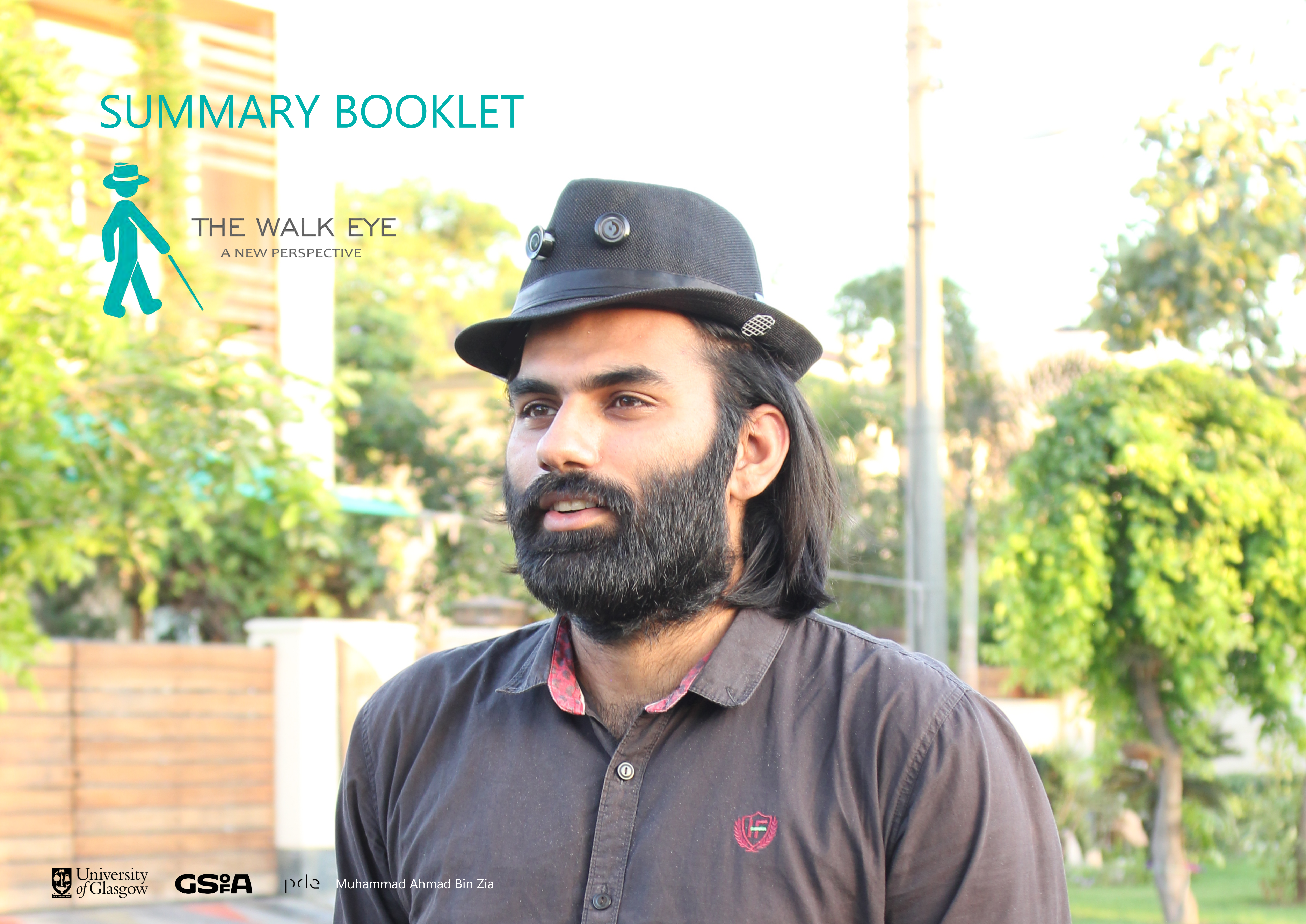
SUMMARY BOOKLET

THE WALK EYE

A NEW PERSPECTIVE



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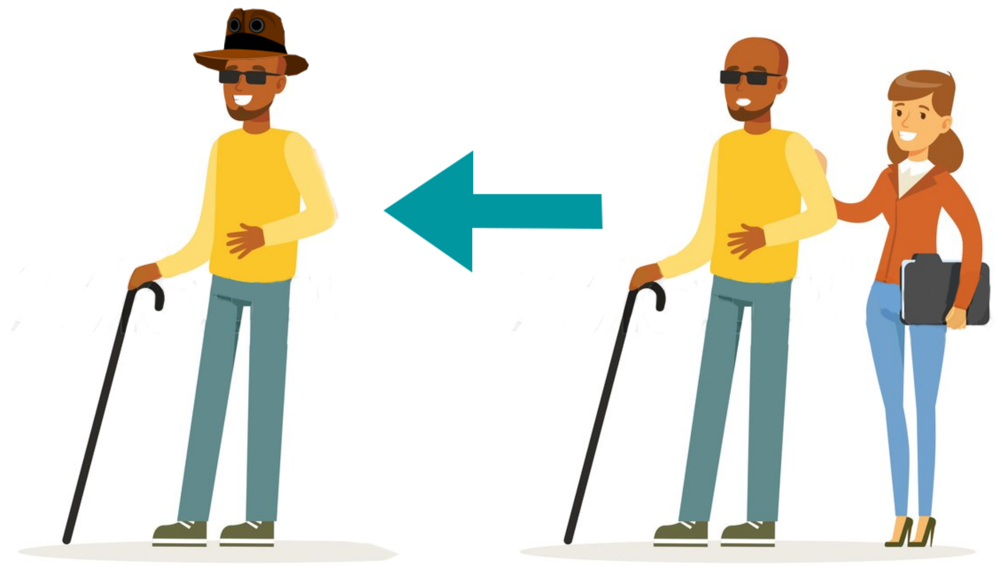
PRODUCT INTRODUCTION

The Walk Eye is a smart hat which aims to increase the mobility of visually impaired people (VIPs). The smart device designed, works in coherence with the user's skills and forms a highly reliable obstacle avoidance/ guidance system.



The system employs a set of Ultrasonic sensors to detect obstacles and notify the user about the direction, proximity and motion of obstacles ahead of them. The user is alerted by sounds emitted through speakers or by vibrations on special bone conduction points.

The user has the option to shift between these two output modes. Mostly the alerts are used to second the user's intuition. The product stops beeping if an obstacle distance has not changed in 10 sec, this is so that when the user is having a conversation with someone the system will not keep bothering them.

THE PROBLEM

Vision impairment has a significant negative effect on quality of life. People with vision impairment have lower rates of job involvement and lower productivity, as well as high rates of depression and anxiety. Visual impairment in the elderly human often leads to social isolation, difficulty walking, a higher risk of falls and fractures, and a higher probability of entering nursing or care homes early.

Most visually impaired people (VIP) depend on others to perform daily activities. It is very hard for them to do simple tasks like walking on busy roads or even in new indoor environments. As the major sensory organ of a person is their eyes VIP have much lesser access to information. Normal mishaps keep happening like stumbling upon an office chair that was not neatly tucked under the desk or knocking a glass off the table because it was left right on the edge.

THE USER

285 Million People

- **90%** are from developing nations
- From these **36 Million** People are Blind
- **82%** of all blind people are **50 years** or older.

SUPPORT TOOLS

EXISTING SOLUTIONS

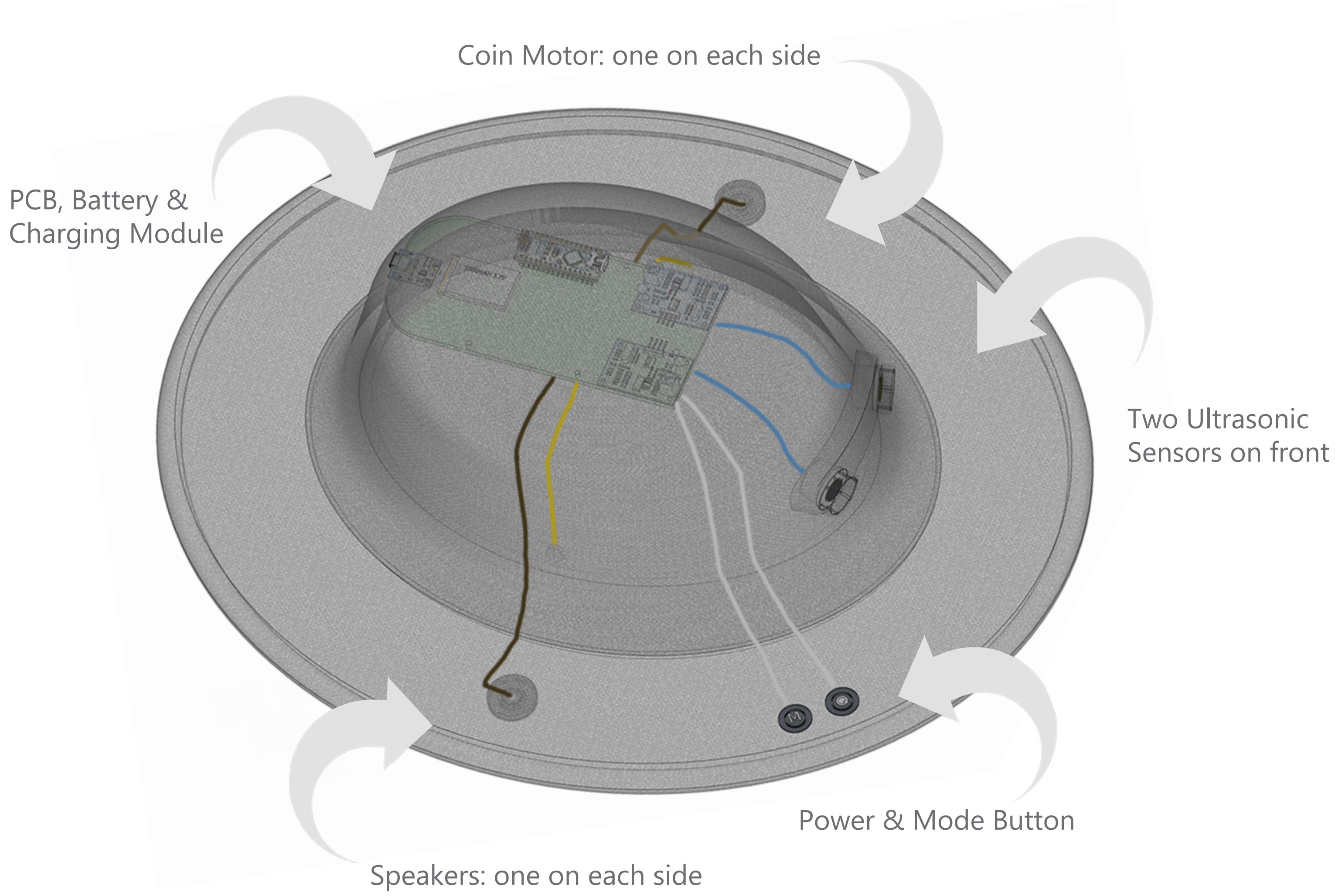
Hundreds of products exist and many researches are ongoing. **90%** of this work is being done in developed countries and it is not suitable for the chaotic environment of developing countries like Pakistan. A clear gap is found for a user centric product which is easy to understand and assist the user in their day-to-day life.

THE BRIEF:

Design a economical user friendly product to increase the mobility of Visually Impaired Individuals

- Focusing on users from third world countries.

THE WALK EYE - Guidance system for the visually impaired

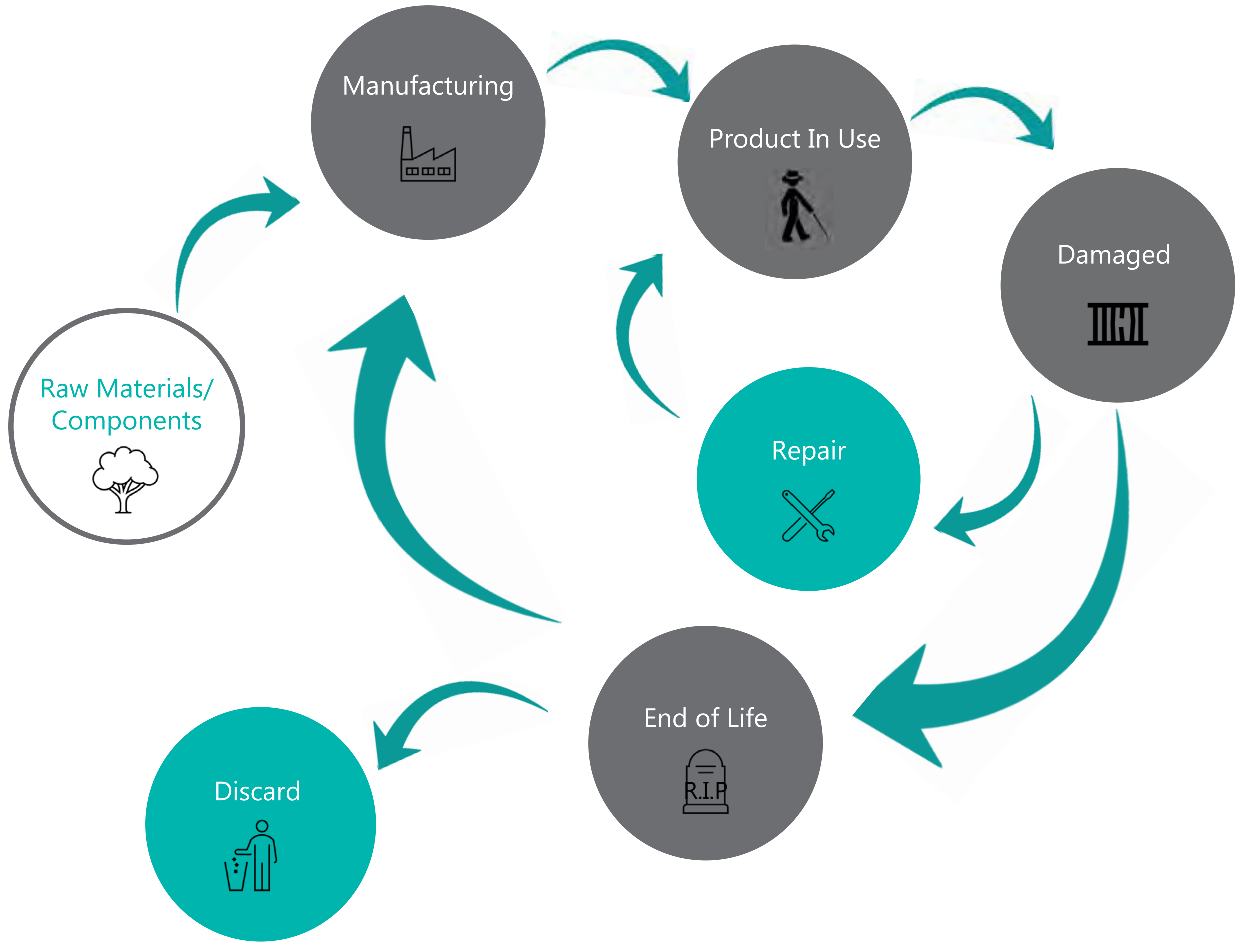


KEY FEATURES

. Obstacle proximity indication within **2.5 m** range.
. **90˚** frontal obstacle detection & direction indication.
. Vertical detection beam covers area from user's head to waist.
. Interchangeable sound and vibration output modes.
. Battery percentage indication through voice notes.
. Fluorescent indicator on the back side for user safety.
. Stops beeping if obstacle distance hasn't changed in **10 seconds**.
. **10 - 12 hr.** Battery life.

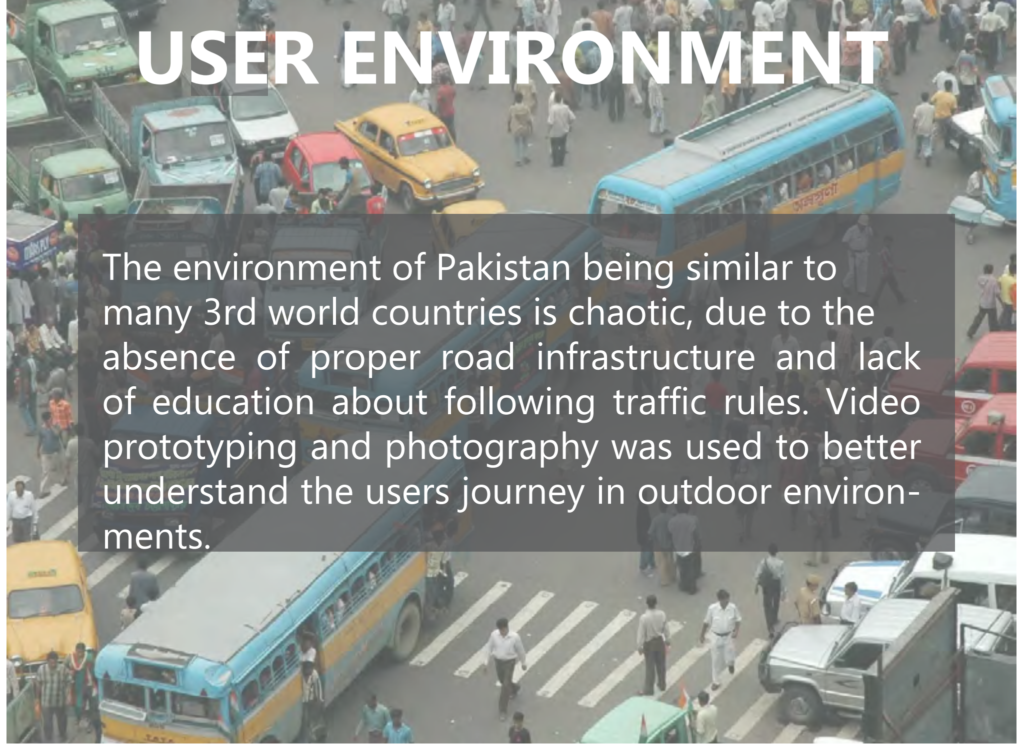
P.s. It's not just a guidance system, it's a fashion statement!

PRODUCT LIFE CYCLE



SELLING POINTS

The Walk Eye presents multiple advantages over existing products. Apart from having aesthetic benefits and being waterproof, the product benefits from its **low learning curve**. The learning curve is kept low as most users are above the age of 50. The product is also extremely **lightweight (250g)** as it has to be used throughout the day. It is made **economical** as is primarily to be used by people in 3rd world countries.



USER ENVIRONMENT

The environment of Pakistan being similar to many 3rd world countries is chaotic, due to the absence of proper road infrastructure and lack of education about following traffic rules. Video prototyping and photography was used to better understand the users journey in outdoor environments.

RESEARCH

To understand the user's problems, multiple interviews were conducted. Through research, user interviews and empathetic modeling a set of design requirements were achieved.

Empathic test showed that the white cane is a strong tool, which gives the user a lot of information about the environment. The major concern is that it only does detection below waist high. I also understood how much information the user can gain from listening to the environment so the designed device should allow the user to hear their surroundings.

DESIGN SPECIFICATION

Functional Performance: The device must identify all the obstacles in the persons path. It needs to provide simple and clear feedback.

Geometrical Constraints: The smallest possible form factor is preferred. The device must not occupy the user's hands.

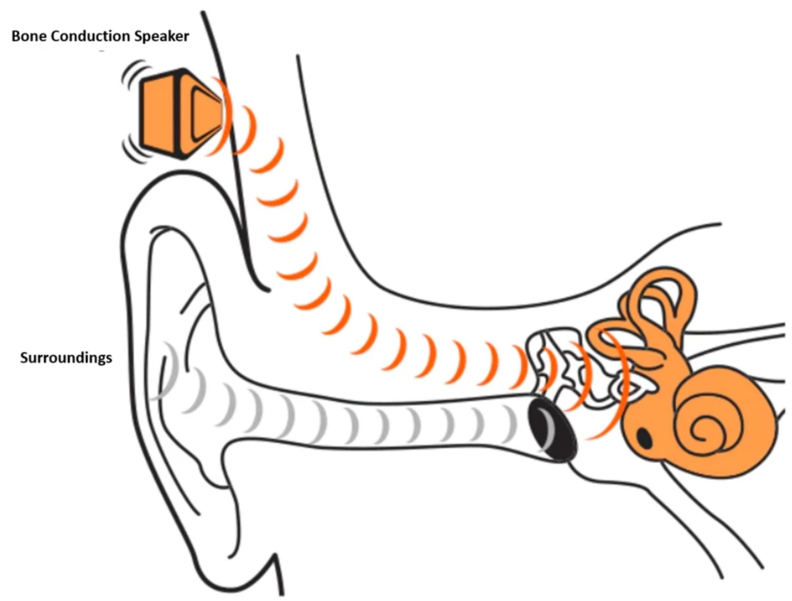
Physical characteristics & Ergonomics: The device designed should be light weight and ergonomically strong as most of the existing product's lag in this area.

Safety: The proposed solution must not have any adverse effects on the user's health and wellbeing. The device must be safe for the user and the people in their surrounding.

Cost: The initial and running costs of the device are one of the biggest constraints in the project as the primary users are from developing countries with limited buying power.

Recycling: Environmental effects are a key aspect of every large-scale project. A circular system must be designed to minimize the adverse environmental effects from manufacturing.

TECHNICAL RESEARCH



Vibrations on bone conduction points are used to provide feedback to the user. The points on temporal bones (above the users ears) are used. The user gets the feedback while still being able to hear their environment. It is also suitable for noisy environments.

Alternative audio feedback mode is also added to the product. This is for people who suffer from migraines. This is done through two Mini-Speakers, one near each ear.

INPUT SYSTEM SELECTION

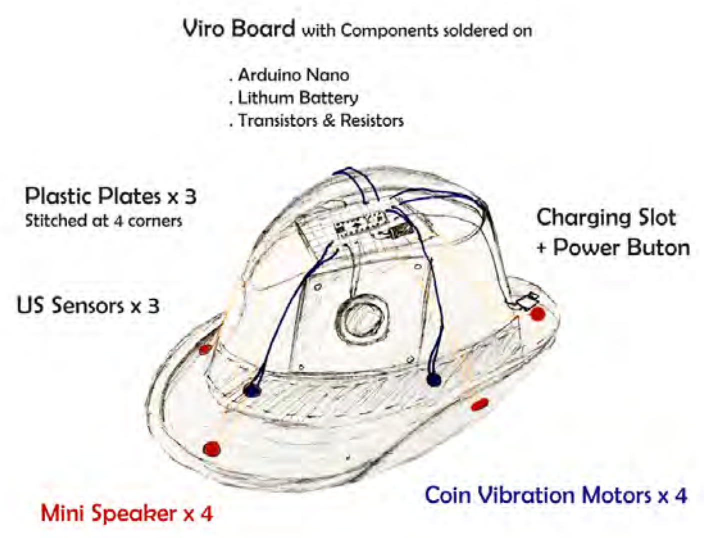
. LIDAR
. 3D Cameras
. Stereo Camera
. Infra-red sensors
. Ultrasonic (US) sensors

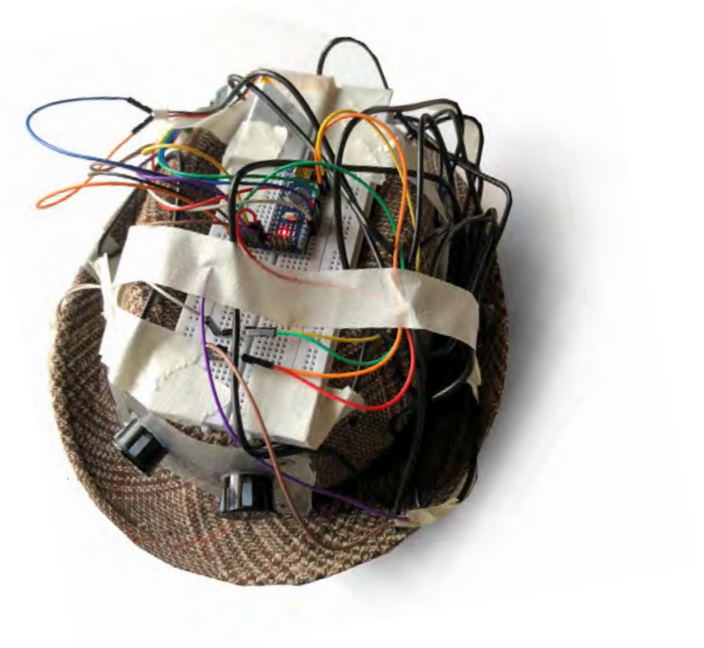
Considering all the input system options US sensor is found to be most suitable.

CONCEPT GENERATION

After selecting US sensors as the input system the major considerations for the product were the form factor and the user interface.

DEVELOPMENT OF SELECTED CONCEPT





Smart Hat Concept

. Selected Concept
. 3 US Sensors
. 4 Coin Vibrators
. 4 Mini-speakers

First Working Prototype

. Working Model to test code
. 1 US Sensors
. 1 Mini-Speaker

Prototype Two

. Model for testing the product
. 2 US Sensors
. 2 Mini-Speaker
. Battery added for power

Prototype 3

. Model for test vibrational user interface (at bone conduction points).
. 3 US Sensors
. 3 Coin Vibrators
. Complete battery circuit

Final Prototype

. All electronics covered up
. 2 US Sensors
. 2 Coin Vibrators
. 2 Mini-speakers
. Buttons for Mode change & power

Final Product Concept

. 3D model made to explore final design aesthetics.
. A non-functional model of the final Design.

TECHNICAL WORKING

```
int tonePin = 11; //Speaker pin
void setup() {
  // put your setup code here, to run once:
pinMode(2,OUTPUT); //Triger pin
pinMode(4,INPUT); //Echo pin
Serial.begin(9600); //enabling Serial monitor
}
```

This is the setup section of the code. Output and input pins are initialized here. The US sensor trigger pin is set as output at pin 2 and its echo pin is set as input on pin 4. Serial monitor is added to see distance on monitor.

```
void highfreq() {
    tone(tonePin, 60, 35.0);
    delay(50.0);
}

void midfreq() {
    tone(tonePin, 60, 35.0);
    delay(150.0);
}

void lowfreq() {
    tone(tonePin, 60, 35.0);
    delay(300.0);
}
```

Here three functions are created, each will result in a different beeping pattern, the patterns are shown on the graphs. The frequency of 60 Hz is selected after research and testing (multiple frequencies).
Indication patterns comply with British Standard: BS **EN ISO 24500:2010**

Each function is called at a different obstacle distance, this helps the user to understand obstacle proximity.

```
void loop() {
  // pulse output
digitalWrite(2,LOW);
delayMicroseconds(4);
digitalWrite(2,HIGH);
delayMicroseconds(10);
digitalWrite(2,LOW);
```

Sending and receiving ultrasound pulse, time of received pulse is converted to distance, using speed of sound in air.

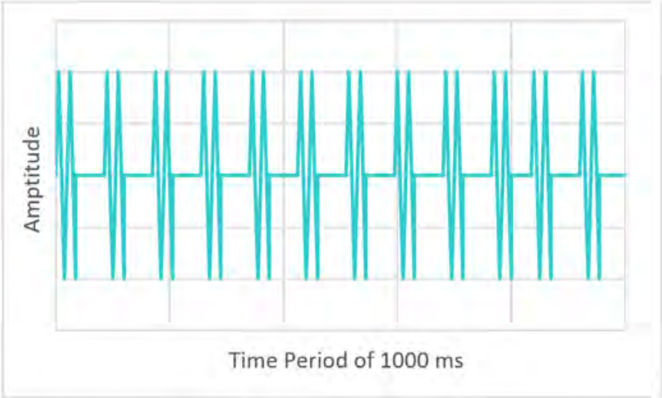
```
long t= pulseIn(4,HIGH); //input pulse and save it variable
long cm= t /29 / 2; //time converted to distance
String CM = " cm";
```

Converting time to distance.

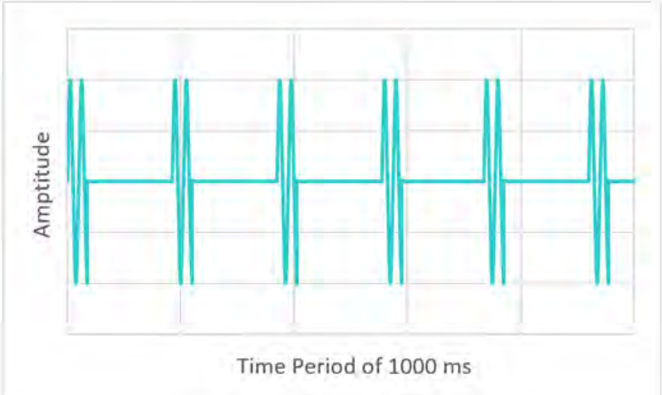
```
if (cm >= 250){delay(50); };

if (cm < 80){highfreq();}// Play high frequency audio

if  ((cm < 150)&&(cm >= 80)){midfreq();}// Play midum frequency audio

if  ((cm < 250)&&(cm >= 150)){lowfreq();}// Play low frequency audio

Serial.println(cm + CM); //print serial monitor cm
Serial.println(); //Print space

}
```

This piece of code checks the value of measured distance and sends the appropriate signal to the speaker. In first case no audio is played.

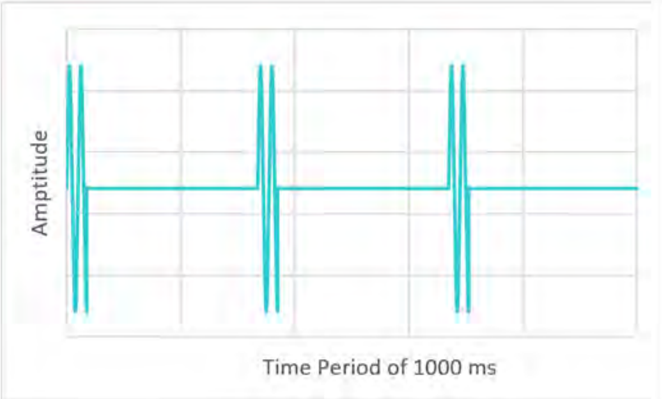
The code shown is for using one US sensor and one speaker. This is replicated for two US sensors in the product, the setup section and audio functions remain the same. The void loop section gets repeated twice, one for left sensor and one for right sensor. Further a button is added to the system, the code will check the button state and depending on it, the system will give output either on speakers or on vibrating motors. This is done by writing the code twice, one for each mode and depending on the button state the system decides which half of the code to run.



Graph of high pitch sound – Function: highfreq()



Graph of medium pitch sound – Function: midfreq()

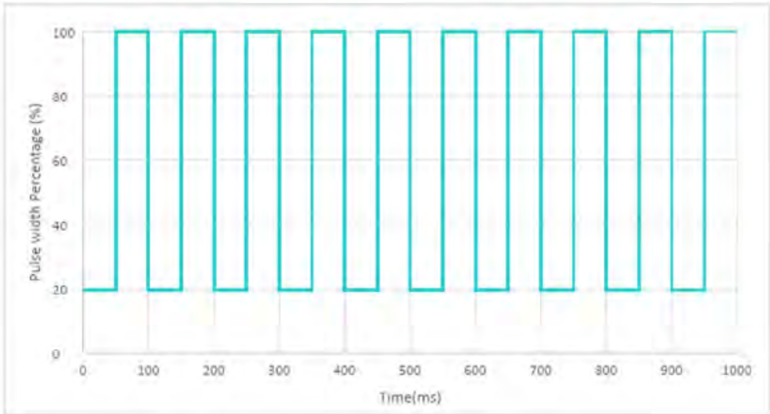


Graph of low pitch sound – Function: lowfreq()

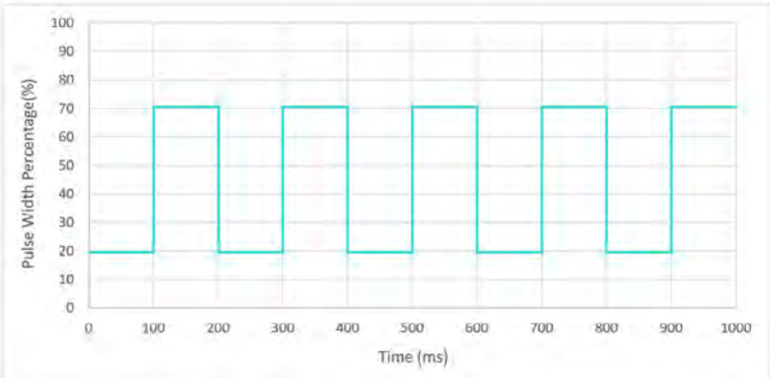
VIBRATING MOTOR CODE

```
void highvib(int pin) {
    analogWrite(pin,255); //setting pin value to Maximum
}

void midvib(int pin) {
    analogWrite(pin,50); //setting pin value to zero
    delay(50);
    analogWrite(pin,255); //setting pin value to half power
    delay(50);
}

void lowvib(int pin) {
    analogWrite(pin,50); //setting pin value to zero
    delay(100);
    analogWrite(pin,180); //setting pin value to 1/3 the power
    delay(100);
}
void stopvib(int pin) {
    analogWrite(pin,0); //setting pin value to Maximum
}
```

Similar to audio mode, functions are created in vibration mode, which will be called for different distances. Analogwrite is used to vary intensity, combined with the delay function it is used to create different patterns which can easily be differentiated by the user.

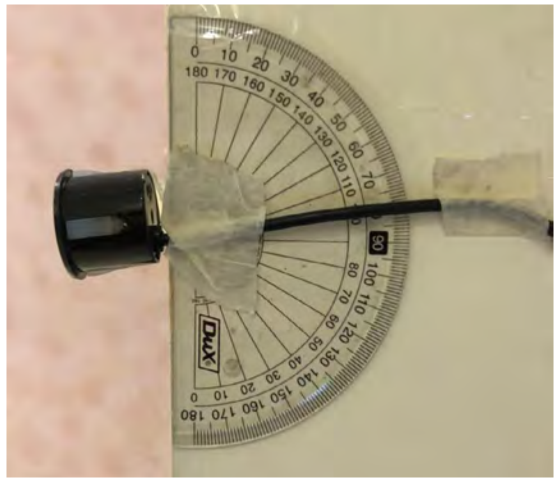


Variation in intensity wrt time - function: midvib().

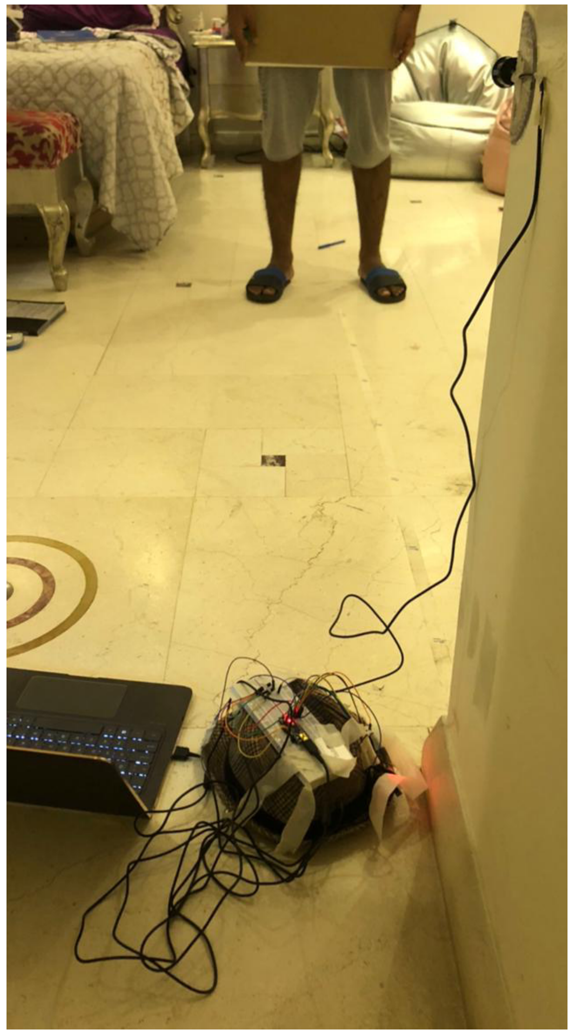


Variation in intensity wrt time - function: lowvib().

TESTING



A setup was created to find the right angle of tilt at which the sensor does complete detection in front of a person from head to waist. An angle of **110 °** from the vertical was found to be appropriate. The sensors were placed at the right angles and empathic testing was performed.



RESULTS

. The feedback is easy to follow
. All obstacles detected
. The person can move their head around to find exact position of an obstacle.
. The beeps were getting over shadowed in outdoor environments.
. The beam width was lesser than expected, because of the overlap between the sensor beams.

TESTING PROTOTYPE 3

Beeping sound is added to the empathic testing video so the viewer can relate to the user experience.

RESULTS

Vibrations transmitted through bone conduction are found to be an excellent user interface. As it can be a problem for users who suffer from migraines, both the output options are kept in the final design.

The third sensor on the back resulted in over information so it is removed. A High reflective tape is added to the back side of the product so people approaching from behind can identify the user and avoid hitting them.

USER TESTING

User testing yielded a positive response. Some users made comments about the fact that one size can not perfectly fit all as the coin vibrating motors have to be on a certain point. So the product will be available in 6 different sizes to accommodate everyone.

USER JOURNEY

Note - Click the Play Button
to view the user Journey Video

User Puts the Hat On

User Presses Power Button **-** voice indicates that the product is on and the mode it is in.

The User Start's walking

The User Presses Mode Button - in order to shift to mode of their choice

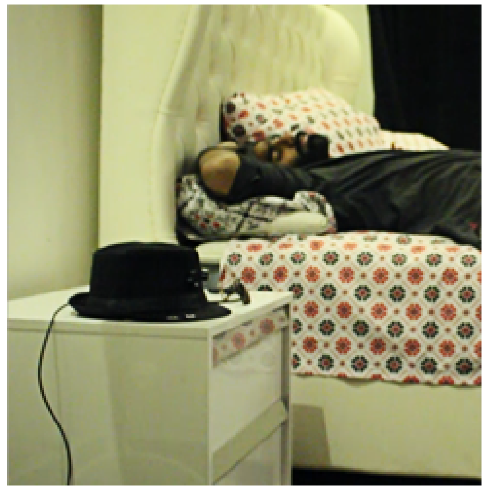
System stops indication if object distance has not changed in 10 sec - so user can have a conversation.

Indication only to left side **-** as the only obstacle is to users left. Same goes for right side.

Uses it along with white cane

The system notifies the user when the battery is down - through voice note.

The user puts the system on charging - voice indicates that charger is connected.



Time to rest

(1)

(2)

(3)

(4)

(5)

(6)

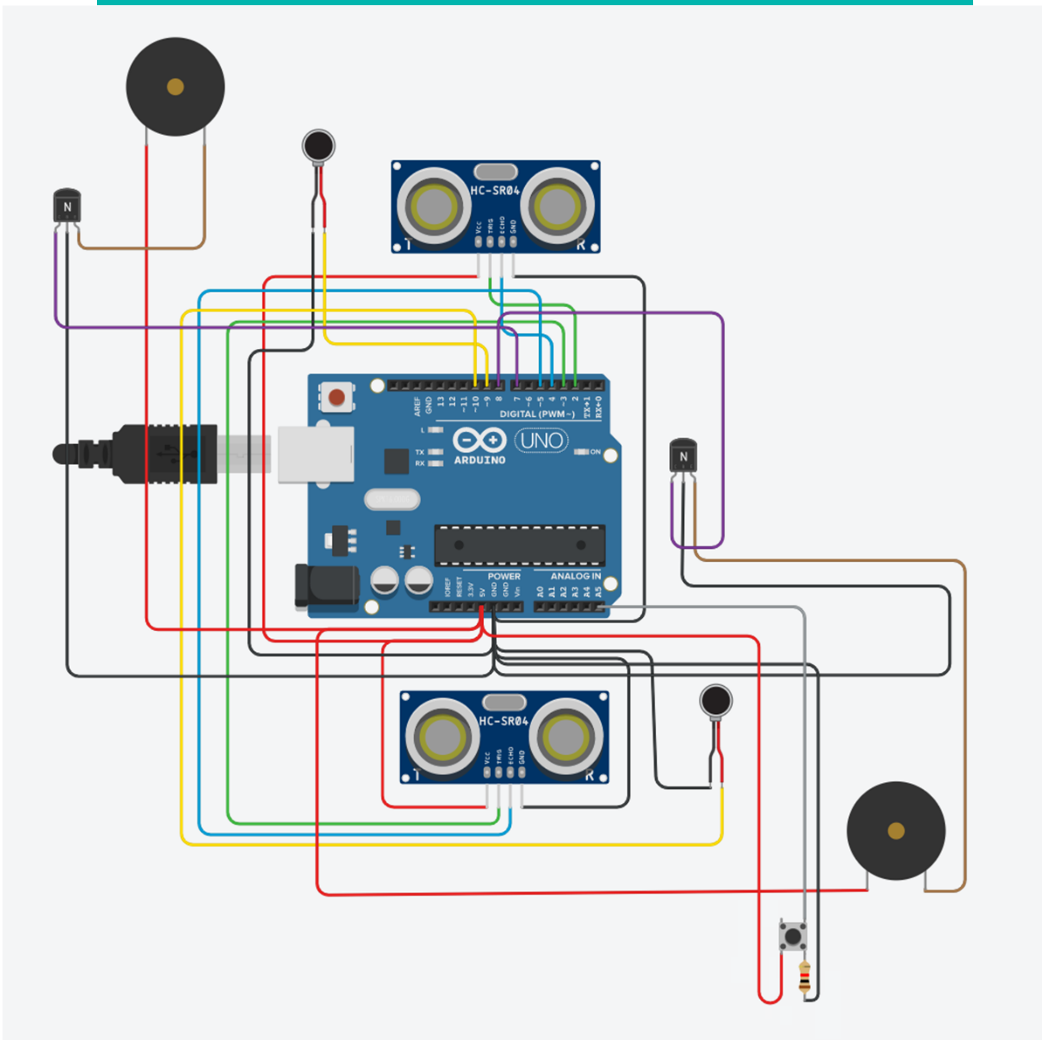
(7)

(8)

(9)

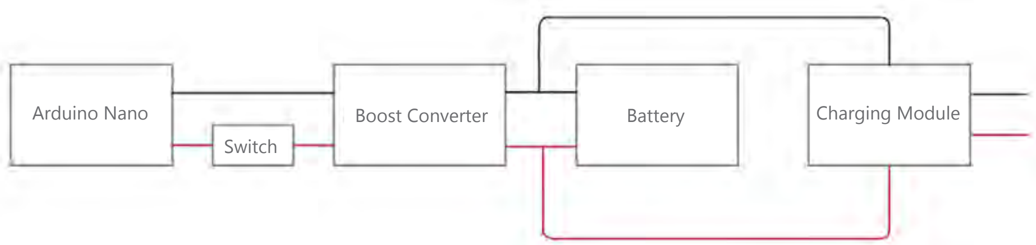
(10)


FINAL CIRCUIT



The above shown simulation is the representation of the final developed circuit without the battery connected, the battery circuit is shown bellow. The circuit has two US sensors for obstacle detection, two speakers and two coin motors to alert the user. It also shows a push button to switch between audio and vibration modes.

The boost converter shown in the diagram bellow is not shown in the list of parts as it will be built onto the PCB.



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LIST OF PARTS

No.		Part Name	Quantity
(1)	-	1000 mAh Lithium Battery	1x
(2)	-	TP4056 Charging Module	1x
(3)	-	Arduino Nano	1x
(4)	-	PCB (Printed Circuit Board)	1x
(5)	-	Sensor Housing Unit	1x
(6)	-	HC-SR04 Waterproof Sensor	2x
(7)	-	HC-SR04 Sensor Kit	2x
(8)	-	Mobile Vibrator Flat 1027	2x
(9)	-	Micro Speaker	2x
(10)	-	1 Key Membrane Switch	2x
(11)	-	Hat Cover	1x
(12)	-	Base Hat	1x

(12)


MATERIALS & MANUFACTURING

Sensor Housing - Injection Molded Polyethylene terephthalate (PET).

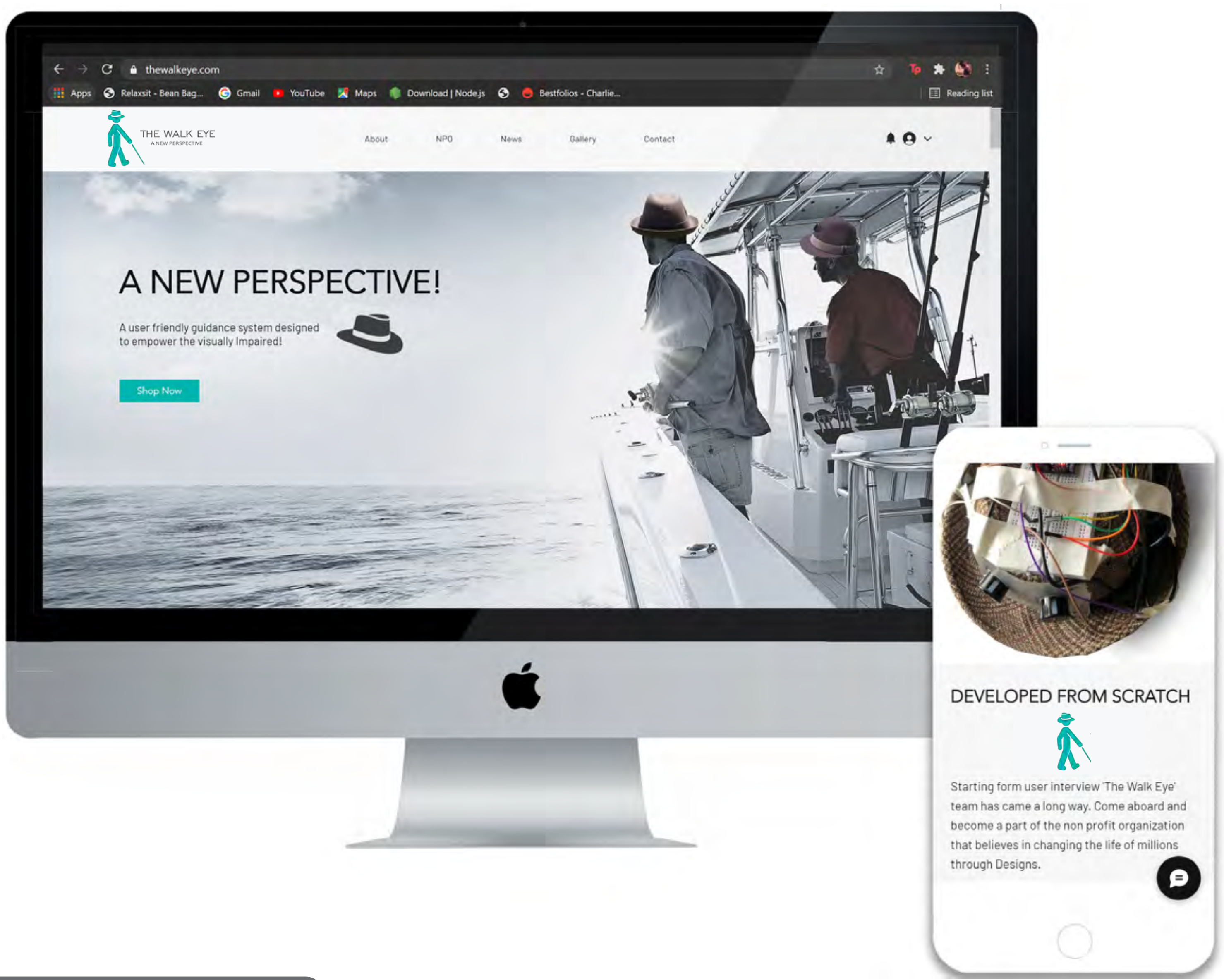
Electronics - Components are attached to a PCB on an electronics plant.

Hat Base - Linen hat manufactured at an existing hat manufacturing plant.

Top Cover - Canvas cover manufactured at hat manufacturing plant.

BUSINESS MODEL

A public funded non profit organization operating through www.thewalkeye.com



COST PER PIECE

Cost when Manufacturing 1 Unit =	**$82.60**
Cost when Manufacturing 100 Unit =	**$24.63**
Cost when Manufacturing 1000 Unit =	**$13.90**

NEXT STEPS

Further user testing needs to be performed as it was hindered by national lock-down during the process. Few refined prototypes should be created with the input of manufacturers and given out to visually impaired individuals so they can use the product in their day to day life. Feedback from the users should be used to further fine tune the product. A circuit board should be designed and printed as it will significantly reduce the size of the product. Finally the product should be mass produced and provided to visually impaired individuals firstly in third world countries, which can be followed by spreading it to the global population.