The GRD Companion

(Gesture Controlled Reminder Device)

Julius Gamboa, Tro Hovasapian, Muti Shuman

Advisors: Radhika Grover, Ahmed Amer

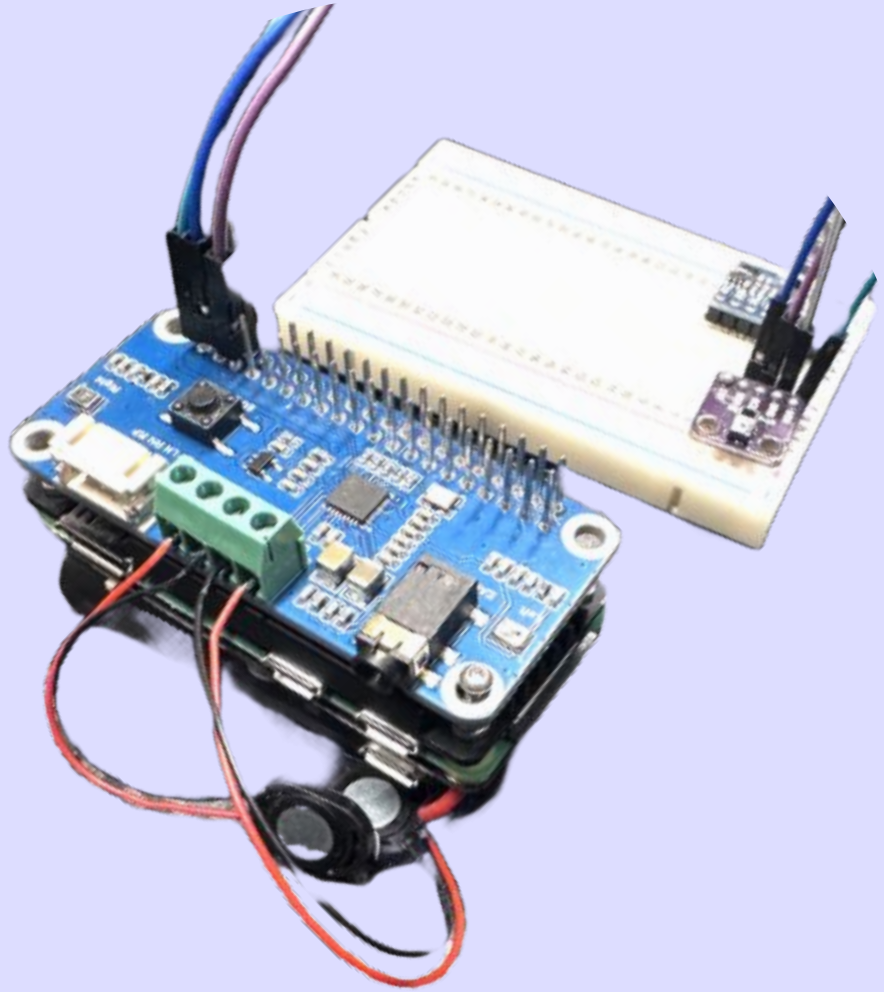
Santa Clara University

Santa Clara
Engineering

“We can change the world and make it a better place. It is in our hands to make a difference.”

Nelson Mandela

Overview



01

Background

Background

01 Special Needs adults go through challenges everyday in communication and staying focused [1]

02 Teachers, Caregivers, and Families are not provided enough help for special needs adults

Problem Statement

01 Individuals with special needs may face challenges in remembering daily tasks

02 Aiding special needs individuals in gaining more independence

03 Completing work/personal tasks successfully

Santa Clara Adult Education
Where learning and community meet

1851
Santa Clara Engineering

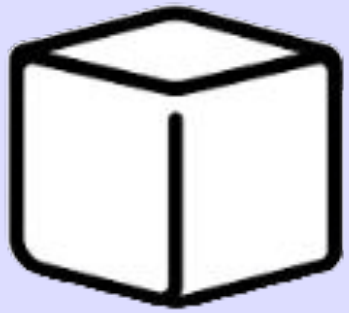
Background

Our Engineering Solution

Record & Send Audio Tasks

Output Audio Tasks

Gesture Controlled



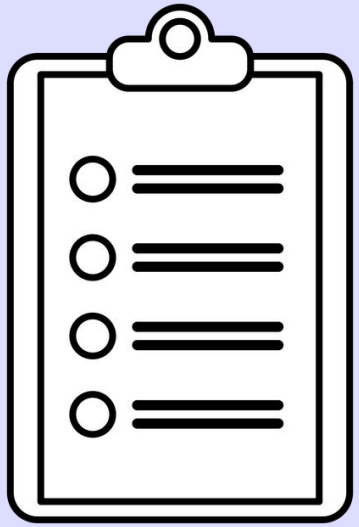
Portable

Alternative Analysis

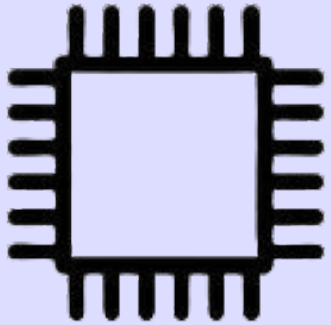
Feature Need	Existing Products	Our Product
Task Input Method	Manual Setup	Remote Setup
Task Output for Users	Text Based sent through notifications	Audio Reminders
Control Interface	Buttons and Touchscreens	Gesture Recognition
Portability	Smartphones and Tablets	Placed anywhere or clipped onto belt
Accessible for Special Needs	Could be complex or distracting	Designed for special Needs

Constraints

User-Centered Design



Testing and Feedback



Hardware Availability

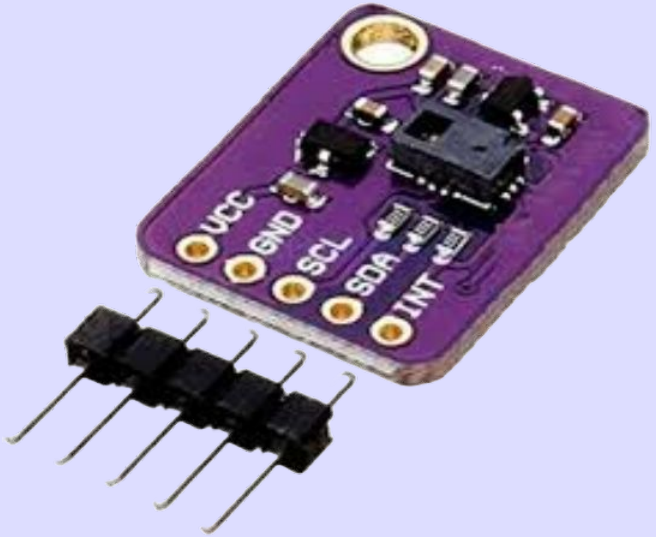
Ethical Considerations

02

Engineering Design

Hardware

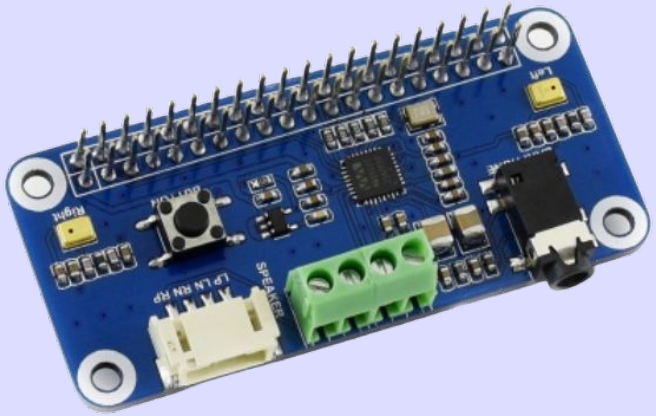
Raspberry Pi Zero 2 W



PAJ7620U2 Gesture Sensor

Hardware

PiSugar 2
Portable Battery

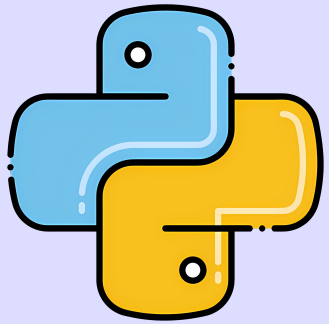


WM8960 HAT

8Ohm 2W
Speaker

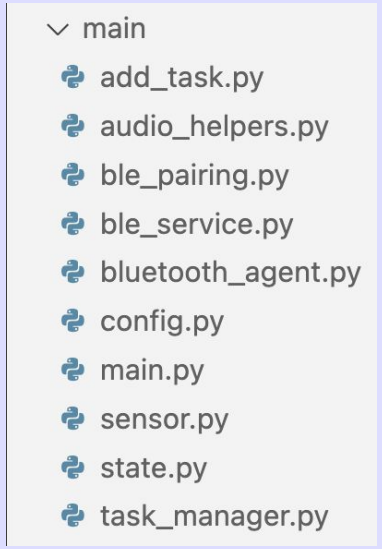
Software

- Python
- C++
- Swift



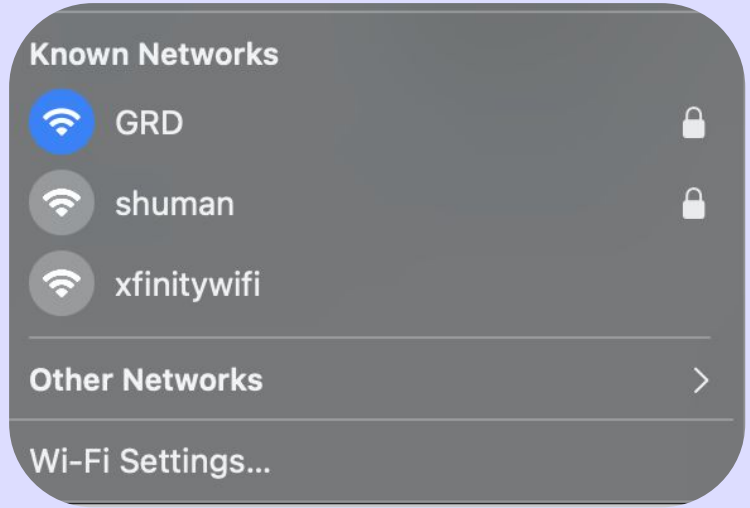
Code Structure

- Main.py
- sensor.py
- ble_service&pairing.py
- state.py
- task_manager.py
- audio_helpers.py



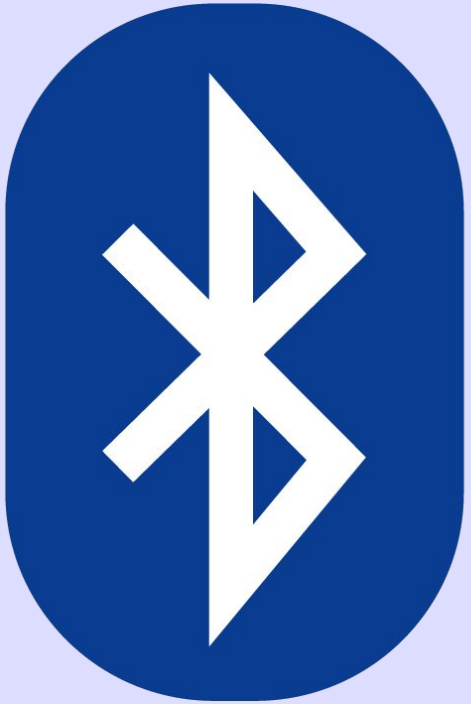
WIFI/Hotspot Connectivity

- Consistent Network Access
- Wireless connectivity
- Ease of development
- Secure & Auto Connect



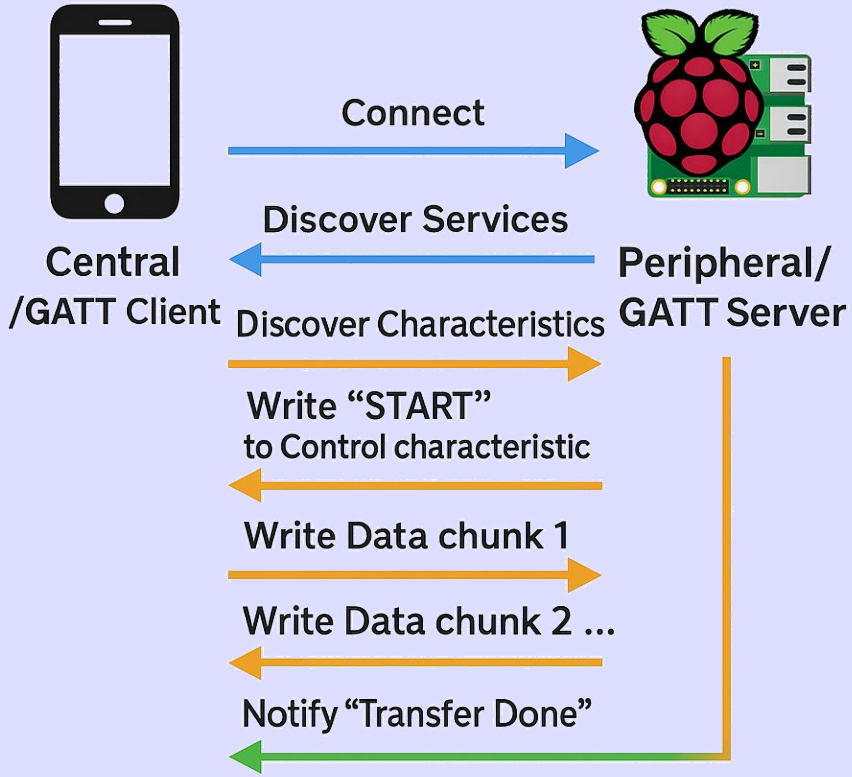
Bluetooth Connectivity

- Utilized BLE to ensure low power draw when connecting to device
- Secure connection using code pairing authentication
- Auto connects to RPI when bluetooth is activated and in range



BLE and GATT

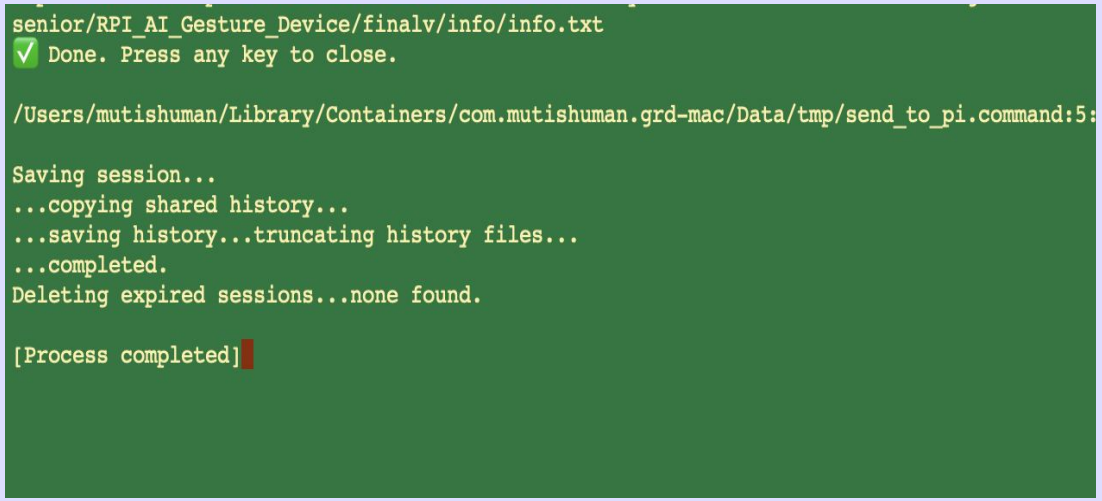
- BLE's framework for organizing data into services and characteristics
- GATT lets the app automatically discover which characteristics to write to



Engineering Design

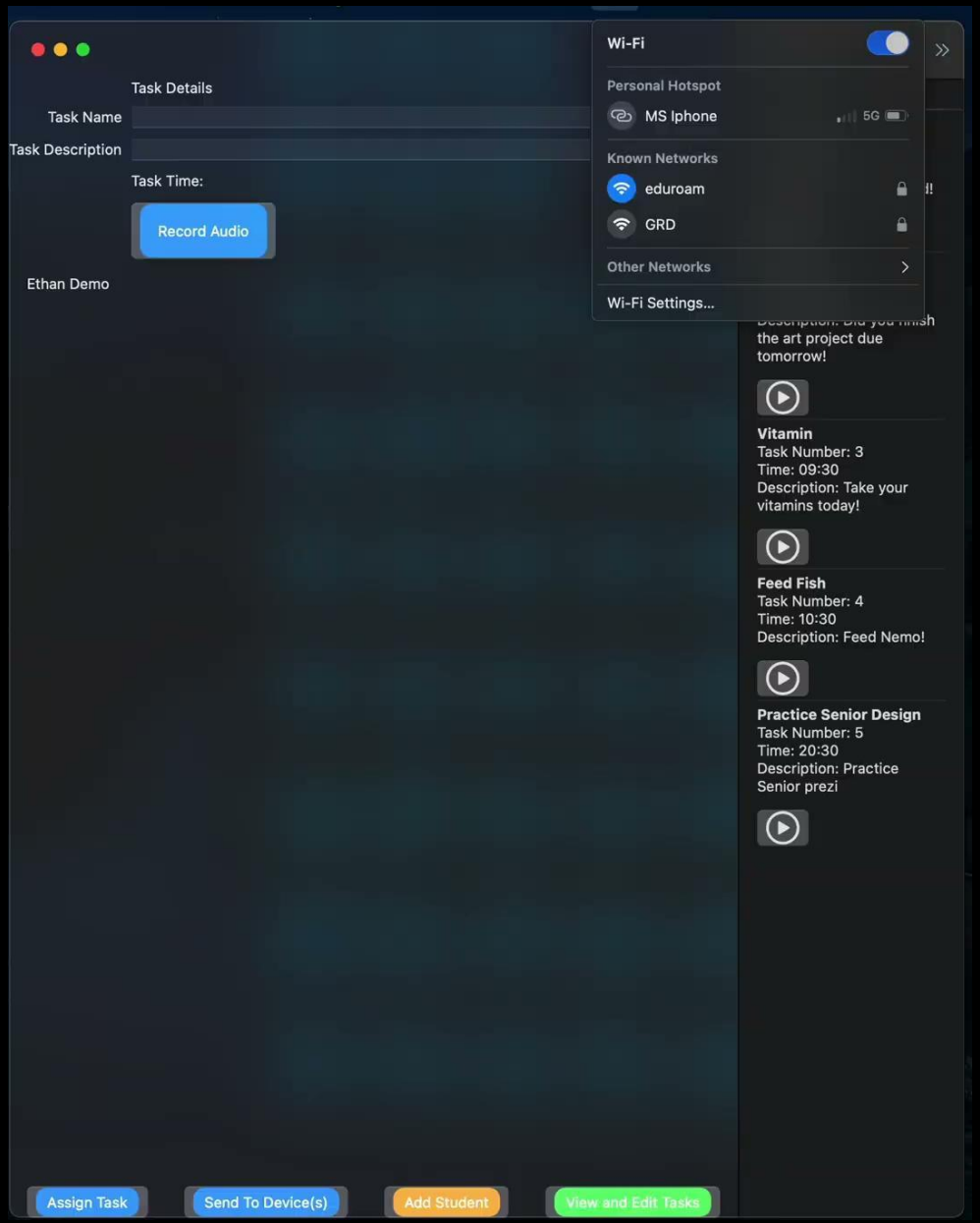
WIFI and BLE

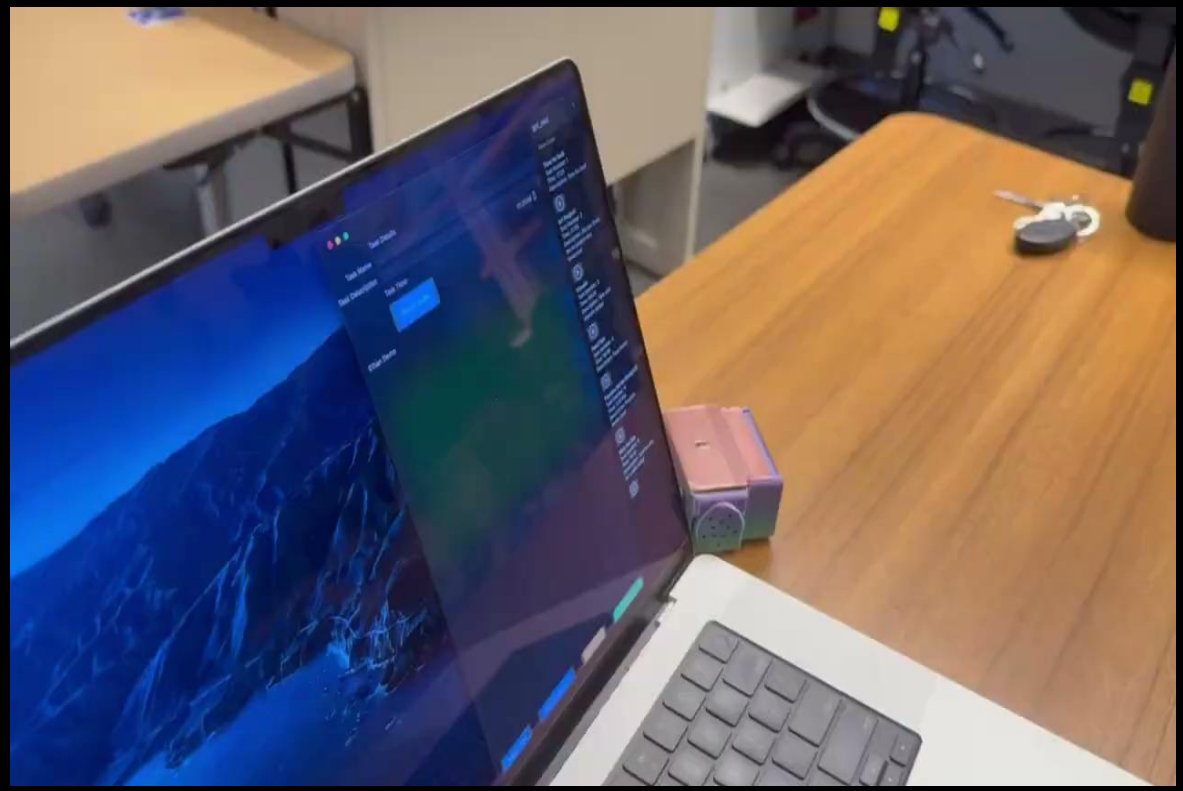
- Shell Script
  - Used to send information to the mac via wifi
- BLE_pairing.py
  - Utilizes bleak scanner and gatt to connect the app to the device



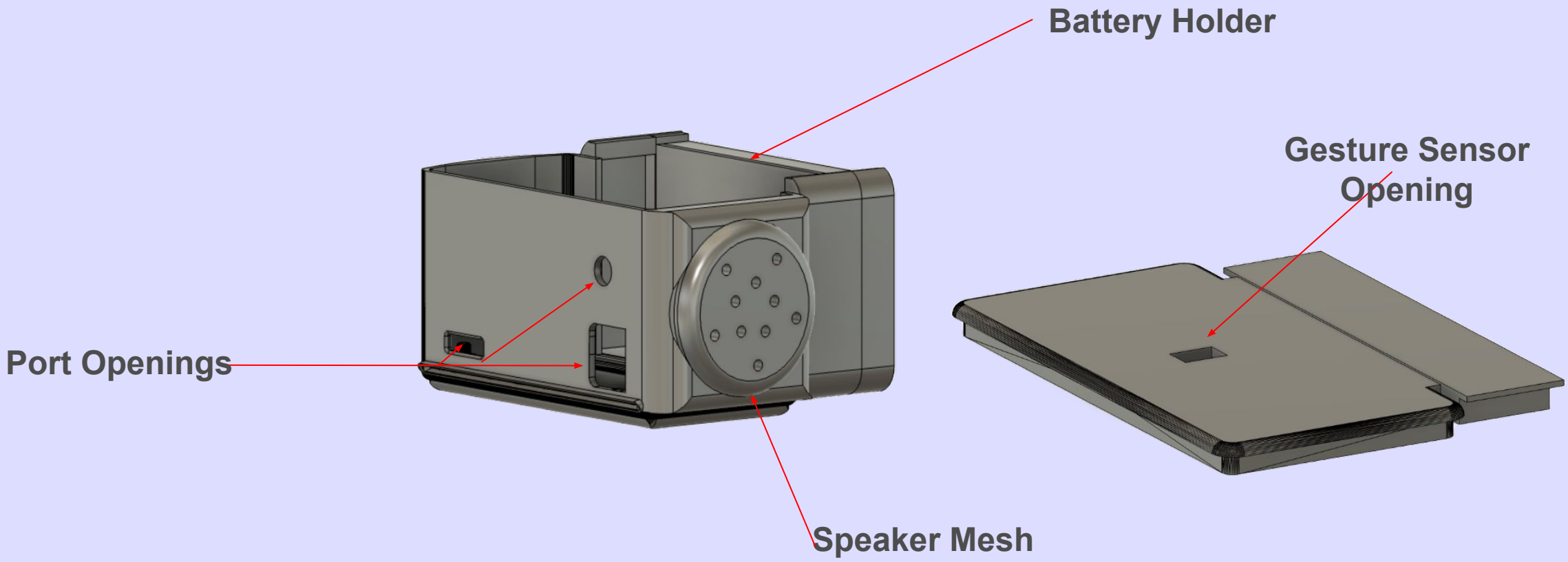
03

FINAL PRODUCT DESIGN

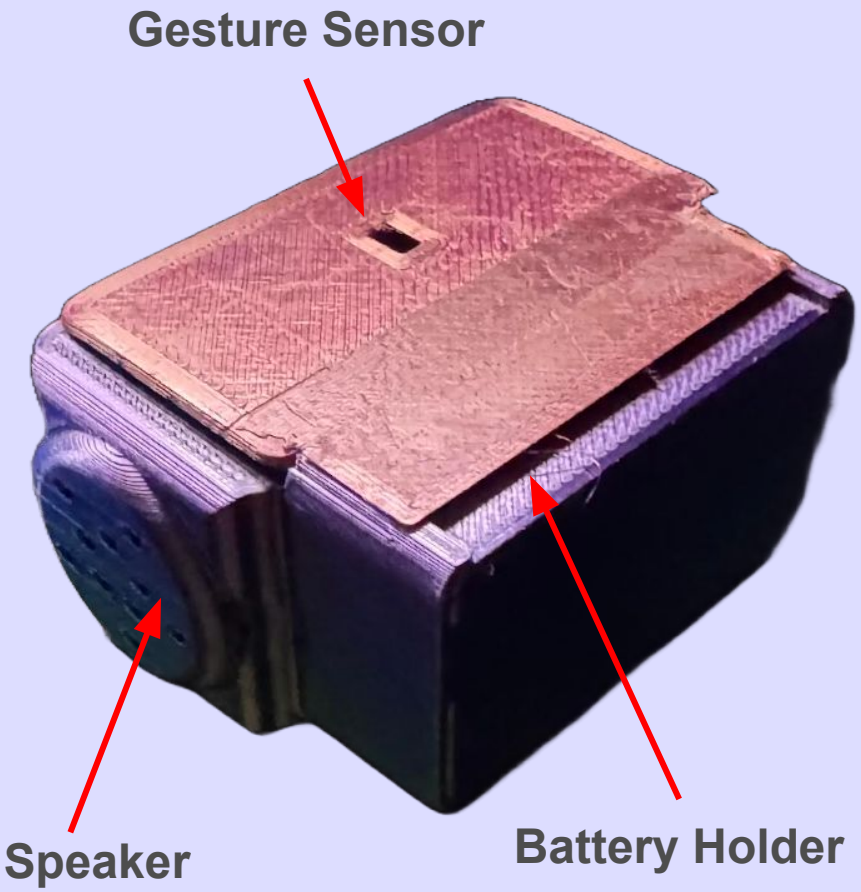

Task Details
Task Name
Task Description
Task Time:
Record Audio
Ethan Demo
Wi-Fi
Personal Hotspot
MS Iphone
5G
Known Networks
eduroam
GRD
Other Networks
Wi-Fi Settings...
the art project due tomorrow!
Vitamin
Task Number: 3
Time: 09:30
Description: Take your vitamins today!
Feed Fish
Task Number: 4
Time: 10:30
Description: Feed Nemo!
Practice Senior Design
Task Number: 5
Time: 20:30
Description: Practice Senior prezi
Assign Task
Send To Device(s)
Add Student
View and Edit Tasks



3D Printed Case Design

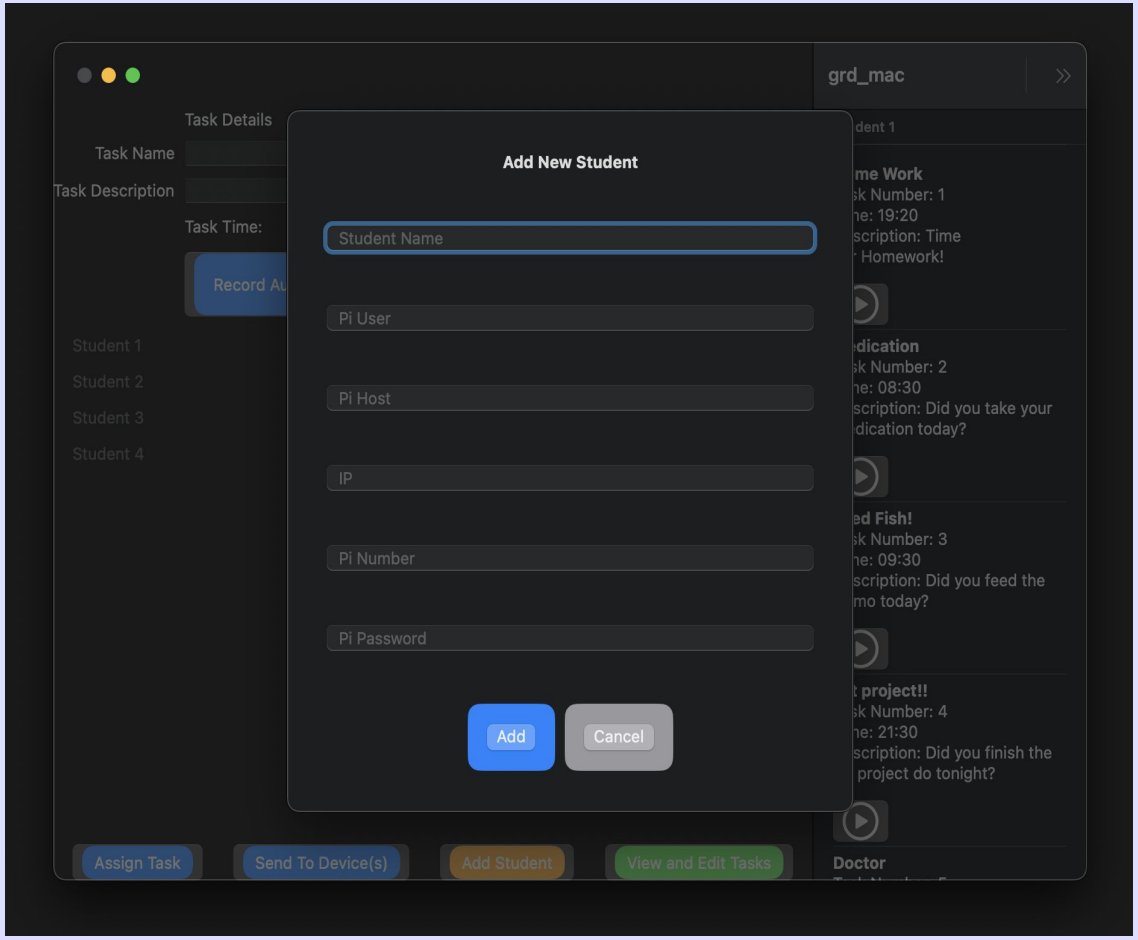


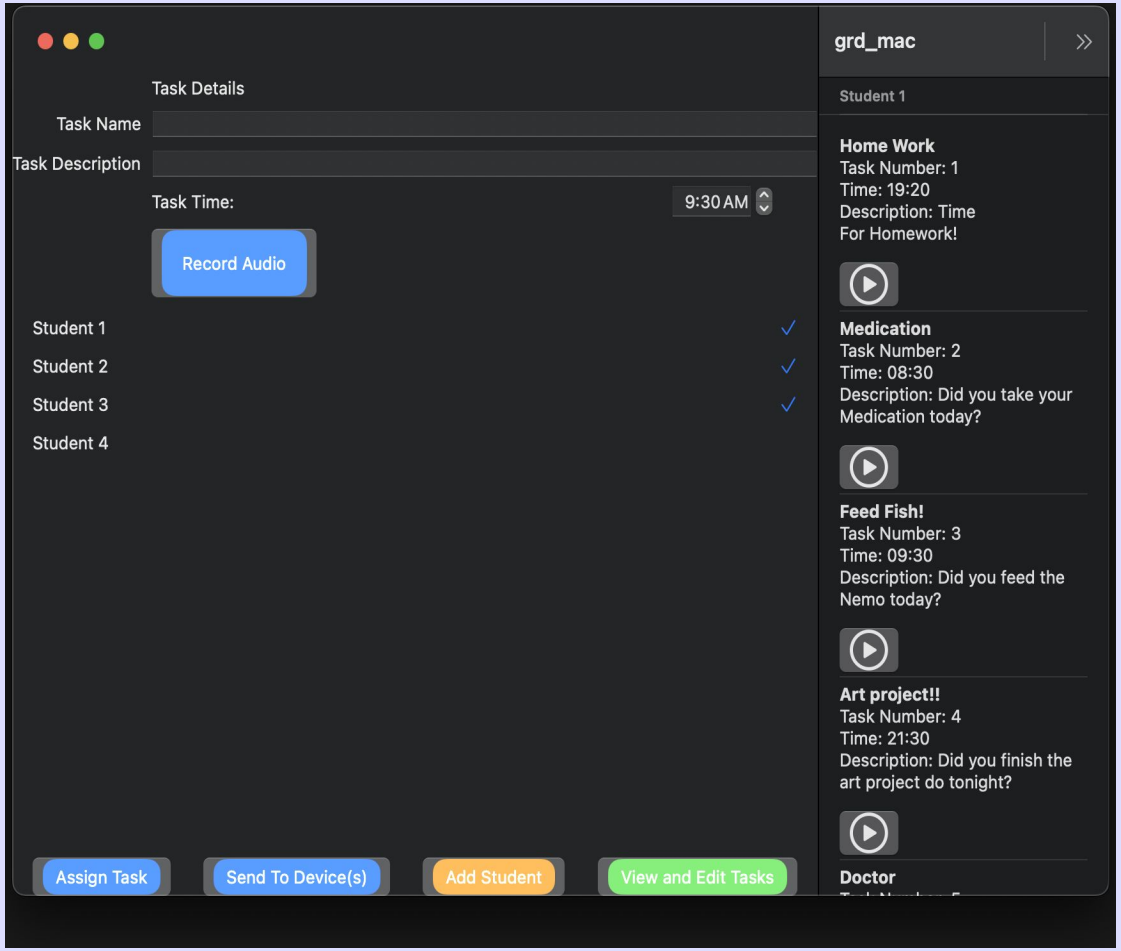
Final Product Design



Final Product Design

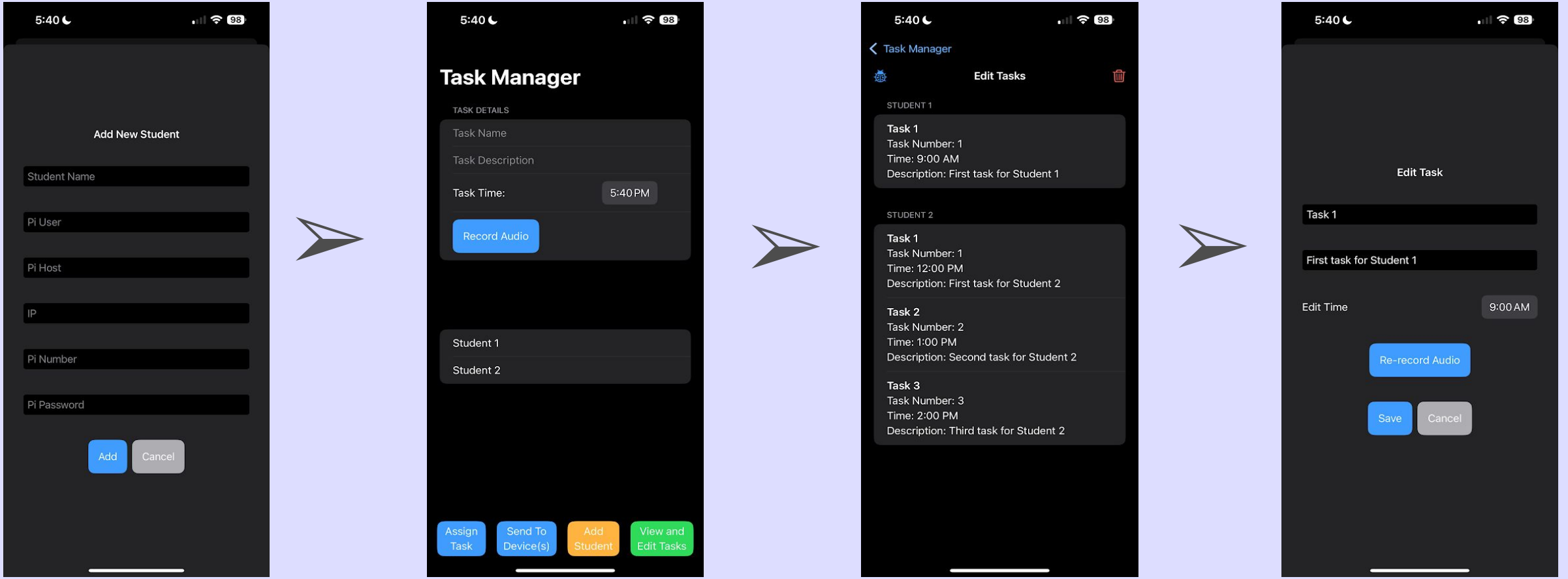
Wave Link Desktop



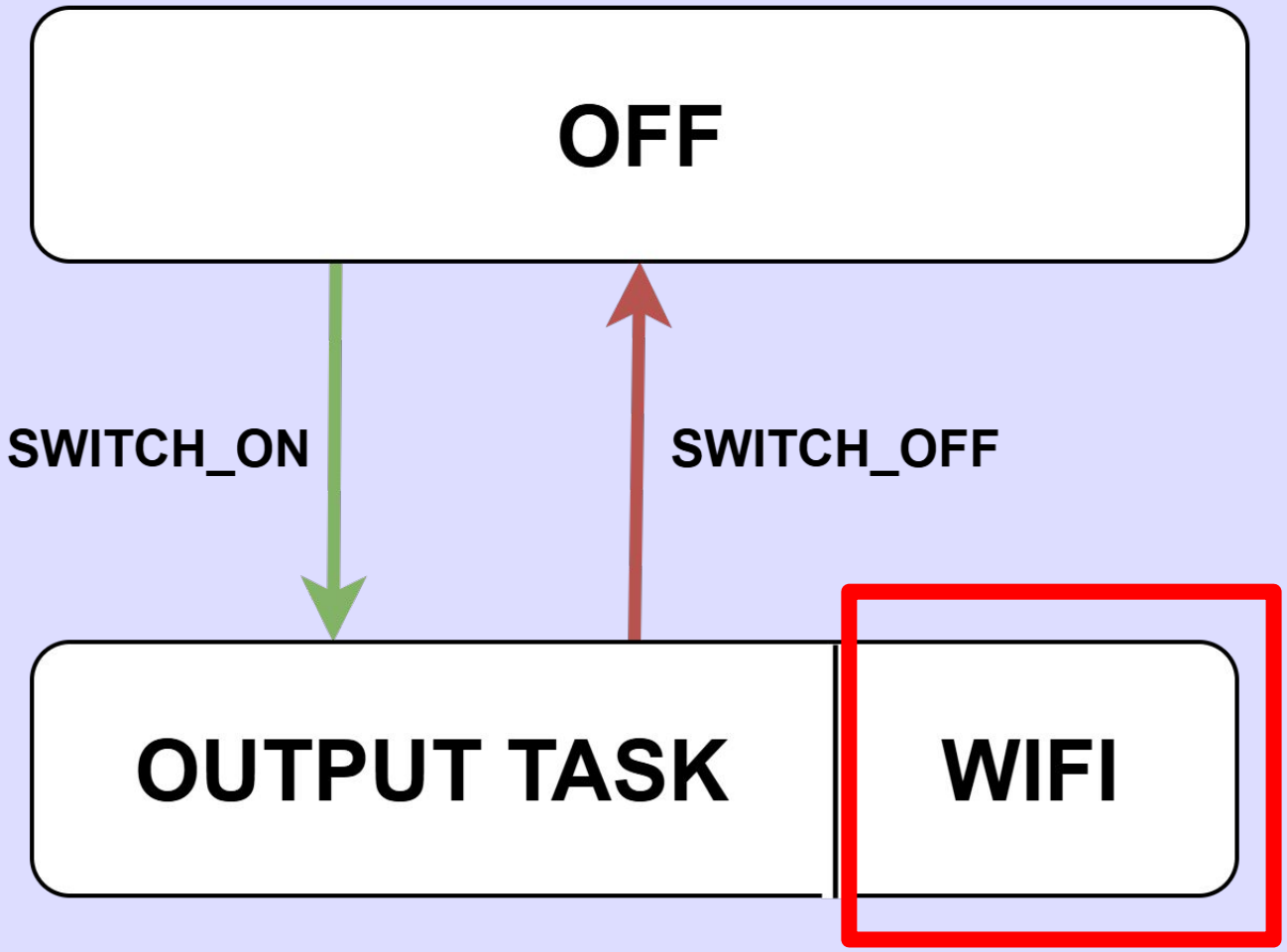


Final Product Design

Wave Link Mobile



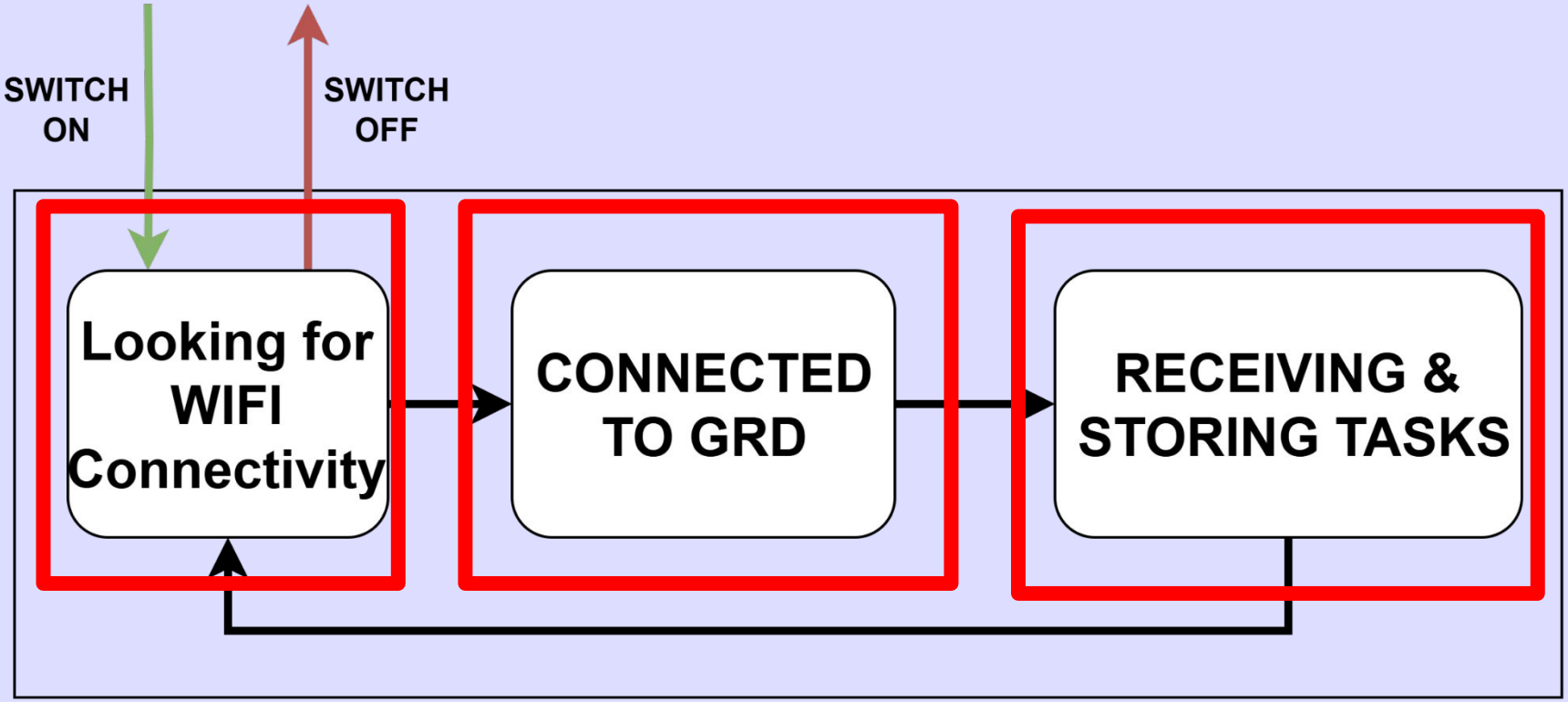
State Machine



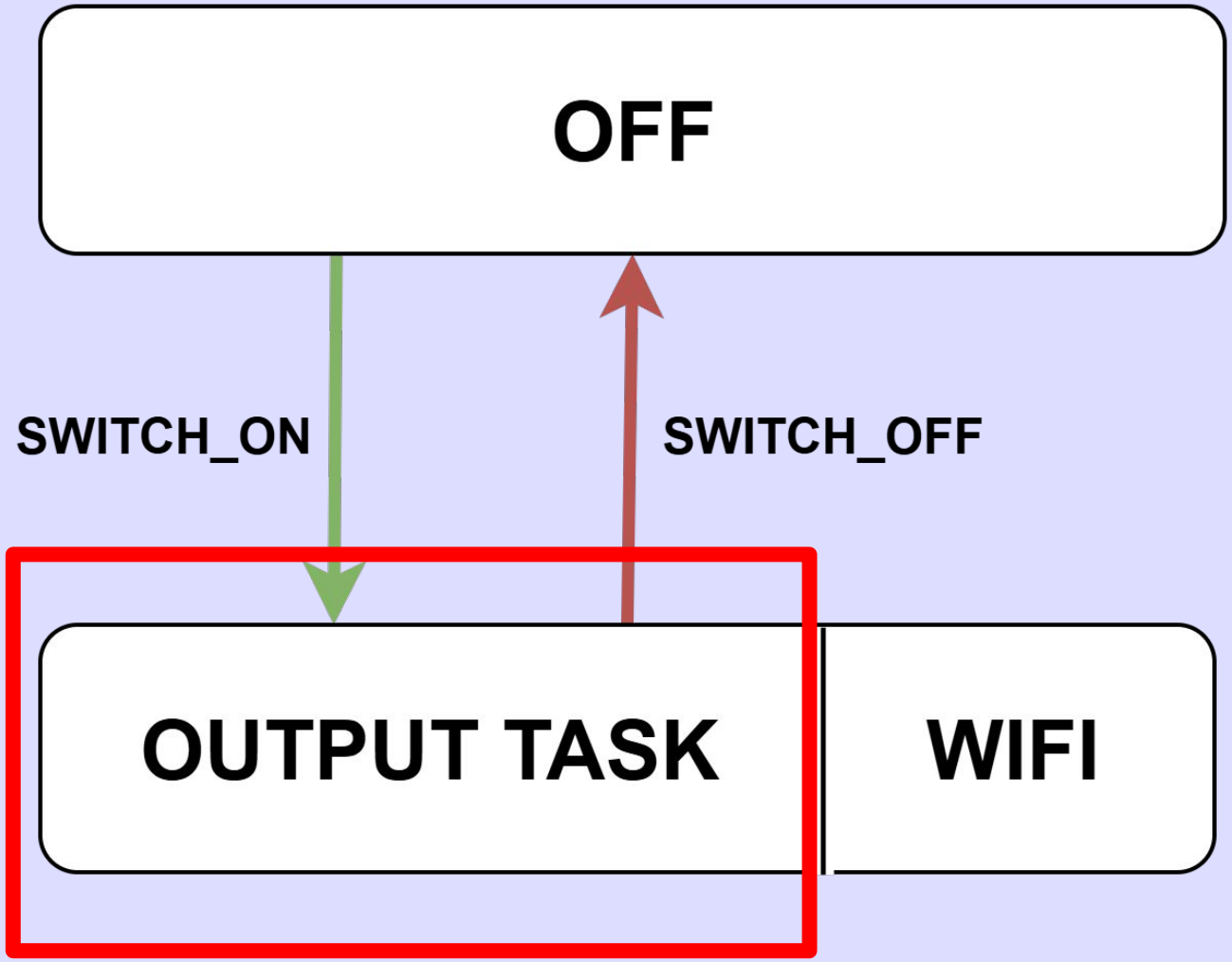
States:

- **OFF**: Device is Shutdown
- **OUTPUT TASK**: GRD will output the reminder task for user
- **WIFI**: GRD Connects to App via WIFI to send reminder tasks

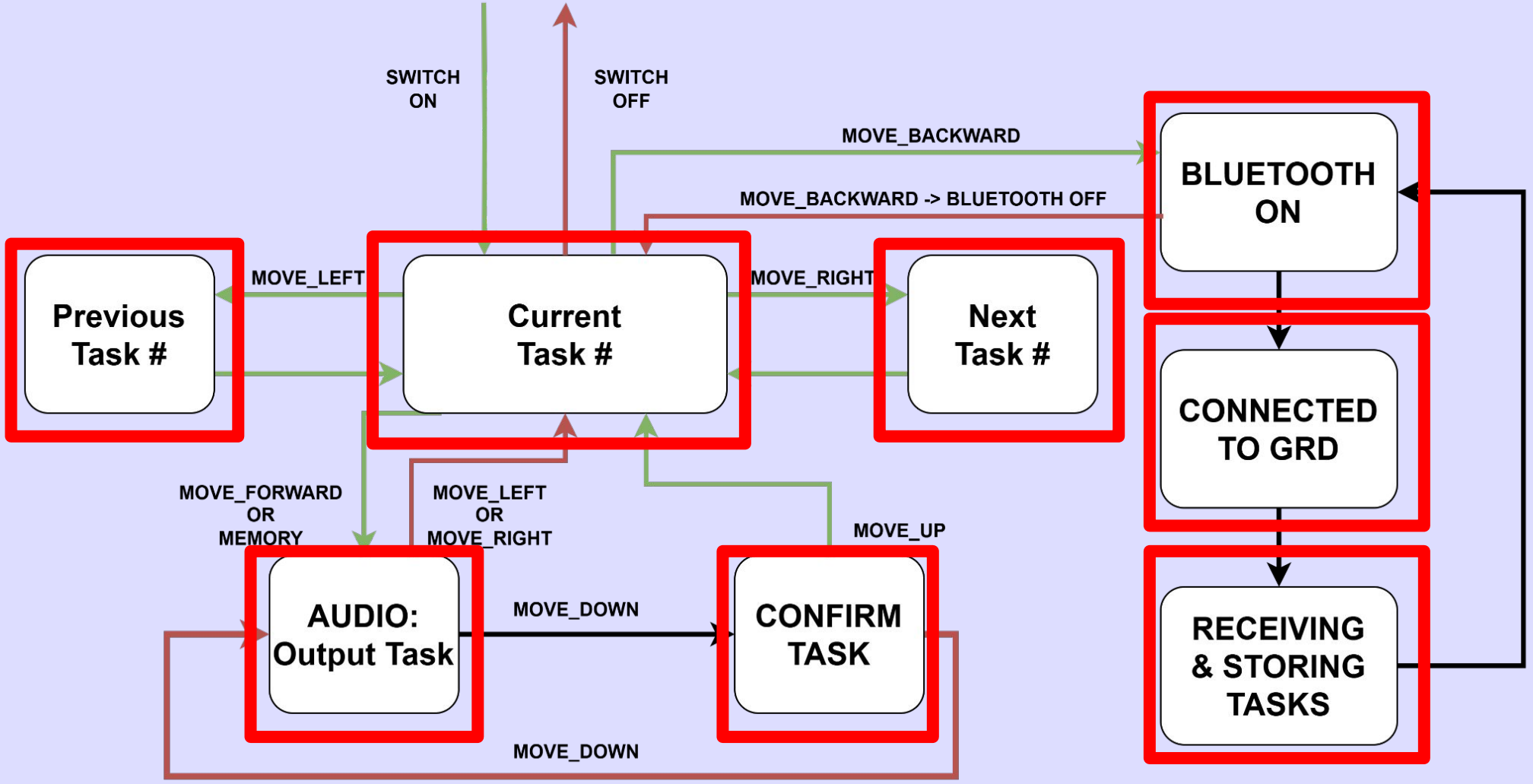
State Machine



State Machine



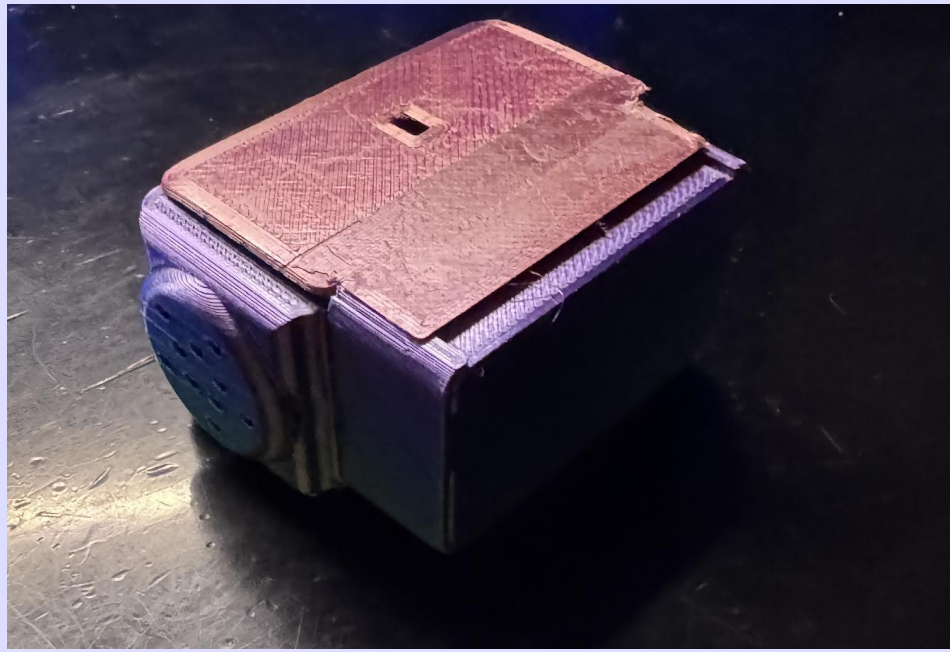
State Machine



Results

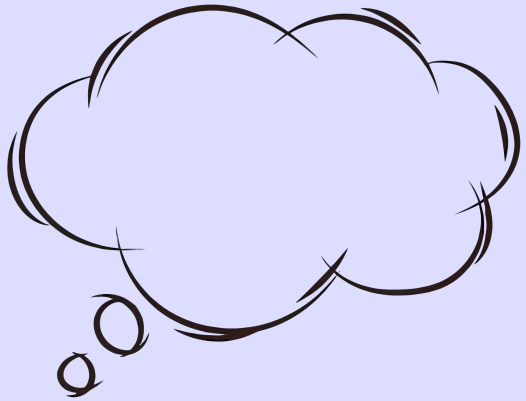
Does the GRD do what we envisioned?

- GRD can receive tasks created by the Teacher/Caregiver through the Wave Link app
- GRD can output tasks for the user to do
- GRD is controlled through simple gesture recognition
- GRD is small and portable

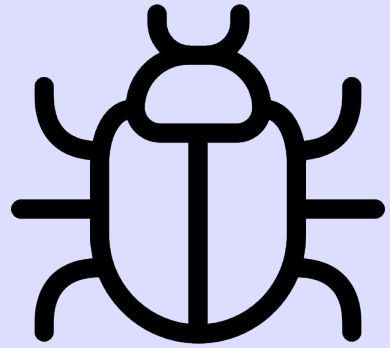


Challenges and Struggles

Accuracy



Design



Software Issues

04

ETHICAL CONSIDERATIONS

Ethical Considerations

Ethical Consideration	Our Approach
Economic	• Lower Cost GRD ($30) BATTERY ($30)
Health and Safety	• Designed GRD to be safe and easy to use
Social and Political	• Helping with services for Special Needs • Privacy considerations

Ethical Considerations

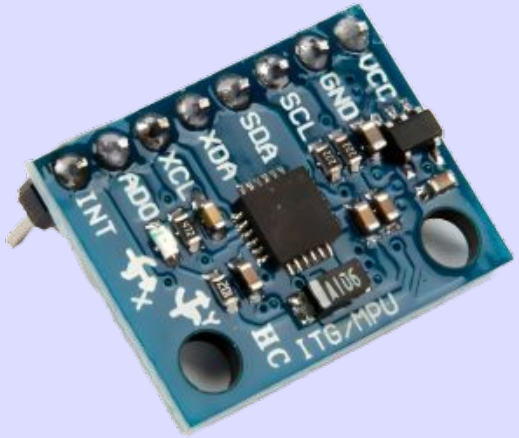
Ethical Consideration	Our Approach
Sustainability	Using Low Power Components
Manufacturability	Components are accessible and easy to replicate
Environmental	No Hazardous materials were used

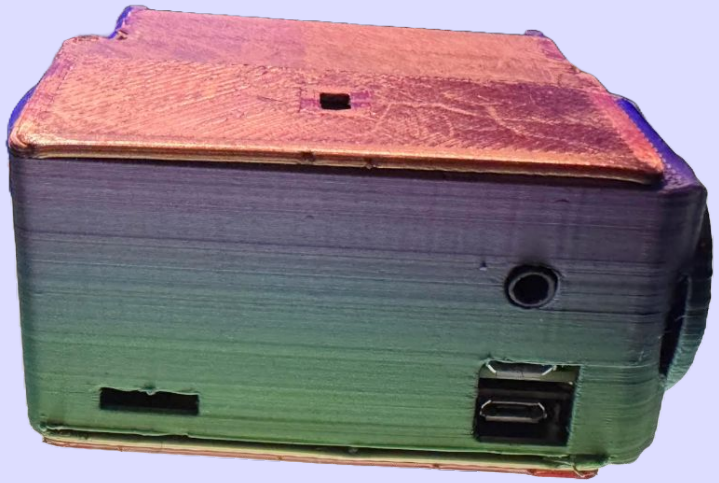
05

CONCLUSION

What's Next

- Start Testing the device with a student at Independence Network
- Continue to fix features to the software
- Potentially add more features to the device





06

ACKNOWLEDGEMENTS

Thanks to

Independence Network

Advisors: Dr. Grover & Dr. Amer

ECEN & CSEN Departments

Santa Clara Engineering

Santa Clara Adult Education
Where learning and community meet

References

[1] Hume, K., Loftin, R. & Lantz, J. Increasing Independence in Autism Spectrum Disorders: A Review of Three Focused Interventions. *J Autism Dev Disord* 39, 1329–1338 (2009). https://doi.org/10.1007/s10803-009-0751-2

[2] A. with, "DRO," *DRO*, Jan. 16, 2023. Accessed: May 7, 2025. [Online Photo]. Available: https://www.droregon.org/know-your-rights/americans-with-disabilities-act

[3] "Independence Network - Santa Clara Adult Education," *Santa Clara Adult Education*, Mar. 21, 2025. Accessed: May 7, 2025. [Online Photo]. Available: https://www.santaclaraadulted.org/independence-network/

[4] Raspberry Pi Zero 2 W. Accessed: Dec 8, 2024. [Online Photo]. Available: https://www.amazon.com/Raspberry-Zero-Bluetooth-RPi-2W/dp/B09LH5SBPS/ref=sr_1_1?crid=WZII02AMZ0CR&dib=eyJ2IjoiMSJ9._aa2DALNqDdQhYnIXw1mxtKXrPGy0_AHAf87tp7ynlNfUlc3HL0CO8_RVyB9Bqfq0cNNRNDLZkqYd0lii7_MjYT2I58epJnCh3OldtAUv3HZo9lHl8HPP8hrbdtAwljmSHKqEDSlm0QzTNhqHq7-33ySx1cAx2_6jqZXpt1fX-njjJ4oKG2qpP-VfRbbYsjzQyR5u9gDRzkGZUwfZdcFcc7cWX6vT1UOk7ol6wtVXnM.wTTPX6xkE62Teny0CNi6J7QyQZYcxPr7cNhlu8XbWo8&dib_tag=se&keywords=raspberry+pi+zero+2+w&qid=1733716820&sprefix=raspberry+pi+%2Caps%2C196&sr=8-1

[5] PAJ7620U2 3.3V Gesture Recognition. Accessed: Dec 8, 2024 [Online Photo]. Available: https://www.amazon.com/HiLetgo-PAJ7620U2-Recognition-Detection-Recognize/dp/B07QGZV4ZG/ref=sr_1_3?crid=3OUPVVGWD0S6V&dib=eyJ2IjoiMSJ9.xOT_KRVwyIXglaH_tugRiGBNju99zIQURwjUQSiq6lHXqGWAk8pHYOGD1sov0l70fFlf7dxxO0U8f_MOKKVe1V2M0rfHVWSnOJlpsvjhaN6GHu63leevGdtxnPugzFT2dP6xtaOWqr4J01qq8Z8OFNcrWtq-olluUvfo8PuzOxSnA-43Ve_QpNHi7wsiosI9QkN-184R4u8VjRmYQwdxOjv90XnxOWmInnbia6A7g1A.nWaTTzaiutikEw6c9PrXp7h2pax2yz314lg0_F_MCml&dib_tag=se&keywords=gesture+sensor+rpi&qid=1733717012&sprefix=gesture+sensor+rpi%2Caps%2C203&sr=8-3

[6] "PiSugar 2 1200 mAh Raspberry Pi Zero Battery," *PiSugar Kitchen*, 2025. Accessed: Dec 8,2024 [Online Photo]. Available: https://www.pisugar.com/products/pisugar2-raspberry-pi-zero-battery

[7] WM8960 Hi-Fi Sound Card HAT for Raspberry Pi, Stereo CODEC, Play/Record. Accessed: Dec 8, 2024 [Online Photo]. Available: http://waveshare.com/wm8960-audio-hat.htm

[8] "Amazon.com: Weewooday 6 Pcs 2W 8 Ohm Small Speakers Metal Shell Round Internal Magnet Speaker Micro Internal for DVD, EVD, Mini Multimedia Loudspeaker : Electronics," *Amazon.com*, 2025. Accessed: Apr. 07, 2025 [Online Photo]. Available: https://www.amazon.com/Weewooday-Speakers-Internal-Speaker-Multimedia/dp/B09MRK24PP?source=ps-sl-shoppingads-lpcontext&ref_=fplfs&psc=1&smid=A1JX4L5CBS4J9K&gQT=1

THANK YOU!

Q&A