Institute technical Summer Projects
2023

iKshana

Guiding steps, Empowering Journeys

Content

The Problem

Several in a visually impaired person's life..

Navigation

One in around every eighty Indians are partially or completely blind , who require constant aid and face problems in even moving around in their own house, let alone streets and footpaths.

Cumbersome and inefficient solutions

Human/animal guides or smart sticks necissitates dependance on individuals/accessories. More sophisticated solutions are costly.

Walking shouldn't feel "Different"

Current solutions easily cause the user to be viewed as visually impaired, which creates segregation in something as simple as everyday commute and may even compromise their safety.

The Objective

What we're trying to accomplish..

A More Natural Solution

We hope to provide the same level of aid through a device which is more convenient than the other solutions available today.

Affordability

If our goal is to reach the most affected by limited vision, affordability is a high priority, which we draw from easily available components, modularity and integrating its use with your smartphone

Self-Confidence & Self sufficiency

We want to create a place where the visually impaired are as confident and self-sufficient as any other person, in this aspect at least.

What is iKshana?

As simple as an accessory

iKshana is a wearable harness with straps which you put on over your shoes and around your ankle.

Large-scale navigation

It uses integration with the navigation capabilities of the phone to tell you where you can go. One major part of navigation we decided to address was navigating road intersections.

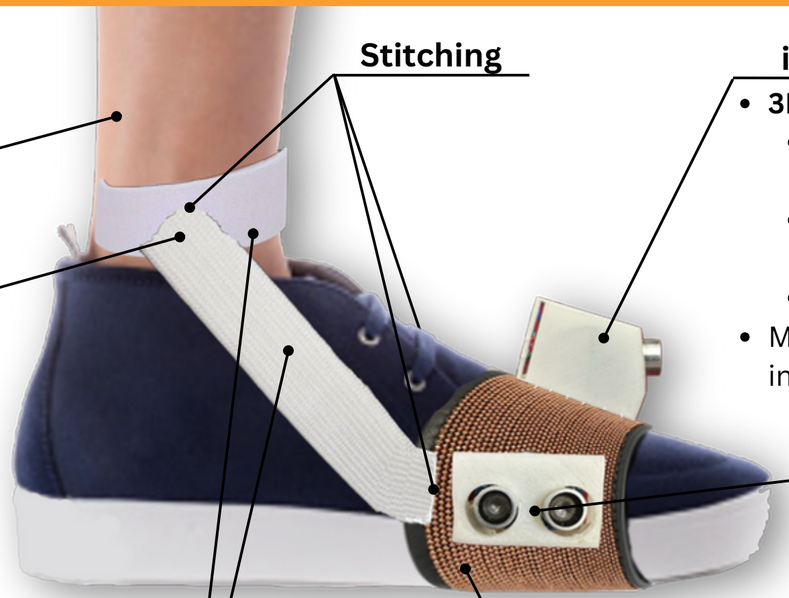
Know your surroundings

iKshana is equipped with ultrasonic sensors to check for any obstacles in the user's path and around the user.

Haptic feedback

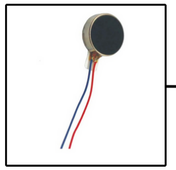
The mode of communication with the user is through vibrations both of the smartphone and coin motors, which is easy to get used to , are intuitive and feels as natural as walking is for any other person

How it works: Hardware



Right Foot

Stitching



Coin vibration motors

- **C1026B002F** - Datasheet
- 4 in number
- Vibrate when an object comes within your vicinity
- Separately vibrate to indicate direction
- Concealed within 2 layered straps

iKshana Module I

- **3D printed** case with holes for wiring
  - Chamfered front edge at 23º (to maintain LOS parallel to ground)
  - Contains an Ultrasonic sensor **HC-SRO4** (Datasheet), **ESP-32** WiFi module (Datasheet)
  - Power source (Not final) --> 2 **9-volt batteries**.
- Measures front distance for obstacle detection. ESP-32 interfaces hardware with **android app for long range navigation**

iKshana Module II

- **3D printed** cover with holes for wiring
  - Contains only the Ultrasonic sensor **HC-SRO4** Datasheet
- Measures distance to objects around the outer side of either foot and sends information to the ESP-32
- Line of Sight parallel to ground inherently
- (attachment)

Elastic Strap II

- Made from **Elastic** material- Polyester and Natural Latex Rubber
- 2 layers stitched together
- High durability
- Wire connections to the coin motors pass between the layers

Elastic Strap I

- Made from Elastic material taken from exercise bands
- **Higher durability** than type II to account for frequent contact with the ground

How it works: Software

Aim

To enable visually impaired people to grasp general directions of possible paths they can take at path intersections and provide more directional accuracy to their intuition,
while keeping them aware of obstacles constantly

How it works: Software

1a

Made an app in Android Studio to obtain latitude and longitude of the person through the Fused Location Provider client API in Google Play Services.

1b

Using Open street map, obtain data about the map geometry of the areas in and around IIT Bombay, in .OSM form

2a

The API finds the user's location through nearby Wi-fi access points and GPS.

2b

Python code parses the data and builds a database specific information of path intersections using the Osmium library with geocoding functions.

3b

This involves coordinates of road intersections, the number of branching roads, bearings of roads.

How it works: Software

1c

The database of all intersections is uploaded to the app backend.

2c

Data about a particular intersection is accessed as the user nears that intersection.

3c

Identify the user's path, send data to the ESP-32 and help the user manoeuvre the junction through vibrational cues.

4b

Export this data in JSON format to the android app

ESP-32's Job

The ESP-32 code features an obstacle detection part and a part for intersection manoeuvring, which at any point is overriden by obstacle detection when needed. One ESP-32 on each foot bridge the sensors, actuators and smartphone. It receives instructions about the possible directions at an intersection from the Android app which is relayed to the user through vibrations.

How it works: User

1. The person's phone vibrates and the intensity of vibrations increase as the user nears an intersection.

2. A special signal like a blink denotes you've reached.

3. The program finds the road you're travelling along wrt the intersection using the JSON database in the app.

4. Vibration motors on the left and right iKshanas vibrate accordingly to indicate the direction that person can go.

Design Process

An overview

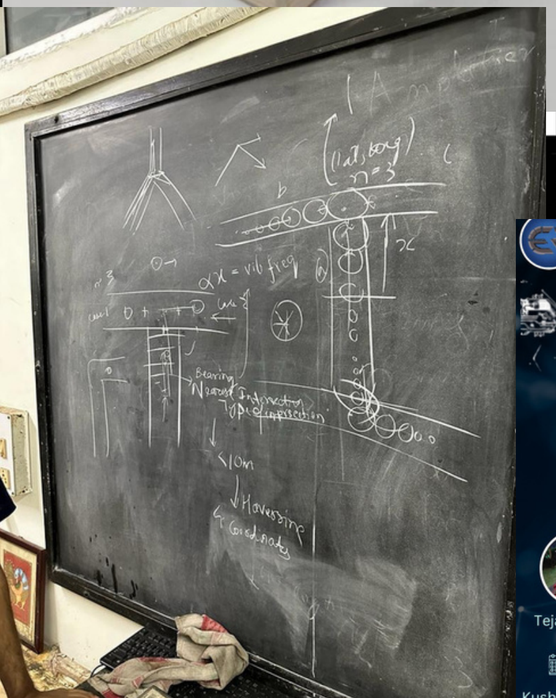
Testing T_T
Calibration, checking the overall functions, remodel.

Prototyping
Procuring materials, Stitching, Wiring, Programming, SOLDERING

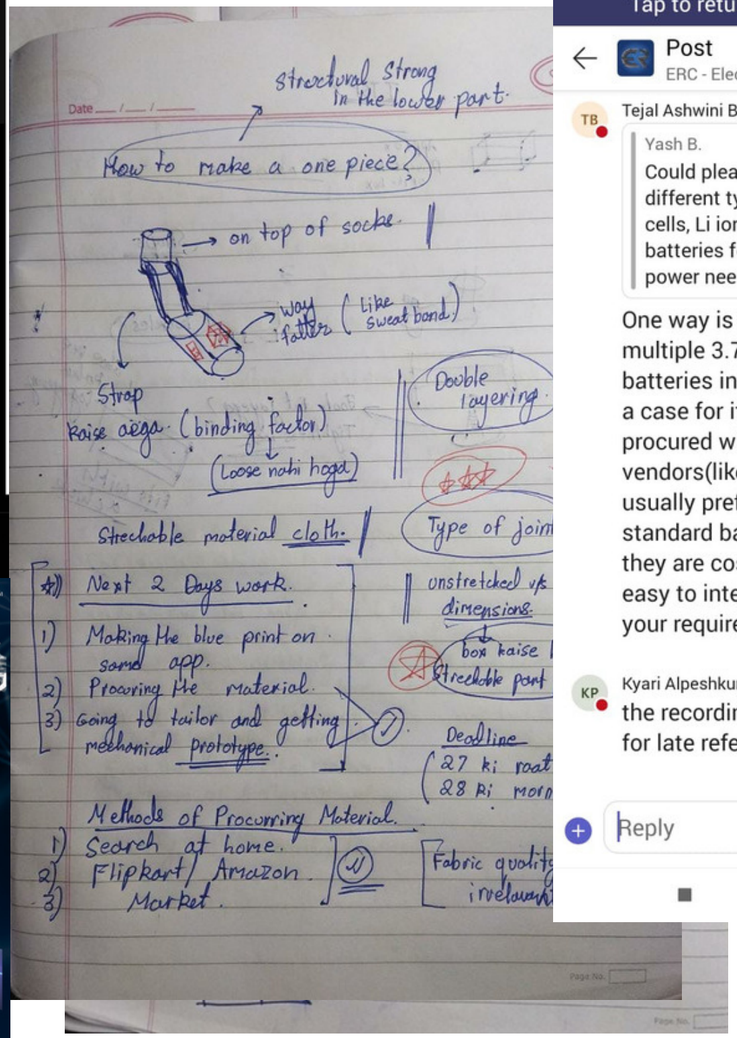
Modelling
Program flow, soft design, refinement, sketching, research

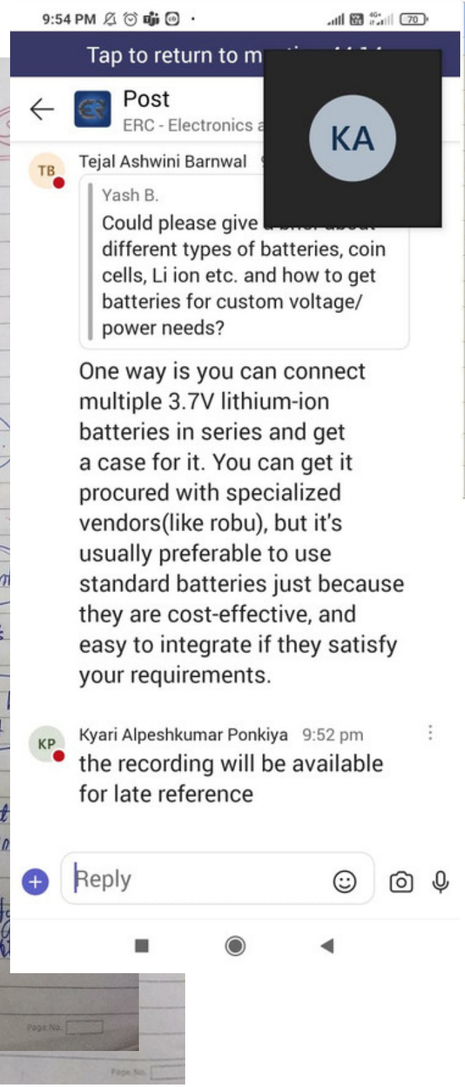
Ideation
Brainstorming, research
Approaching people, thought experiments

Ideation

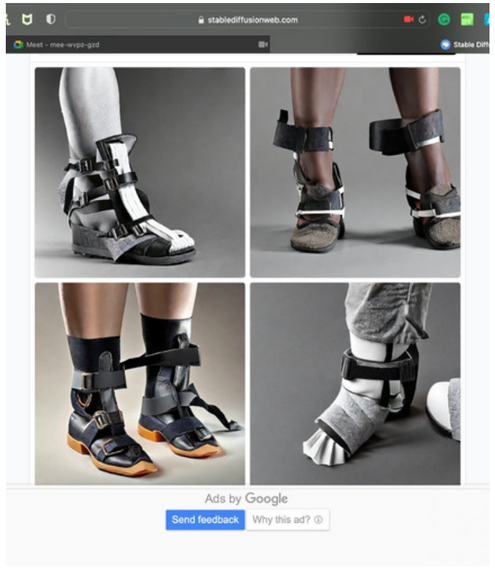


average angle for a normal foot, is around 21deg, so we can take it to be around 23-25 deg, for our

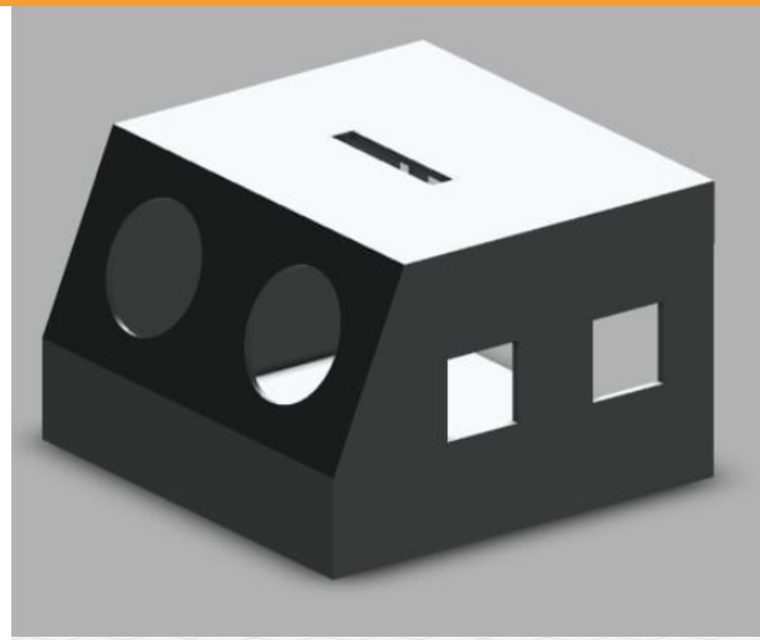


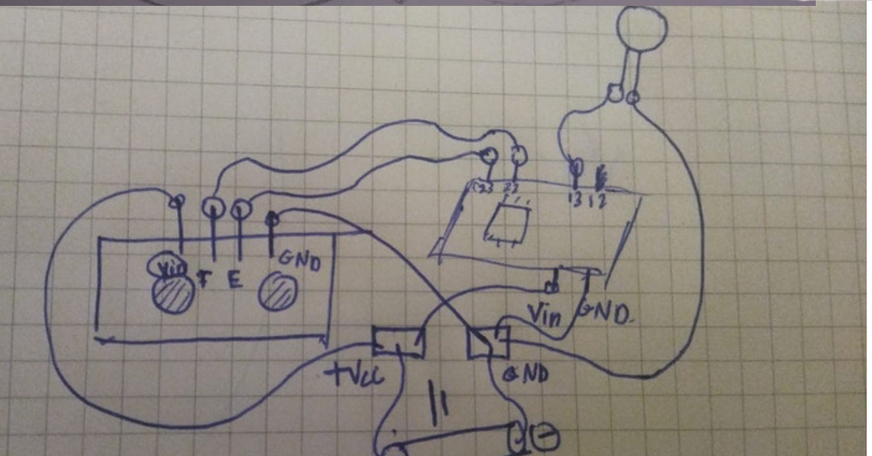


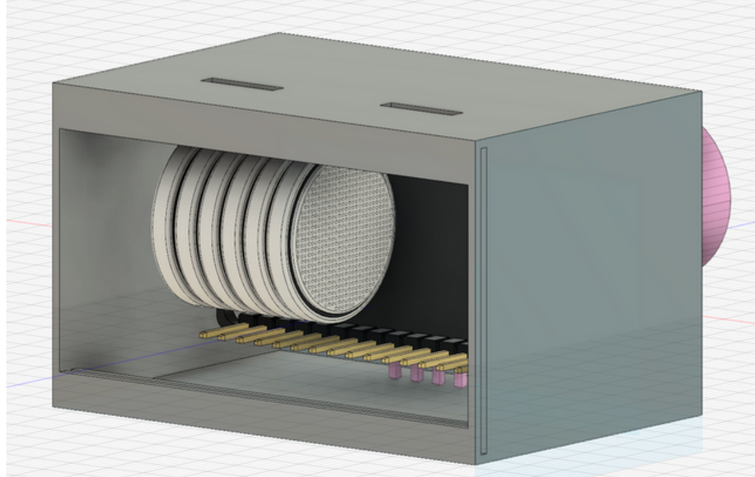
Picture	Model	Nominal Voltage(V)	Nominal capacity (mAh)	Dimensions		Average Weight(g)	Cross reference model		
				Diameter(mm)	Thickness(mm)				
	AG13	1.5	150	11.6	5.4	1.95	LR44	L1154	357A
	AG12	1.5	120	11.6	4.2	1.55	LR43	L1142	386A
	AG11	1.5	16	7.9	2.1	0.40	LR721	-	362A
	AG10	1.5	75	11.6	3.1	1.16	LR1130	L1131	389A
	AG9	1.5	48	9.5	3.6	0.87	LR45	L936	394A
	AG8	1.5	41	11.6	2.1	0.87	LR1120	L1121	391A
	AG7	1.5	40	9.5	2.7	0.65	LR927	-	395A
	AG6	1.5	26	9.5	2.1	0.54	LR920	-	371A
	AG5	1.5	45	7.9	5.4	0.94	LR754	-	393A
	AG4	1.5	17	6.8	2.6	0.34	LR626	-	377A
	AG3	1.5	38	7.9	3.6	0.64	LR41	L736	392A
	AG2	1.5	25	7.9	2.6	0.47	LR726	-	396A
	AG1	1.5	14	6.8	2.1	0.28	LR621	-	364A
	521A	1.5	10	5.8	2.1	0.23	LR63	-	379A



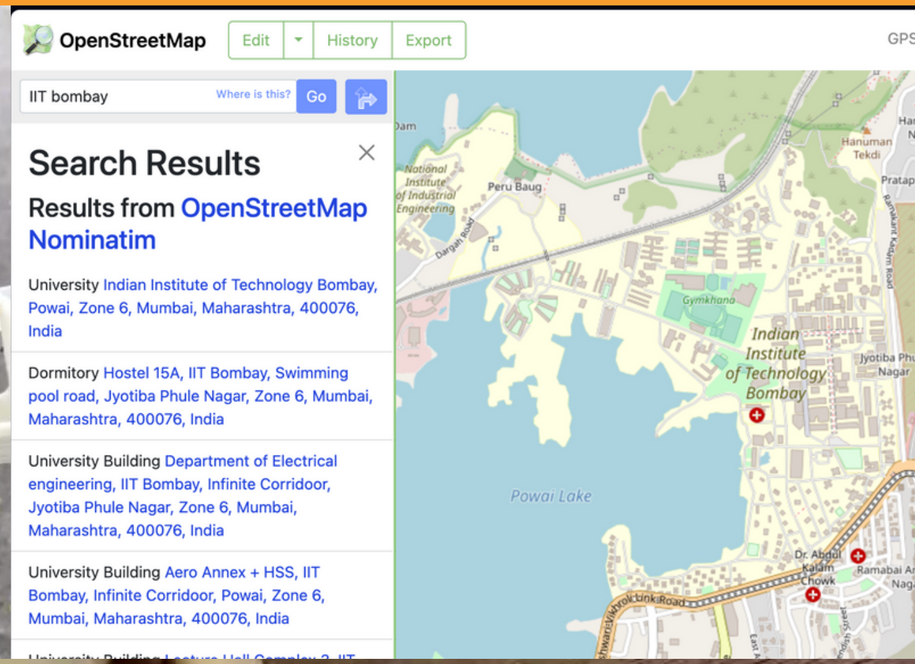
Modelling





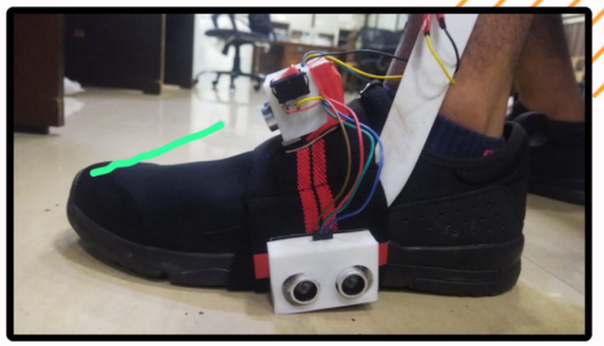


Prototyping

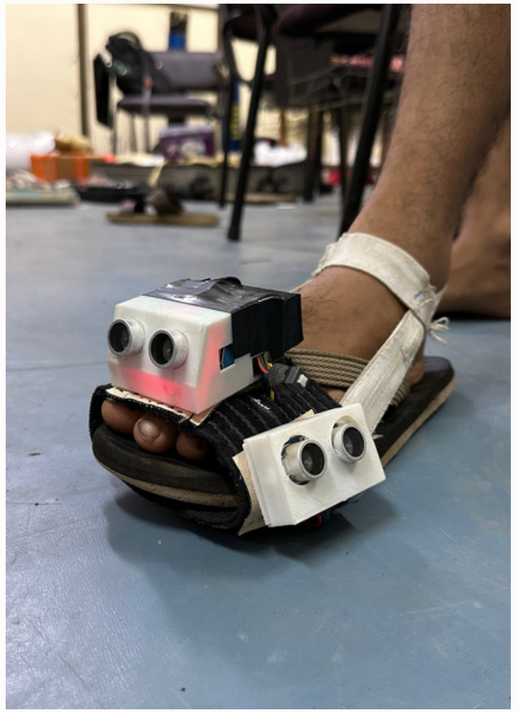


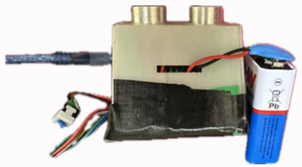
RESULTS

Results: Hardware



The mechanical designs we modelled went through some iterations with minor changes, but in the end we have successfully been able to make 2 iKshana harnesses. 4 3D-printed modules which hold our electronic components, are durable and are superglued to stitched pads on the modules.





The power source also changed from sets of 6 lithium coin cells to 9V Batteries

Results: Software

From code to coordination...

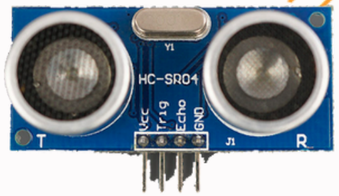
Inputs

Location of the user obtained on UI

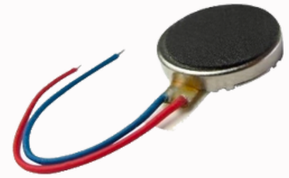
OpenStreetMap data of intersections stored in the app files in a usable form

Osmium library was used to extract this intersection info from the mapping data

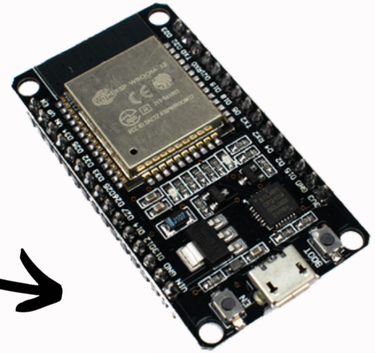
Ikku: The android app



HC-SR04 sends obstacle detection signals



vibration motors indicate when an obstacle is close, and tell you about junction types



Communicates with the app to recieve and use appropriate info

Check out the Github repo here

Near Future goals

In the near-future, our goals are more accuracy, longer-lasting hardware and battery-life, and a more natural feel.
Here's how we might achieve them:

- Using Lidar Sensors in place of Ultrasonic sensors.
- Using more durable materials, bettering the design so it is easy on our wiring and more comfortable.
- Thinking of better ways to use vibrational cues, and more vibration motors to increase freedom of movement.
- Incorporate stronger & lightweight (ideally) power sources into the iKshana modules

Far Future goals

Software

- Machine learning algorithms can be used to make our model more accurate for daily routine commute.
- We want to replace ultrasonic sensors with cameras and state-of-the-art computer vision algorithms to make our product more accurate and safer, and more suited to smaller scales, where GPS may not work. One drawback is that this will be expensive.

Mechanical & Electrical

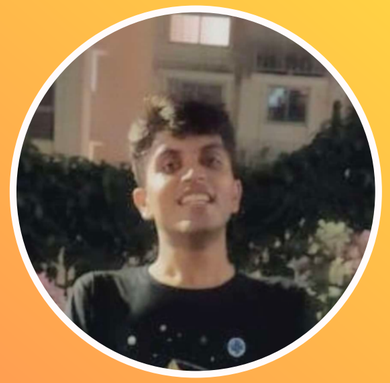
- We want to work on the power supply front. We plan to use piezoelectric motors coupled with batteries to charge them from the user's motion.
- Design PCBs and get them manufactured to have more reliable electronics.

One Critical Problem

The accuracy of our app in calculating relevant coordinates is limited because of disparities in the OpenStreetMap (open-source) data that we are using

Access to better map geometry data which may be under license might help us

Our Team



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