IC 201P – Design Practicum

Silent Voices: Empowering Deaf and Blind Individuals through Communication Technology

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Certificate

This is to certify that the work contained in the project report entitled **"Silent Voices: Empowering Deaf and Blind Individuals through Communication Technology"**, submitted by Group 42 to the Indian Institute of Technology Mandi, for the course IC 201P – Design Practicum, is a record of bonafide research works carried out by them under our direct supervision and guidance.

Himanshu Mishra Signature and Date : Signatured at the end

Nirmalya Kajuri Signature and Date : Signatured at the end

Acknowledgements

The completion of this project would not have been possible without the participation and assistance of a lot of individuals contributing to this project who guided us all along in this project. We owe a special thanks to our mentors, Dr. Himanshu Misra and Dr. Nirmalaya Kajuri and also our T.A., Mr. Mayand Malik for guiding us throughout the project. We also thank the IIT Mandi administration for giving us this opportunity to research problems in our society and heal it.

Abstract

Deaf and Blind often have a problem of communication with the outer world and their messages do not get conveyed. One of the major reasons for this is the fact that literacy in Braille language is far from what it should be so that normal people can understand what is being said by the differently abled person. In such conditions the disabled person feels helpless and treats himself differently from society. Therefore, we are going to make a product which can solve this problem using technology.

The title of our project is “Empowering Deaf and Blind Individuals through Communication Technology”. The working of our product is such that the Braille Language Type by the Blind person will get converted into normal english language. And also English spoken by normal people gets converted into braille language which can be easily understood by blind persons with the help of our device .

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Chapter 1 Introduction

Background of the problem

Deaf and Blind often have a problem of communication with the outer world and their messages do not get conveyed. One of the major reasons for this is the fact that literacy in Braille language is far from what it should be so that normal people can understand what is being said by the differently abled person. In such conditions the disabled person feels helpless and treats himself differently from society. Therefore, we are going to make a product which can solve this problem using technology. The problem faced by the deaf and blind people at the present time and the difficulties of their communication with the normal people sparked our interest and led us to try to find a solution to their difficulties and to minimize them as much as possible. Our main motive is to make communication possible in a simple and better way between differently abled people and the surrounding with the help of present technology. So that they can easily express their thoughts and convey their messages/ideas to the society.

Scope of the problem

"Communication Is the Fundamental Human Right". Communication is
a two-way interactive process and it plays a major role in daily life.
Communication strategies can affect one's ability to engage in interaction and cope up with social conflict, but this communication is not possible for the people who are deaf and blind. Scope of this problem is large as not only the deaf and blind people want to communicate with each other but also the normal people also want to communicate with deaf and blind people.

Design philosophy used in this report

We have tried to make the project as cheap and accessible as possible. This is done because communication is a basic human right that should be accessible to all. This was our primary motive for this project and most of the design decisions were made to be able to follow this paradigm. We have used IoT and app development to take over the project.

Problem statement

We are trying to create a system which helps the deaf and blind convey the messages. It will use the Braille Language to detect what's being said and then output it in some form that's easily accessible to other people. For that we are using a mobile application.

Beneficiaries (Intended market)

Our product will be beneficial not only for deaf and Blind people to communicate with everyone but also help normal people as normal people can also understand what they are trying to communicate.

Organization of this report

The whole report is divided in the following sections:

1. *Market Research* : In Chapter 2, we discuss the existing products in the market and compare them with our product. We also briefly discuss how our intended product stands different from the existing products.

2. *Designing:* In Chapter 3 discuss the conceptual design and in Chapter 4 discuss the detailed design of the product. The designing section can further be divided into:
    a. Product Architecture
    b. System Level Design
    c. Detailed Design
        i. Electronics aspect
        ii. Software Aspect
        iii. Mechanical Aspects

Chapter 2 Market Research

Existing Products In Market

The person who is deaf and blind can understand the conversation or the written sentences through a braille display.
Braille display is an electro-mechanical device for displaying braille characters, usually by means of round-tipped pins raised through holes in a flat surface

F*ig1 : Existing device in market*

Comparison with current products

Although both products are intended to solve the similar problem, both work on different principles. Orbit Reader 20 allows for simple transferring between this device’s different user-friendly functions, which include reading, writing, bookmarking, searching, creating and editing braille, as well as file management but our device include hand gloves which has some vibration sensors which allows a blind persons to feel the braille code of language(English language) speak by a normal person. Which is also easy to carry for a blind person and also our product has a 3x2 braille keyboard which is connected to a display through MCU which displays the thoughts of blind person in English Language.

Problems with current alternatives

Some problems associated with the existing alternative: -

1. It is not easy to carry for a blind person .
2. Uneasiness to use in public.
3. The cheapest refreshable display cost around Rs. 38,000 (orbit reader 20)

Our Product vs Existing Alternatives

The current Product , “orbit reader 20” is a refreshable eight-dot braille cell. It offers reading books via SD card, simple note-taking, Bluetooth and USB connectivity .The main problem with this product is that it is only limited to written sources only but in our case we are making a kind of communication device which takes speech as input and converts it into braille language ,which can be easily understood by the blind persons and vice versa as well .Our device is also very easy to carry for blind persons.

In our product there is no need for an extra device for sending the voice signal to our main device, we will use the android app which sends the voice signals to our device which then further converts the voice signals into braille language.
Also the existing product is very costly, it cost around 38,000 but our product cost below 8,000 , which is very cheap compared to that of the existing product.

Chapter 3 Conceptual Design

How did we find our problem statement?

Initially, we had come up with a couple of ideas or problem statements. They consisted of an autonomous grass cutting machine, automatic door locking system, Medicine delivering robot,braille device for those who can't see , etc. Then, upon discussing with our mentors and considering the novelty of the idea we decided to go with the braille device idea. Our problem statement was -

"Deaf and Blind people often face difficulties in communicating with the rest of the society as most of us are unaware of Braille language. This makes them feel helpless and different from other people."

Our problem statement hasn't changed but the implementation methods have changed over the period of time. They have been discussed in the next section.

Brainstorming and Idea Generation

Our first implementation method involved the use of solenoid and raspberry pi. Where solenoid is used to produce the braille code for normal english language spoken by normal people.

However, on investigating further we found that this method is very common with many papers written about it. Also, we got to know about some limitations like the user has to carry this device everywhere which isn't feasible for him/her.

Hence, we came up with the idea of using gloves with Haptics Device instead of solenoid.Gloves also allow the user to carry wherever and interact with the outer world.

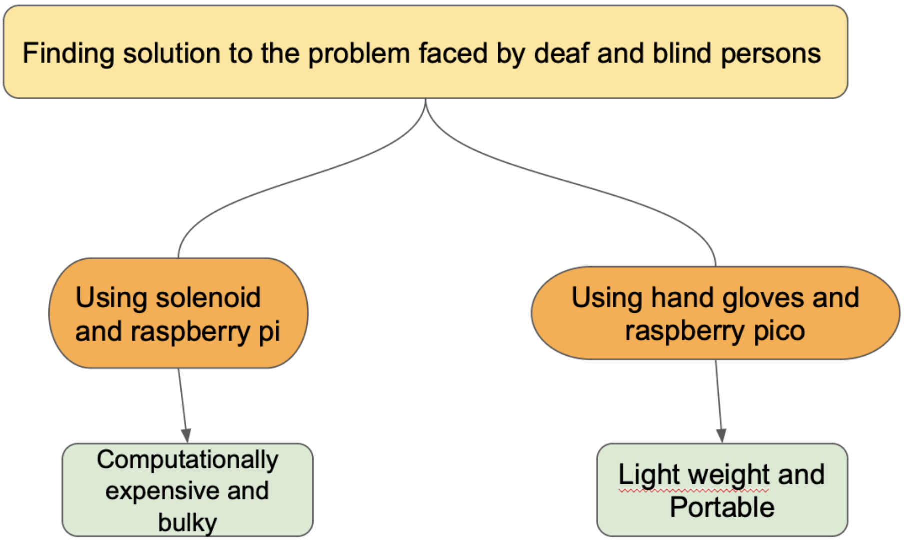


Fig 2: A flowchart of different approaches to the problem statement.

Project Selection:

The different problem statements that we initially encountered were mainly related to daily challenges faced by an individual. While listing down these scenarios, we found that the basic need of an individual for survival is communication. If we are not able to explain/ put up our point in front of others, we feel suffocated. Similarly, it is happening with the special disabled people. As communication is a fundamental human right. It is always possible between at least two people with the condition that both can understand each other's message. When the facts related to the above statement were presented before the team, the team unanimously decided to work in the field of communication for disabled people.

After discussing with the mentors and the group members we concluded that we would select **Silent Voices: "Empowering Deaf and Blind Individuals through Communication Technology"** as our final project. The reason behind choosing this project is.

Most of the projects which we had discussed are available in the market and can be easily implemented. Our project is also available (using solenoid) but we can implement it by using hand gloves and an Android app (which is not present in the market) which help us to learn something new. As a solution to problem definition, our method is also realistic and affordable than the other.

Criteria/ Ideas	Learning	Innovation	Cost to develop (0-High cost 5- least cost)	Of People reached (More people is better)	Total
Autonomo-us grass cutting machine	5	2	1	5	13
Automatic door locking system	2	3	3	1	9
Medicine delivering robot	3	2	2	4	11
Silent voice	**5**	**4**	**4**	**3**	**16**

Table 1:ratings of different Projects that we thought of

Chapter 4 Embodiment and Detailed Design

- **Product Architecture**

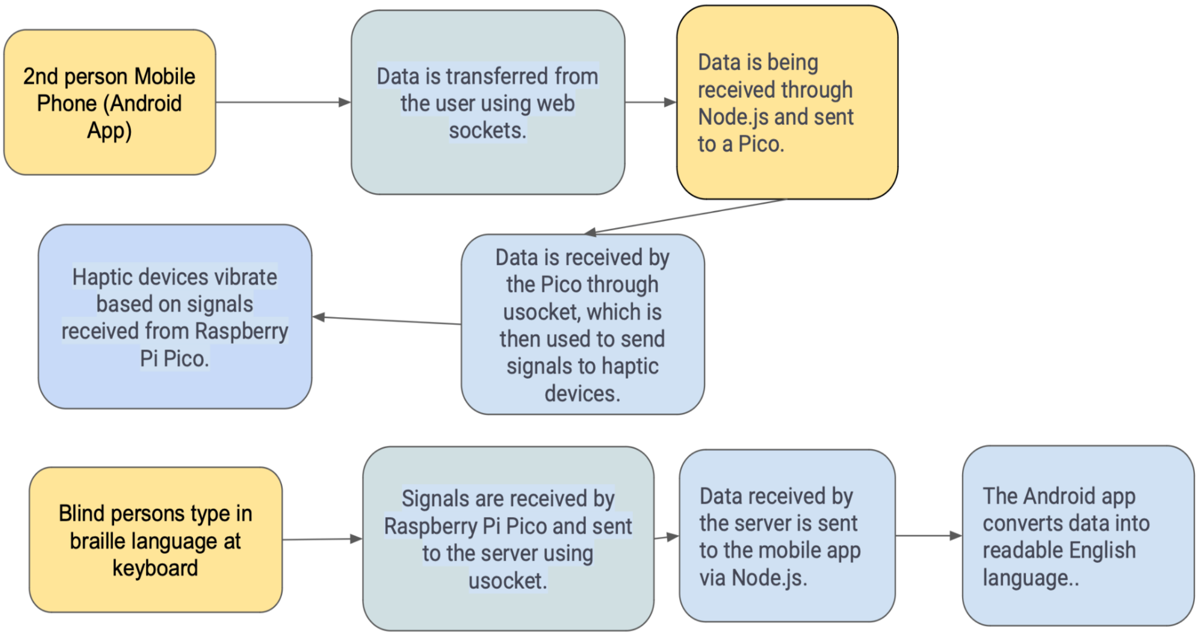


Fig. 3: Flowchart of the overall design

- **System-Level Design**

➢ **Raspberry pico w**

Raspberry pico w controls the haptics , 6 haptics are connected to the pico w and respond as per signals transferred by the pico.

It also receives the braille language codes from the server through usockets.

Specifications:

Optimum Operating Voltage	3.3 V
Input Voltage	3V - 5V
GPIO Pins	23
Size	21mm x 51mm x 1mm
Flash Memory	2MB
SRAM	264 KB
PSRAM	4 MB
Bluetooth	v4.2
WiFi	802.11 b/g/n
Weight	8g

Table 2 Pico specification

Pin Configuration:

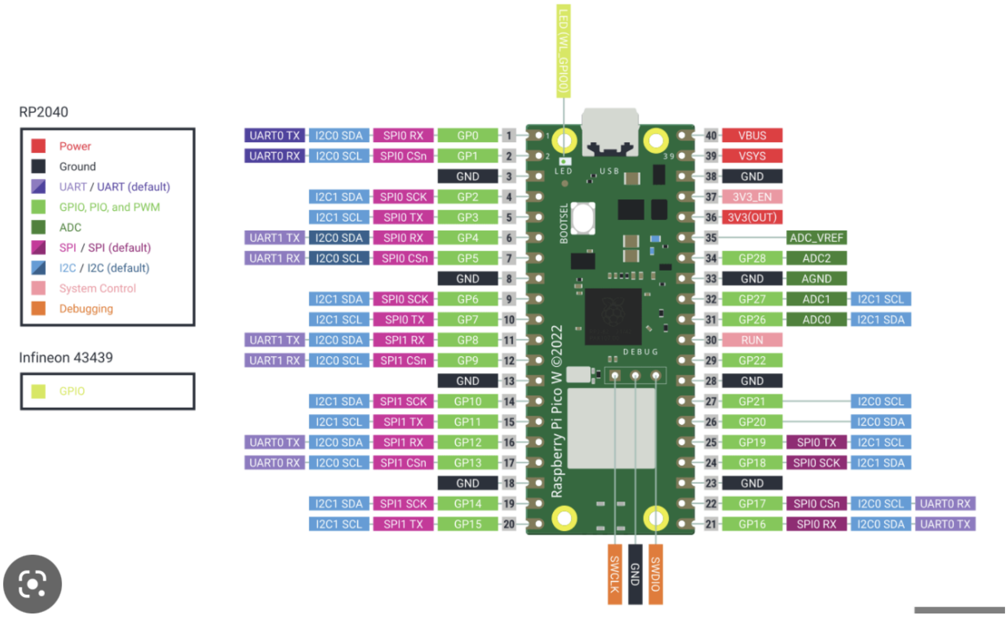


Fig.4 : Pin Configuration of raspberry pi pic

Block Diagram:

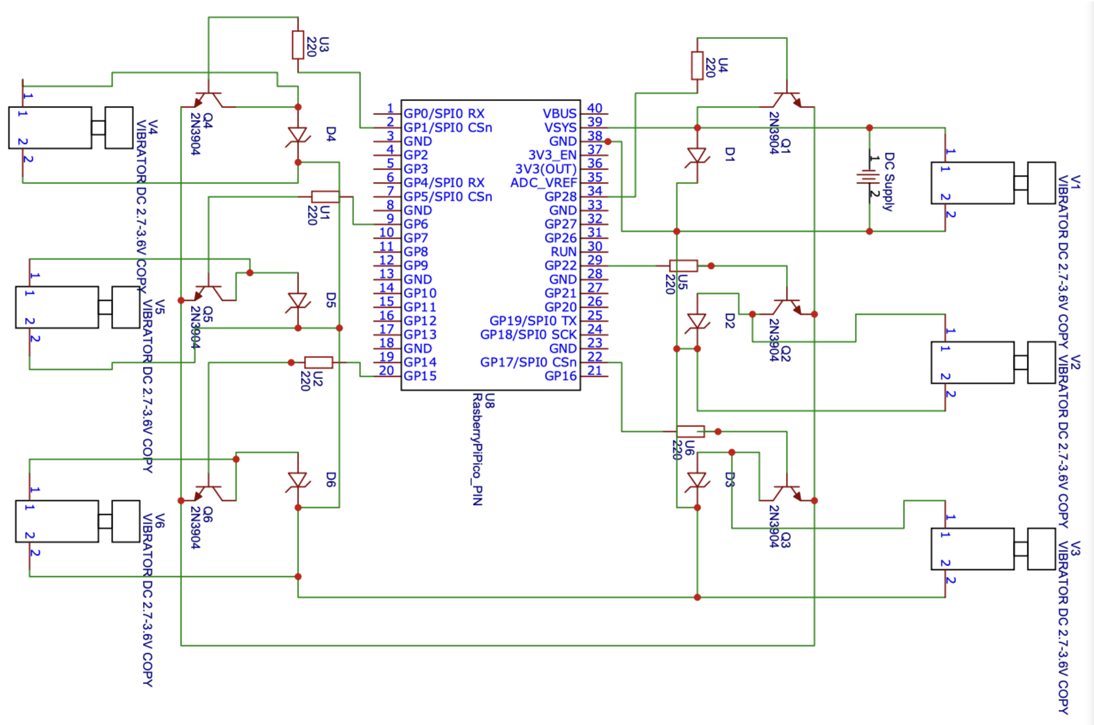
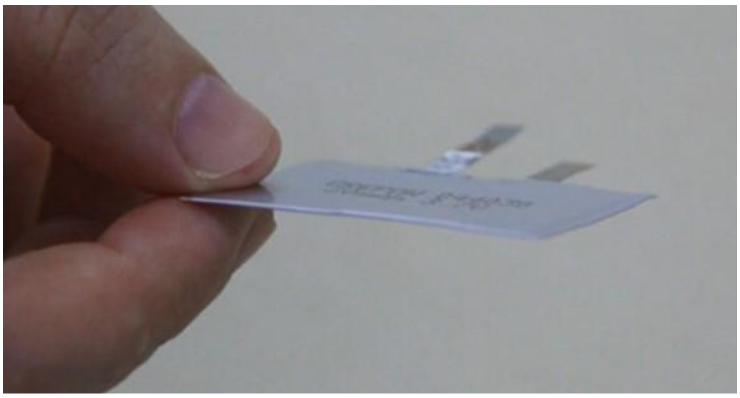


Fig. 5: Block Diagram

➢ **Ultra-Thin Lipo Battery:**

To provide a power supply to our Raspberry Pi Pico W and to make our application thinner we will use Lipo Battery whose thickness is in the range 0.4mm to 2.9mm. We are planning on using the 2.9mm cell that will give up 800mAH of battery capacity and can run our gloves for 72 min and our keyboard for about 30 hours .

Fig. 6: Lipo Battery



Specifications:

Part Number	LP286380
Dimensions	80*63*2.8 mm
Weight	34g
Capacity	800 mAH
Nominal Voltage	3.7 V
Charge Cut Off Voltage	4.2 V

Table 3

➢ **Battery charging circuit:**

To recharge the battery we need a USB connection through which we can connect. This will be done using a battery charging circuit that will connect to the battery and charge it.

Specifications:

Part Number	TP4056A
Charging Current	1000 mA
Max Input Voltage	5.5 V
Min Input Voltage	4.5 V
Regulated Output	4.2 V

Table 4

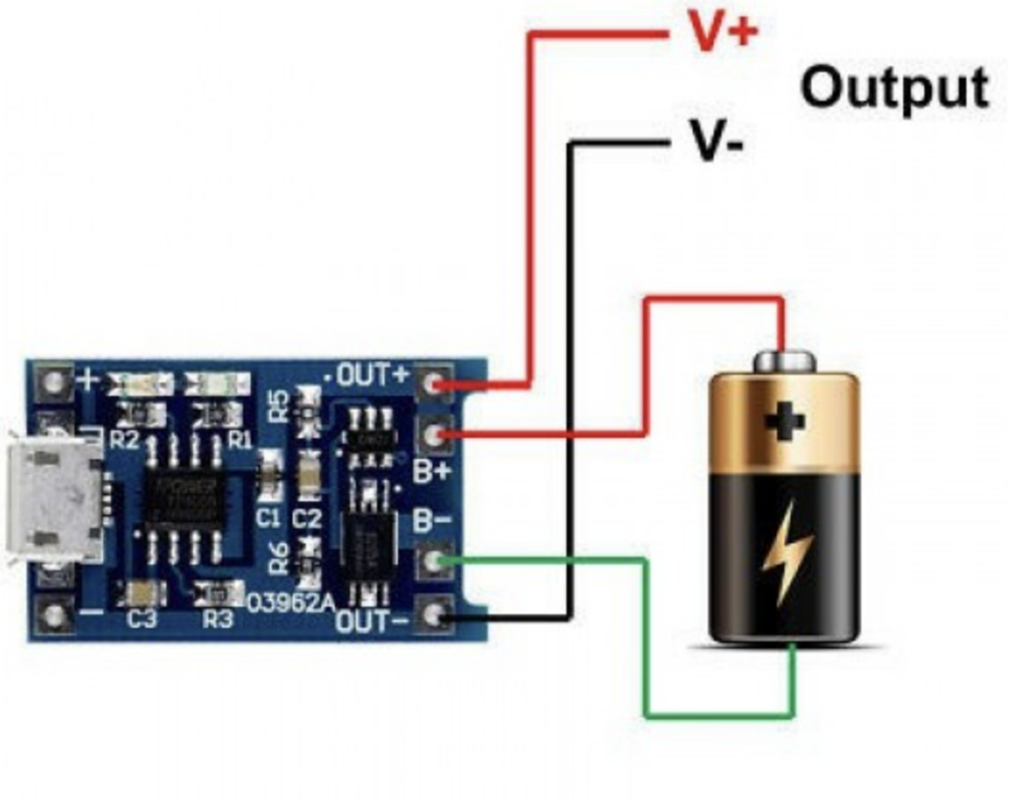


Fig. 7: TP4056 Battery Charger

➢ **Haptic devices**

The haptic devices vibrate in response to signals from the Raspberry Pi Pico, allowing individuals with visual impairments to perceive and comprehend what the second person wishes to communicate.

Specifications:

Rated voltage	3 V
Working voltage	2.5 - 4.0 V
Min. rated rotate speed	9000RPM
Max. rated current	90mA

Table 5

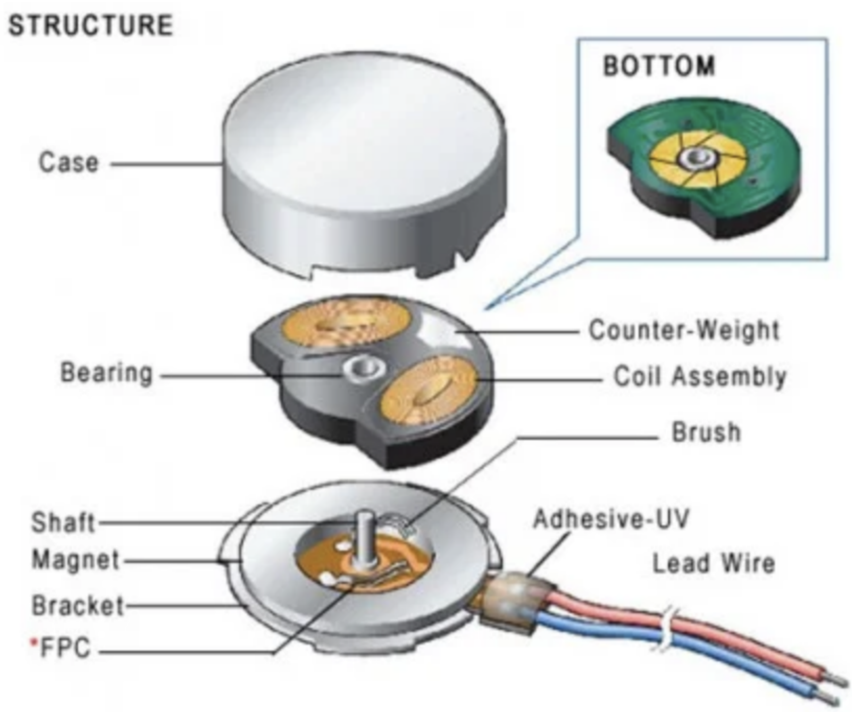


Fig 8: Mobile vibrator

➢ **Push buttons**

The use of push buttons is thoughtfully incorporated into the design of a Braille keyboard that allows blind individuals to send messages with a sense of empowerment and autonomy, thereby facilitating greater communication and connectivity.

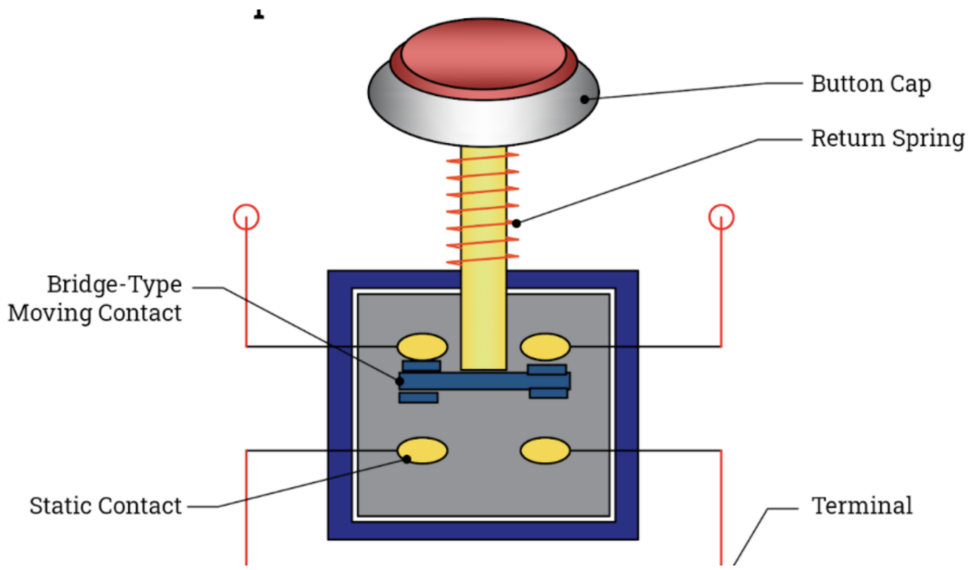


Fig 9: Push button

Detailed Design:

Software Design:

Related to mobile application

- In this project, the mobile application plays a critical role in converting English to Braille and sending the translated message to the Raspberry Pi Pico microcontroller. The haptic devices are then controlled based on the received signal. Additionally, the keyboard can be used by mute individuals to type braille messages. The braille message will be sent to the mobile application of the mute person, and a Python script will be used to convert the braille signal into English. The translated text will be sent to the other person via the mobile application, where it will be displayed. This process highlights the use of various technologies and tools, such as mobile applications and Python scripting, to enable effective communication between individuals with different communication needs.

STEP 1:

//establishing the connection between android app and 2 pico

- In this project, the initial step towards establishing communication between the two Raspberry Pi Pico microcontrollers is to turn on the hotspot on a mobile device. The two Pico devices will connect to this hotspot and share data between them. To ensure fast communication between the devices, a websocket will be created. Websockets enable real-time communication between two devices, making it an ideal choice for this project. By using websockets, the two Pico devices can quickly send and receive data, facilitating smooth and efficient communication. Overall, this approach highlights the use of various technologies and tools to establish effective communication in challenging situations.

Advantages of using hotspot:

Mobile hotspot:

- A Wi-Fi hotspot allows the Raspberry Pi Pico to access the internet through the mobile device. This can be beneficial for various functionalities, such as sending and receiving data, performing online queries, or accessing cloud-based services.

Advantages of using websocket than old style https server:

1) WebSocket is an event-driven protocol, which means you can actually use it for truly real time communication. Unlike HTTP, where you have to constantly request updates with websockets, updates are sent immediately when they are available.
2) WebSockets keep a single, persistent connection open while eliminating latency problems that arise with HTTP request/response-based methods.

How pico connects

- In our project, the mobile application will act as a server, and both Raspberry Pi Pico devices will connect to it. To establish a connection between the mobile app and the Pico devices, we will share the user's hotspot SSID and password. We will set up two websocket channels between the mobile app and the two Pico devices. This approach ensures that the communication between the devices is smooth and efficient. The use of websockets also makes it easier to handle communication issues and ensures that the connection is not lost during transmission. This approach highlights the importance of establishing a robust connection between devices in order to facilitate effective communication.

STEP 2:

//converting speech to text in android app via google speech

- Google provides a machine learning-powered API for accurately converting voice to text in over 125 languages and dialects. This API uses advanced speech recognition technology to transcribe spoken words into text with high accuracy. It supports various audio formats, such as WAV, FLAC, and MP3, and can also recognize spoken punctuation and commands. Developers can easily integrate this API into their applications using simple REST or gRPC requests, and customize the recognition settings based on their specific needs. This powerful and user-friendly API allows developers to add speech recognition functionality to their applications without having to develop and train their own machine learning models.

STEP 3

//the keyboard for the blind person

- The secondary pico w sends the signal to the mobile application through the websocket channel. The mobile application then converts the braille signal into English using a python script and sends it to the primary pico w through the second websocket channel. The primary pico w then sends the signal to the haptic device connected to the gloves of the deaf person, which provides haptic feedback to the deaf person. This way, both the deaf and blind persons can communicate effectively.

- To be more precise, the braille data sent from the secondary pico w is first received by the mobile application. The mobile application then uses a Python script to convert the braille data into text data which can be easily understood by the other person. The text data is then displayed on the screen of the other person's mobile phone. In this way, the mute person can communicate with the other person in a simple and effective way.

Additional Features Of The Mobile App

- When using a mobile device as a hotspot, we have control over the number of devices that can connect to it. This allows us to limit the number of clients that can access our communication system and ensures that only authorized users are able to connect. Additionally, we can block or unblock users by controlling access to the hotspot password. This provides an added layer of security and control over who can access our system.

- By integrating Firebase with our mobile application, we can store the chat history between the blind person and a third person. This allows for easy retrieval and review of past conversations. Firebase also provides a secure and scalable backend for storing and managing data, ensuring that the chat history is reliably stored and accessible.

A brief description of the code used

- A python code is written that enables the communication between the microcontroller and the mobile application. The device is connected to the mobile application via wifi. The device reads data sent from the mobile app, and uses the data to control haptic devices.

- The code starts by importing necessary libraries - "network", "machine", "usocket", "time", and "json". The "network" library is used to connect to a WiFi network, the "machine" library is used to define the pins that will be used to control the haptic devices, the "usocket" library is used to establish a socket connection with the server, and the "json" library is used to encode and decode JSON objects.

- Next, the code defines the name of the WiFi network and its password, and attempts to connect to the network using the "WLAN" function. It waits in a loop until the device is connected to the network. Once connected, it prints a message "Connected to WiFi".

- The code then defines the IP address and port number of the server that the device will communicate with. It also defines a device ID, which will be sent to the server to make the connection channel.

- The device then creates a socket connection to the server using the "socket" function, and sends the device ID to the server in JSON format. The code also defines pins for the haptic devices that will be controlled.

- The code then enters a while loop that repeatedly reads data sent from the mobile application and uses the data to control the haptic devices. The loop waits until it receives data from the mobile application, decodes the data, and sets the values of the haptic pins accordingly. It then waits for a short time before turning off the haptic devices.

- If there is an OSError (typically caused by a connection reset), the code will attempt to reconnect to the server. It creates a new socket connection and sends the device ID to the server again.

I. Electrical/Electronics aspect

Components:

1. Ultra-Thin LiPo Battery

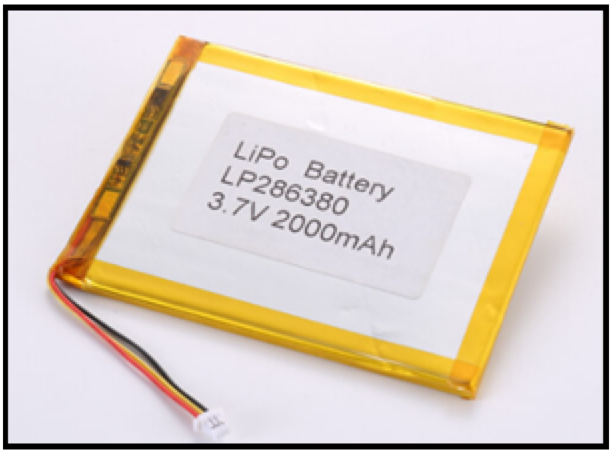


Fig. 10 : Ultra-Thin Lipo Battery

Rating of Battery: 3.7V 2000mAh

2. TP4056 Battery Charger Module

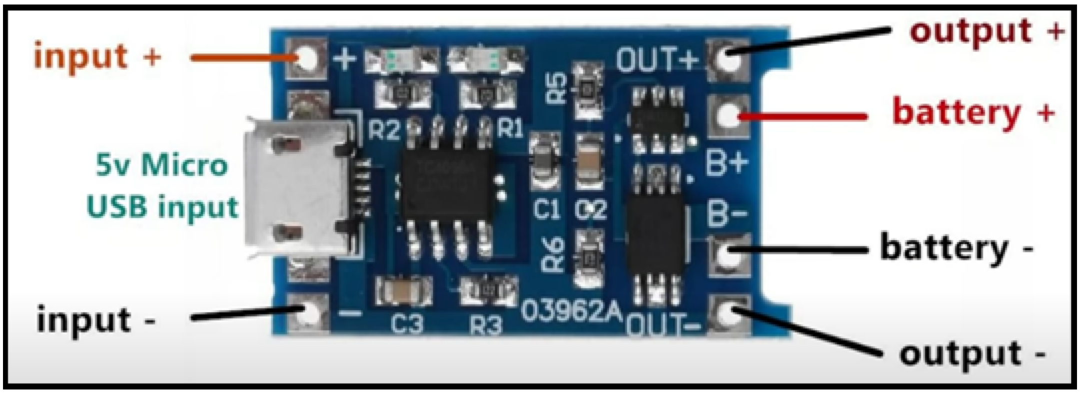


Fig. 11 : TP4056 Battery

ChargerModule

This module is used to charge Li-ion batteries(3.7V) using the constant-current/constant-voltage (CC/CV) charging method. Therefore, we can use a USB of rating 5V, 1A at the USB input port. The +ve, -ve terminals of the battery can be attached to the B+, B- terminals shown in the above figure respectively. To maintain the continuity of the main circuit output can be taken through the OUT+, OUT-. When the battery is in charging mode, a red light will blow through the LED and a blue light will blow when the battery will get fully charged, so that the user can Switch-off the USB input supply.

3. Vibration Motor:

we are using FLAT 1034 vibrator as it is engineered to provide haptic feedback and can be used for various purposes such as for mobile phones etc.

Fig. 12 :Vibration motor

4. Raspberry pi pico w:

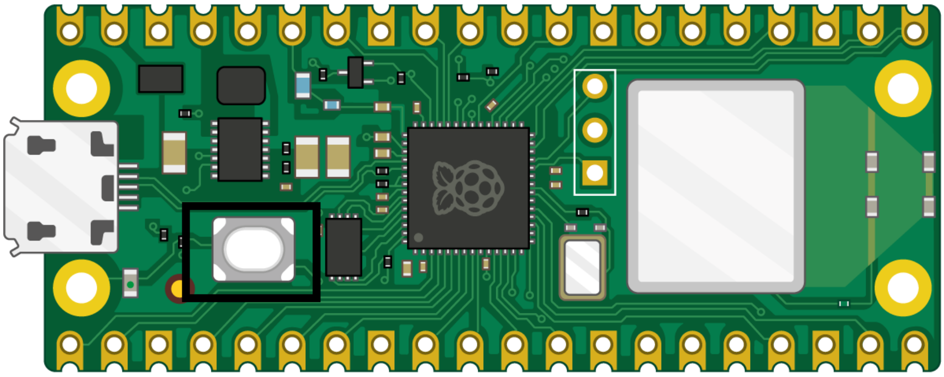


Fig 13 : Raspberry pi Pico W

Raspberry Pi Pico is a microcontroller board developed by Raspberry Pi Foundation. It is built around the RP2040 microcontroller, which is a powerful and flexible chip designed specifically for microcontroller applications. The Pico is a low-cost and compact board with a variety of features, including a dual-core

ARM Cortex-M0+ processor, 264 KB of SRAM, and 2MB of flash memory. It also has a wide range of connectivity options, such as SPI, I2C, UART, and PWM. The Pico is an excellent choice for a wide range of applications, including robotics, home automation, and Internet of Things (IoT) projects.

II. <u>Mechanical Design:</u>

Components:

1. **Glove Assembly with box and Haptics** :

   Here are various perspectives of the 3D model for the glove.

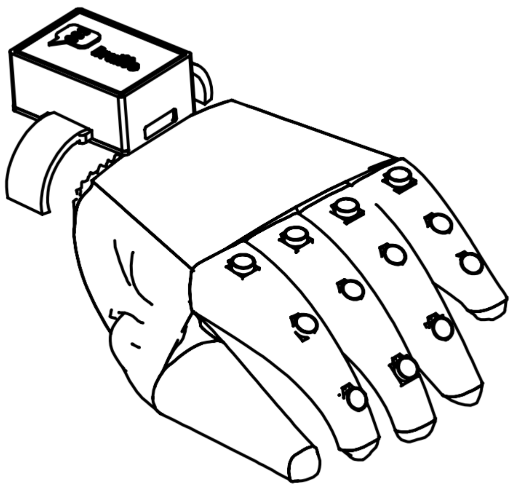


Fig. 14: Isometric view

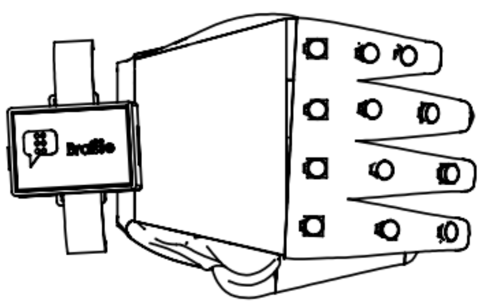


Fig. 15: Top view

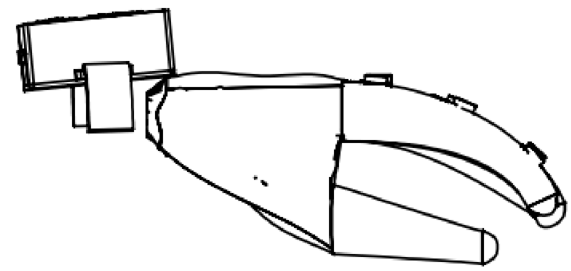


Fig. 16: Right View

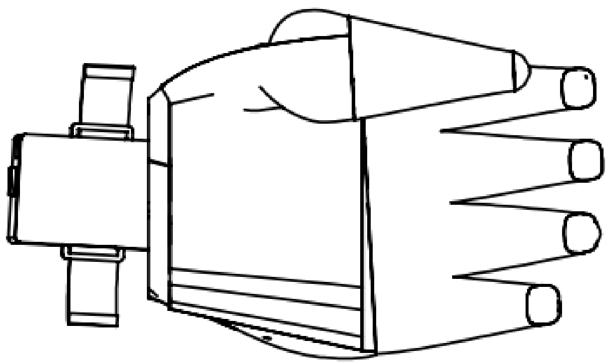


Fig. 17: Bottom View

2. **Glove :** This is used to place haptics and made us help in finding an innovative solution**.**

Here are various perspectives of the 3D model for the glove

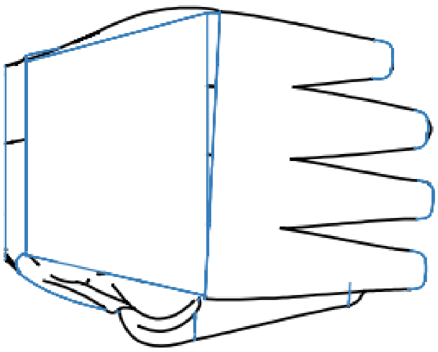


Fig 18: Top View of Glove

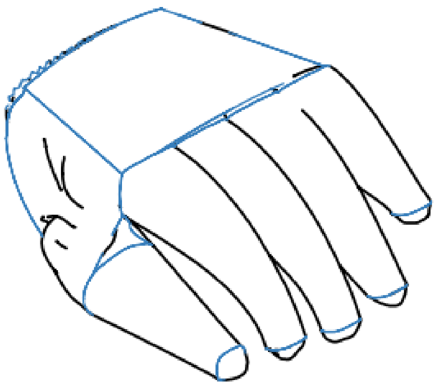


Fig 19: Isometric view of the Glove

3. **Box with Watch Band:**This is made to gain flexibility in terms of placement and positioning of the components, and helps in addition to features

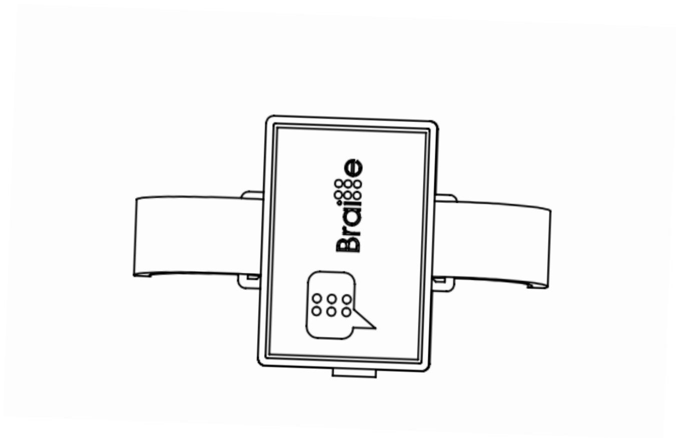


Fig 20: Box with With Band Diagram (Top view)

4. **3D-printed keyboard:** This is a keyboard designed specifically for braille users to communicate more efficiently.

a) Isometric View of Keyboard

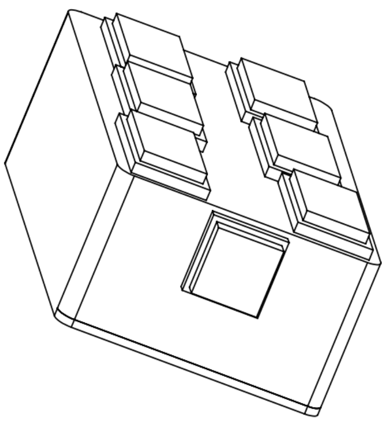


Fig 21: Isometric View of the KeyBoard

Chapter 5:Fabrication and Assembly

1.Product Budget Details:

S.NO	Name of item	Approximate Cost for item	Quantity	Approximate Cost
1.	Raspberry pi pico w	400	2	800
2.	Haptics Device(Mobile vibrator)	25	6	150
3.	Lipo Battery(1100mah and 800mah)	280 + 250	1	530
4.	Gloves	80	1	80
5.	Keyboard switches	7	7	49
6.	Battery Charging Circuit	40	2	80
7.	Body and wired	20+10	–	30
Total				Rs. 1719

Table 5: Budget Details

2.a) Dimensions of raspberry pi pico w board

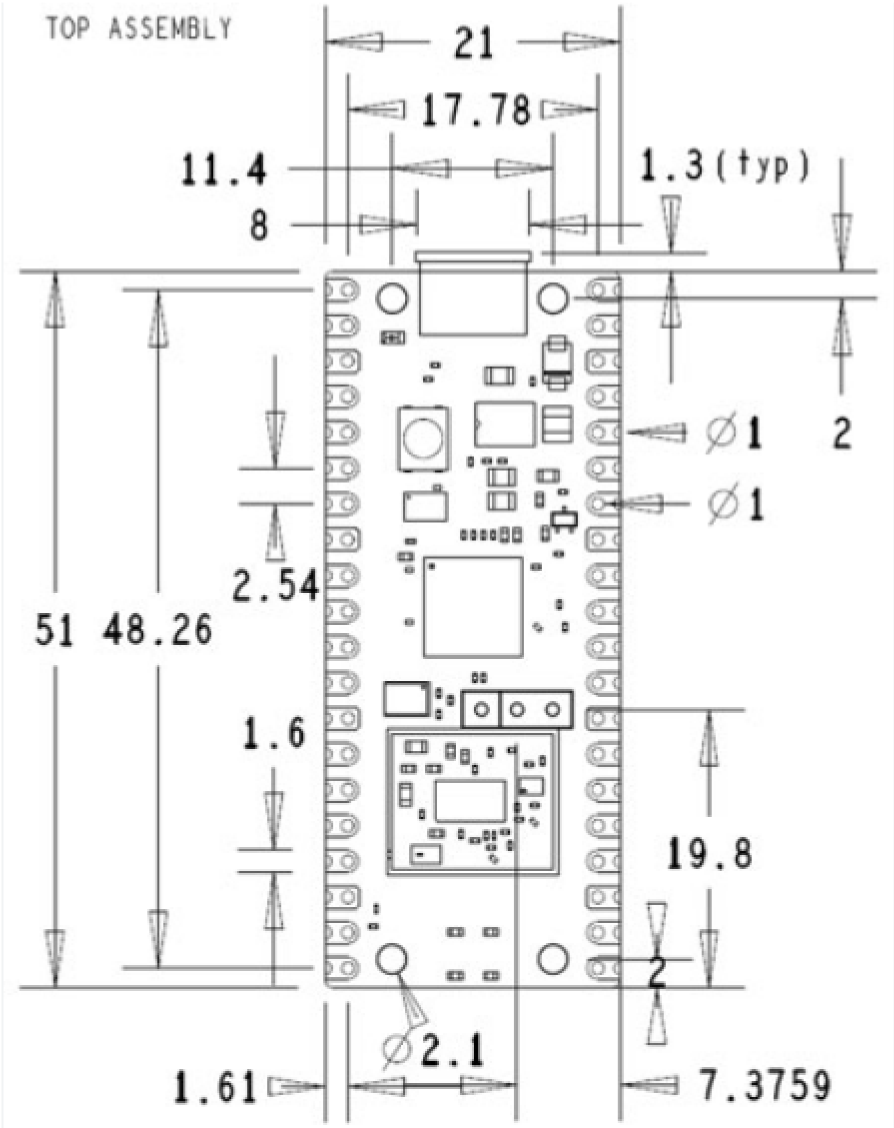


Fig 22: Dimensions of raspberry pi pico w

3.Manufacturing Process description:

a) The use of cotton gloves as the main structural material for haptic devices is a practical and cost-effective solution. The soft and flexible nature of cotton allows for a comfortable and breathable fit, making it ideal for extended use. By stitching haptic devices onto the fingers of the gloves, the wearer can experience realistic tactile feedback while performing various tasks. The decision to use adhesive to attach the haptic devices allows for easy replacement and customization of the gloves. Finally, an external cotton glove is used to cover the haptic devices, providing an extra layer of protection. Overall, this approach provides a practical and effective solution for incorporating haptic feedback into wearable devices.

b)The electrical circuit connection between the haptic device and the Picow is a critical aspect of the wearable device. It allows for the transmission of electrical signals from the haptic device to the Picow, which in turn generates the appropriate tactile feedback response. The use of a lithium-ion battery to power the Picow is a practical choice due to its high energy density, long lifespan, and low self-discharge rate. However, it's essential to ensure that the battery's voltage and capacity are compatible with the Picow's power requirements. Additionally, the circuit connection should be designed with proper insulation and grounding to prevent electrical shocks and ensure safe operation. Moreover, the circuit connection should be designed to be easily detachable to allow for convenient maintenance and replacement. Overall, designing a robust and reliable electrical circuit connection is crucial for ensuring the effective operation of the wearable haptic device.

c) Designing a separate device similar to a watch band to house the Raspberry Pi Pico circuit and battery is a significant modification in the manufacturing process of the wearable haptic device. This new approach provides several advantages over stitching the Raspberry Pi Pico directly onto the gloves.

Instead of integrating the Raspberry Pi Pico into the gloves, a separate box-like structure is created, which is surrounded by a watch band. This design allows for more flexibility in terms of placement and positioning of the components, and helps in addition to features such as on/off buttons so that devices can be turned off when not in use, and placing charging points at an user-friendly position making it easier to access and maintain them.

By housing the Raspberry Pi Pico circuit and battery in a separate device, it becomes more convenient to handle and replace the components if needed. The watch band design ensures that the device remains securely attached to the user's

wrist, providing stability during use.
Furthermore, this modified approach opens up possibilities for further enhancements, such as fabricating a braille watch on top of the box.(which we are planning to do in future.) This addition would provide additional functionality for the user, allowing them to access time-related information through tactile feedback. Overall, the separation of the Raspberry Pi Pico from the gloves and its placement within a dedicated device offers improved flexibility, accessibility, and potential for future enhancements in the wearable haptic device.

d)Using a 3D printed keyboard with push buttons is an innovative solution for braille individuals to communicate more effectively. The push buttons are high-quality switches that provide tactile feedback and require minimal force to activate, making them ideal for braille users. 3D printing allows for the customization of the keyboard's layout and size to suit the user's needs and preferences. Additionally, the use of 3D printing technology reduces production costs and allows for faster prototyping and iteration. Overall, the combination of 3D printing and high-quality push buttons is a promising approach to enhance braille communication and accessibility.

4.Assembly:

Assembly Process:

The assembly process for the described wearable haptic device involves several key steps to bring together the various components and create a functional and user-friendly product. Here is an overview of the assembly process:

1. Fabrication of Cotton Gloves:

- Cut and sew cotton fabric to create gloves that serve as the main structural material for the haptic devices.
- Ensure precise sizing and fit for comfort and extended use.

2. Stitching Haptic Devices onto Gloves:

- Position the haptic devices at strategic locations on the fingers of the gloves.
- Use stitching techniques to securely attach the haptic devices to the gloves, ensuring durability and reliability.

3. Adhesive Attachment for Customization:

- Apply adhesive to the haptic devices, allowing for easy replacement and

customization of the gloves.
   - This enables flexibility in adjusting the haptic devices to suit different user preferences or specific tasks.

4. External Glove Covering:
   - Place an external cotton glove over the haptic devices and stitched area.
   - This additional layer provides extra protection to the haptic devices and enhances the overall appearance of the gloves.

5. Electrical Circuit Connection:
   - Establish the electrical circuit connection between the haptic devices and the Raspberry Pi Pico (Picow).
   - Ensure proper insulation and grounding to prevent electrical shocks and ensure safe operation.
   - Design the circuit connection to be easily detachable for maintenance and replacement convenience.

6. Separate Device Design and Assembly:
   - Create a separate box-like structure surrounded by a watch band to house the Raspberry Pi Pico circuit and battery.
   - Ensure the placement of on/off buttons for easy device power control and positioning of charging points at user-friendly locations.
   - Securely assemble the separate device to ensure stability during use.

7. 3D Printed Keyboard Assembly:
   - Utilize 3D printing technology to fabricate the braille keyboard.
   - Customize the layout and size of the keyboard to meet user needs and preferences.
   - Integrate high-quality push buttons onto the 3D printed keyboard, providing tactile feedback and requiring minimal force to activate.

8. Final Integration and Testing:
   - Assemble all the components, including the cotton gloves with haptic devices, electrical circuit connections, the separate device with Raspberry Pi Pico, and the 3D printed keyboard.
  - Perform thorough testing to ensure the functionality, reliability, and user-friendliness of the wearable haptic device

The assembly process involves careful attention to detail, quality control measures, and adherence to safety standards to create a high-quality wearable haptic device that enhances braille communication and accessibility.

5.Limitations and Challenges:

a) Fabrication is a crucial aspect of the development of any product, and doing it manually can present several challenges. The first challenge that the team faced was the need for precision and accuracy in the fabrication process. Manual fabrication can result in slight variations in the size and shape of components, which can affect the device's functionality. The team must ensure that the components are fabricated to precise specifications to maintain the quality and consistency of the product. Additionally, manual fabrication can be time-consuming and labor-intensive, which can affect the device's overall cost and production efficiency. Overcoming these challenges is critical to ensure the successful development of the wearable haptic device.

b)The second challenge that the team will face in developing the wearable haptic device is making electrical connections between the Raspberry Pi Pico and the haptic devices. Making electrical connections can be a complex process that requires precise wiring and connection techniques. The team must ensure that the electrical connections are secure and reliable to avoid any malfunctions or performance issues. Additionally, the electrical connections must be properly insulated to prevent any interference or signal degradation. Overcoming this challenge is crucial to ensure that the device can generate the intended haptic feedback and operate reliably over time.

c) Another challenge that the team will face in developing the wearable haptic device is connecting the mobile application with two Raspberry Pi Picos through a wireless connection. Wireless connections can be prone to interference, signal degradation, and disconnections, which can affect the device's overall performance. The team must ensure that the wireless connection is stable and reliable to ensure that the device can generate the intended haptic feedback and receive commands from the mobile application. This may involve optimizing the wireless protocol, using high-quality wireless components, and implementing effective error correction and packet loss prevention mechanisms. Overcoming this challenge is critical to ensure that the device can provide a seamless and responsive user experience.
d)The size and form factor of the device, particularly the separate box-like structure, may pose challenges in terms of ergonomics and comfort. It is crucial to ensure that the device is not too bulky or cumbersome, and that it can be

comfortably worn for extended periods without causing discomfort or hindering the user's movements.

e)The complexity of the device may make maintenance and repair more challenging. Accessibility to components, such as replacing haptic devices or repairing electrical connections, should be considered to ensure the device remains functional over time.

6.Scheduling plan:

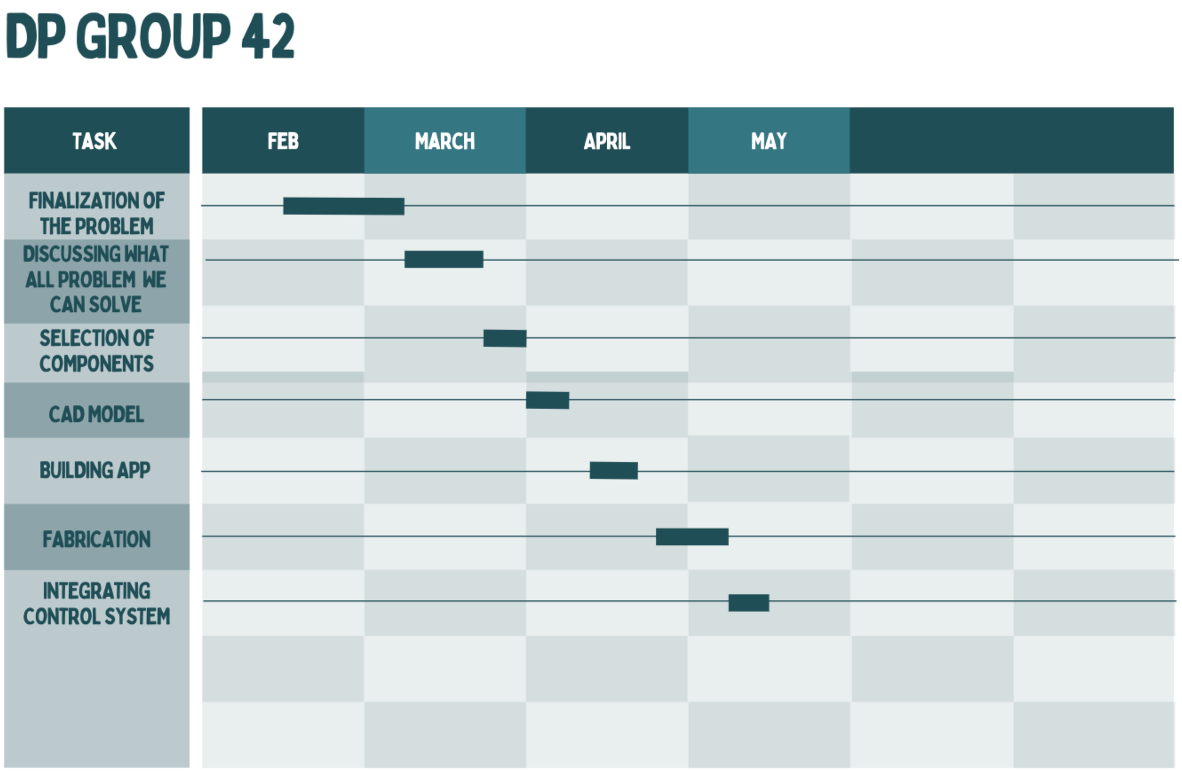


Fig 23: Gantt Diagram

Contributions:

1.

S.No.	Tasks(till Pre-Open House)	Members
1.	Project analysis & Research	Pankaj,Rishi,Ravi,Kalpavalli,Ritik
2.	Parts procurement	Kalpavalli,Rishi,Vinod,Ritik,Ravi
3.	Project finance and logistics	Ravi,Rishi,Ritik,Vinod
4.	Designing CAD model	Rishi, Ravi
5.	Report Writing	Pankaj, Kalpavalli,Rishi,Vinod
6.	Testing and Calibration	Ravi,Ritik,Rishi
7.	Electronics design and assemble	Ravi,Rithik
8.	Software code writing	Ritik,Ravi
9.	Poster writing design	Vinod,Pankaj, Kalpavalli,Rishi

In conclusion, the table highlights the collaborative efforts of the team members involved in various tasks leading up to the Pre-Open House. Each member has made valuable contributions to the project, leveraging their individual skills and expertise.

- The project analysis and research team (Pankaj, Rishi, Ravi, Kalpavalli, and Ritik) have dedicated their time to thoroughly analyze the project, conduct extensive research, and gather the necessary information to guide the development process.
- The parts procurement team (Kalpavalli, Rishi, Vinod, Ritik, and Ravi) has taken responsibility for sourcing and acquiring the required components, ensuring a smooth supply chain and timely availability of all necessary parts.
- Ravi, Rishi, and Ritik have been actively involved in testing and calibration, electronics design and assembly, and software code writing, respectively. Their expertise and efforts have been instrumental in ensuring the functionality and performance of the project.
- Additionally, Pankaj, Kalpavalli, Vinod, and Rishi have contributed to the project by working on report writing, designing the CAD model, and poster writing and design, respectively. Their contributions have helped document and communicate the project's progress and findings effectively.

- The collaborative efforts of all team members have played a vital role in the successful execution of the project so far. Their dedication, coordination, and collective skills have paved the way for a promising Pre-Open House, where the project can be showcased and evaluated. Moving forward, the team will continue to work together to address any challenges, refine the project, and ensure its success in subsequent stages of development.

Conclusions:

The wearable haptic device project combines several different elements and concepts to achieve its goal of creating a communication system for deaf and blind individuals. The project utilizes a Raspberry Pi Pico microcontroller as the primary component, which receives signals from mobile phones and sends signals to haptic devices. Additionally, the microcontroller receives signals from a keyboard and sends them to a mobile phone for further processing. While the design may still have some flaws and could potentially be made more efficient, it provides a solid starting point for anyone interested in further developing and improving communication systems for individuals with sensory impairments. The project highlights the potential of combining different technologies to create solutions that can improve the lives of people with disabilities.

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