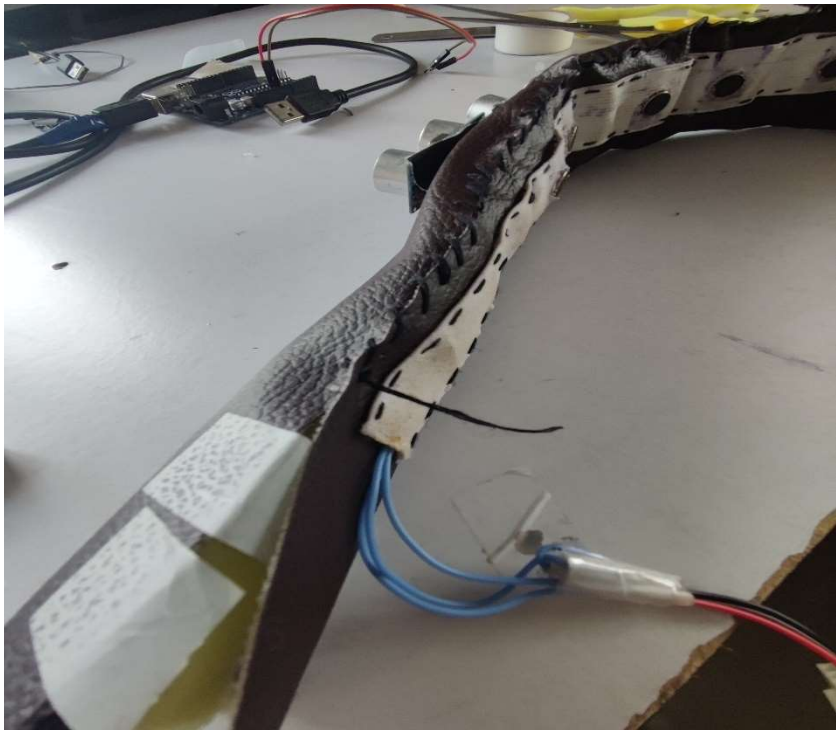


PARD E: Assembling and Stitching of HeadBand

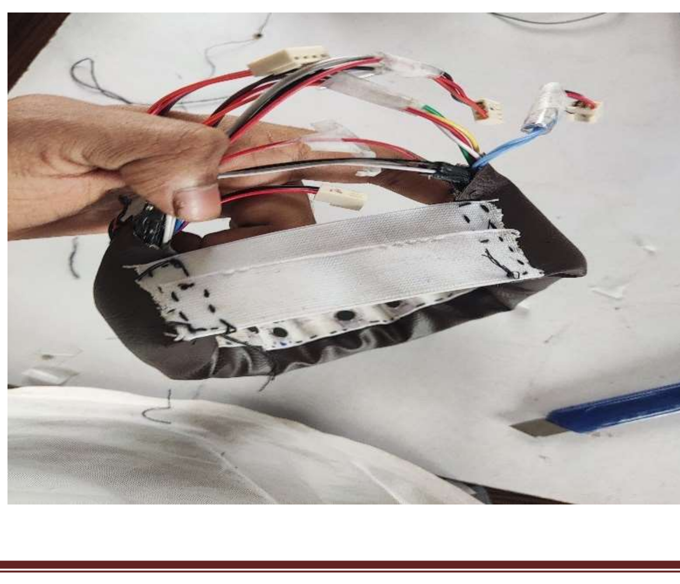
 

a. The haptic Band was first stitched to the inner part of the fiber band with proper position to fit the forehead.
b. The wires were embedded inside with enough space to let the wires stretch freely.

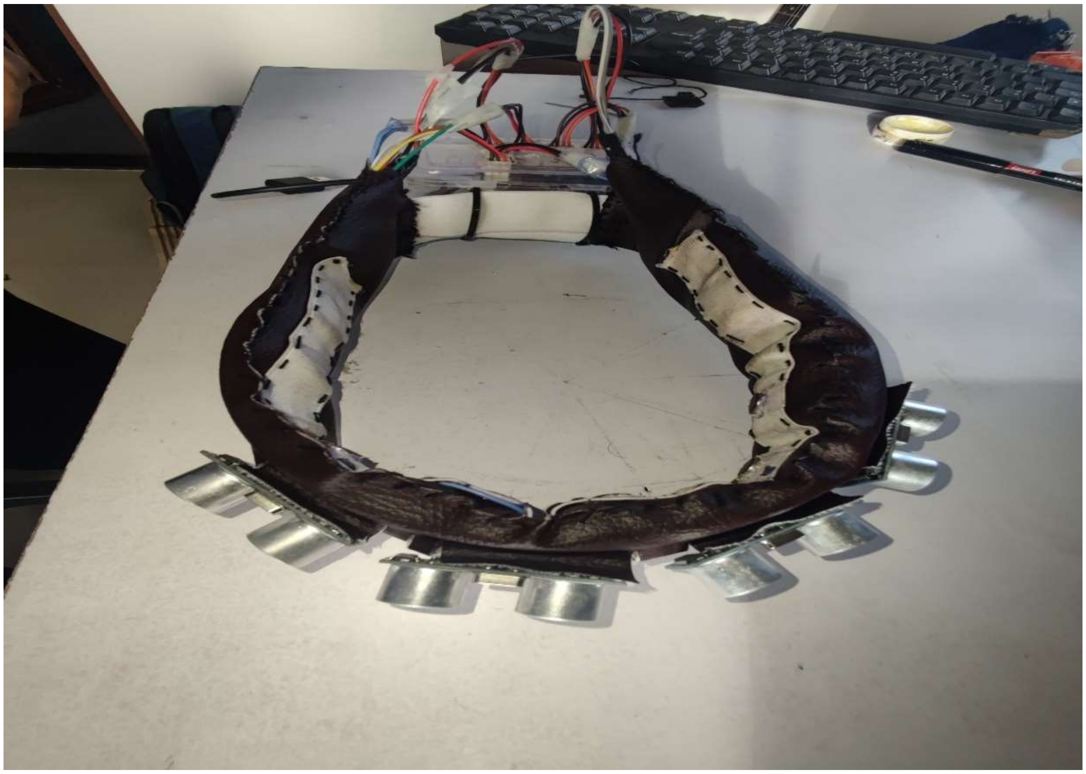
c. Then the Vision crown was inserted inside with slots to let the sensor come out and placed properly.
The fiber was provided with proper cushions to accommodate the fiber without any sharp edges.



d. The Band was then stitched further to enclose the fiber and the openings



e. The band was closed with stretching elastic at the back and for the assembly of controller module.



f. The electronic controller was then assembled at the back with proper connectors for support and all the cables were connected.

FINAL ASSEMBLY

Chapter 8

SOFTWARE DESCRIPTION

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board . you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

The Arduino hardware and software was designed for artists, designers, hobbyists,hackers, newbies, and anyone interested in creating interactive objects or environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or your TV! This flexibility combined with the fact that the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn has led to a large community of users who have contributed code and released instructions for a **huge** variety of Arduino-based projects.

Chapter 9

COST ESTIMATION

S.NO	DESCRIPTION	PRICE	QUANTITY	AMOUNT
1	Arduino pro mini	Rs 1,200,00	1	Rs 1,200,00
2	Vibrating Motors	Rs 70	5	Rs 350.00
3	HC SR04 Ultrasonic Sensors	Rs 150	4	Rs 750.00
4	Wires and Jump Cables	Rs 400		Rs 400.00
5	3D Printed Fiber Crown	Rs 500	1	Rs 500.00
6	Elastic Bands and Stitching tools	Rs 300		Rs 300.00
7	PCB VERO Board, Active Components- BC547 X 5 1K ohm Resistors etc	Rs 530		Rs 530.00
8	Power Unit	Rs 200	1	Rs.200.00

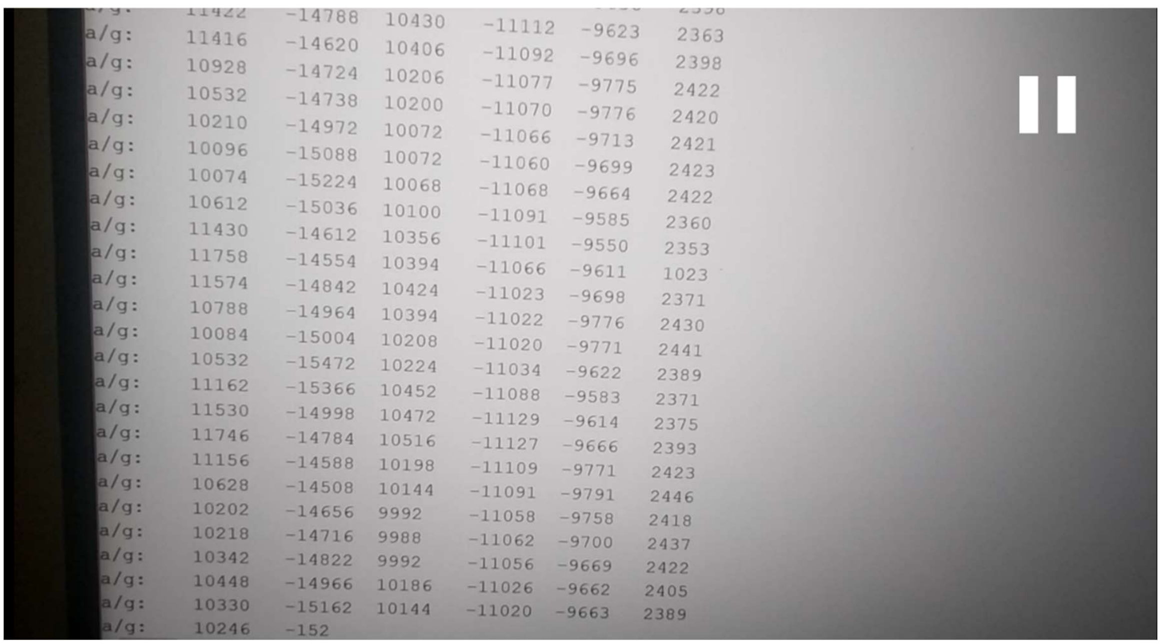
9	Band Leather	Rs. 480	1	Rs 480.00
10	Tools and accessories and Miscellaneous Costs	Rs 840		Rs 840.00
		Subtotal GST (18%)		Rs 5,550.00 Rs 999.00
		Total		**Rs 6,549.00**

Chapter 10

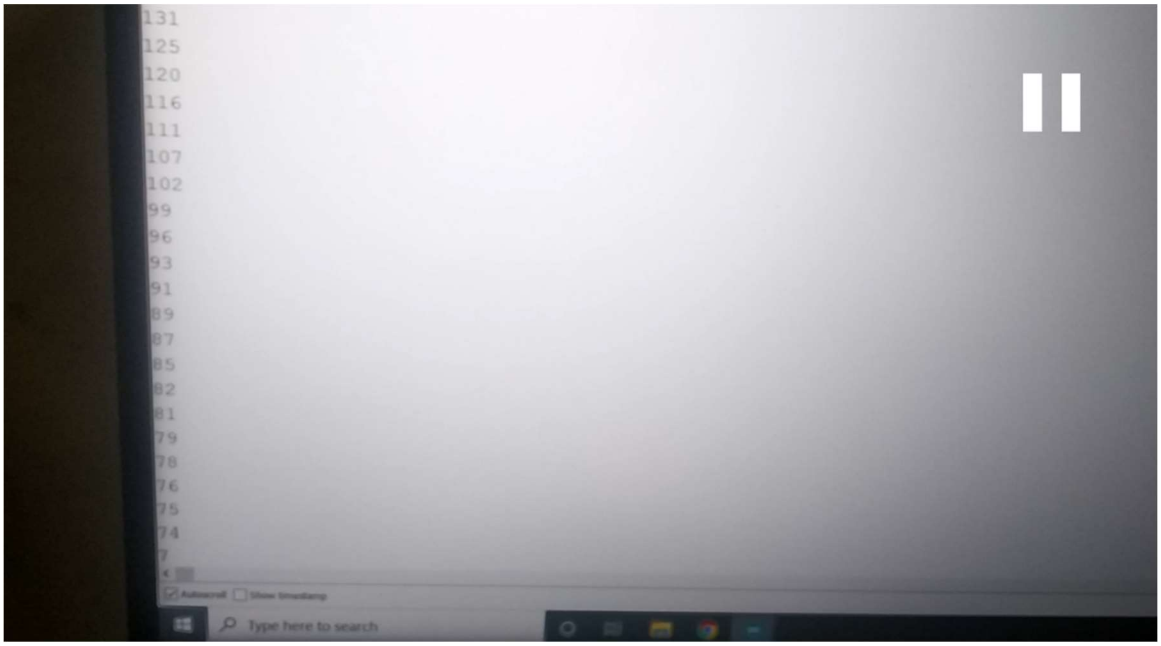
OUTPUT:

The output of our developed code was obtained in the development phase before assembling. The output was recorded as the response of the input sensors capturing the data for calculation and algorithms from sensors and executing the vibrations.

The Output Is produced by the Arduino IDE software console and screenshots were captured.



Pic: OUTPUT OF Ultrasonic Sensors Feeding into our algorithm in Arduino Pro mini



Pic: output of vibrations rates from different motors patterns that were being calculated.

RESULTS AND CONCLUSION

- The aim of this work is to provide anyone in need for a hands-free Navigation System with an inexpensive, full-featured mouse. Particularly, it is addressed to special needs people so that they could have access to information technologies just as average people.

- The proposed Head Mounted, Sonar-based, Navigation has been designed to be like any other regular computer mouse, ready to use with any application on any platform.
- The resulting device fully emulates a conventional computer mouse and it is the first of its class that does not require any specific driver or software installation.

- In fact, this is one of the main differences with other devices such as the well-known Smart Nav. The other is that it is an open device that can be built by following the instructions on the web http://www.earmouz.org, which also contains the embedded software to download, the user's guide, and complementary information about the project.

- The device has been validated with a series of informal, empirical tests at exhibits and specialized centers. Tests consisted of asking users a few tasks like following a link on a web page already opened on the screen or opening an application just after being guided through the device setup.
- The first round of tests with real devices had been carried out at our lab, at the Barcelona Mini Maker Faire (2014) and at a center that work with disabled people. People were asked to wear the device, guided through the calibration procedure and told how to use it.
- After observation of tests, they were asked to give their opinion about the device. At our lab and at the fair, all volunteers managed to use the devices after less than a minute but found some operations like scrolling and dragging a bit difficult.
- In the case of the center for the disabled people, we found out that the version that mimicked the head movement was not suitable for those who couldn't control it (e.g. could not manage to click on an icon on the screen because they could not keep the cursor still) or who had to move it slowly. In fact, people suffering from nervous illnesses that led to hand impairment have several degrees of tremors that hinder the usage of any pointing device, including ours.
- An added difficulty for testing the device with special needs' people is that, among the ones that can use some mouse-like device, most of them were already using one such device and were not keen to using a new one. Indeed, depending on their capabilities, learning how to use a new device is a long and hard process, hence something worth a second thought. The new one proved to be more easy-to-learn and robust.

Chapter 11

ADVANTAGES

- The use of this Band helps the people with special needs to walk without the use of hand and it is cost effective.
- A potential wearable technology for lazy people who do not wish to use hands.
- It can be used for old people with poor vision.
- It can also be used in industries.
- It can be used in railway stations, airports.
- It can also used in commercial places such as shops, hospitals ,offices etc.

FUTURE SCOPE

This system could further developed to support different environment conditions like indoors, offices, more varying patterns and improve the detection for different objects using computer vision. With more patterns variance the device could be more universal.

APPLICATION

The Headband systems could be upgraded to further application like other works apart from navigations like Sports, or reading, Gaming and applications where haptic feedback vision could be applied and used to aid Blind people.

The Headbands can also be applied for entertainment industries for normal humans to enhance user experience by using haptic feedback as additional sensory.

Chapter 12

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[18] “Dropcam pro review: Enhance your wi-fi video like a crime-scene investigator - techhive,” 2013.