Team E1:

Give Me A Sign

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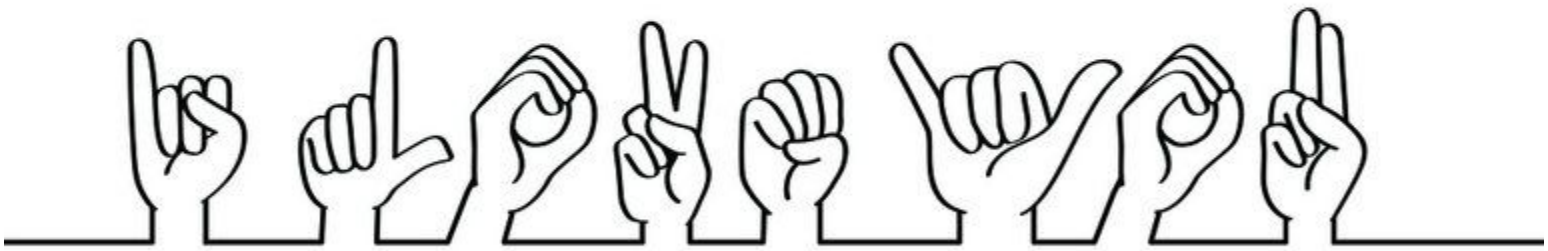
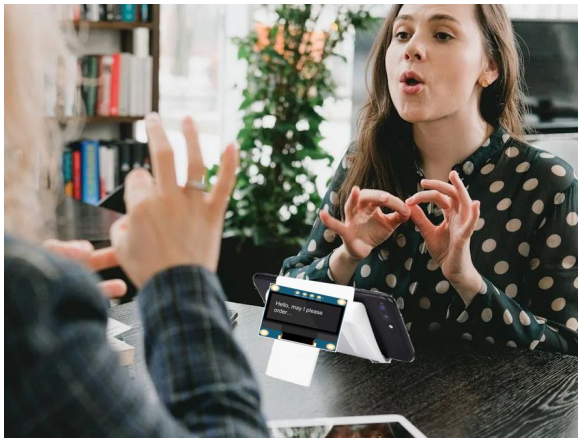


Use Case / Application

There exists communication barriers between the deaf community and those who are not familiar with sign language.

Our Solution:

Real-time ASL Translator App + Phone Attachment



Quantitative Design Requirements

Requirement	Quantitative/Qualitative Specifications
Person must be near camera so gestures are visible and tracked	Distance📏: 1.0 - 3.9 ft + Brightness💡: 10 - 500 lux [1] → Process image (resize, grayscale, normalize) and reduce noise using temporal/spatial filtering and/or background subtraction
Gesture recognition should be accurate	Accuracy🎯: >= 95% → MediaPipe hand & pose recognition (21*2+22 = 64 landmarks)[2]
Translation should be accurate	Accuracy🎯: >= 95% → Use hybrid of CNN for static and LSTM for dynamic signing
Translation should be relatively immediate to work as “live subtitles”	Latency🏃: 1 - 3s → CV frame rate: 10-15 fps + ML processing + NLP correction
Good accessibility for positive user experience for both parties involved	Satisfaction rate😄: >=90% → Minimalistic mobile app UI/UX design + near-random sampling

Solution Approach

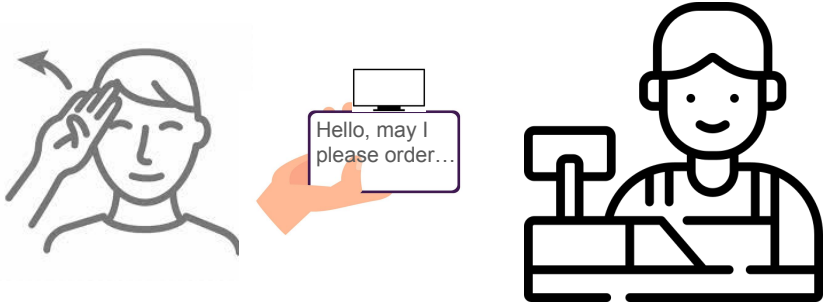
Inclusivity of ASL users and for people to actively engage in conversations even with communication barriers

Our product aims to promote:

- ✓ Public Health & Welfare
- ✓ DEI & Social Support
- ✓ Accessibility

Evolved from proposal (Reach goals):

- Speech to text
- Signal end of sentence
- Facial recognition



System Specification

User Input / gestures / poses

Phone Camera

Video

CV Processing

OpenCV

MediaPipe

DB

CNN/RNN + NLP

ML Translation

English Text

Cloud DB
AWS

Mobile App
ASL user faced

OLED Screen
Non-ASL user faced

legends

HW

SW

Off-the-shelf part

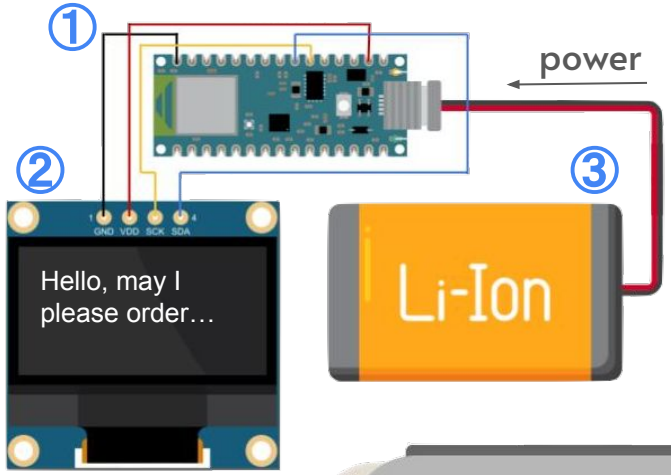
Our design

INPUT

PROCESS

DISPLAY

Hardware Implementation



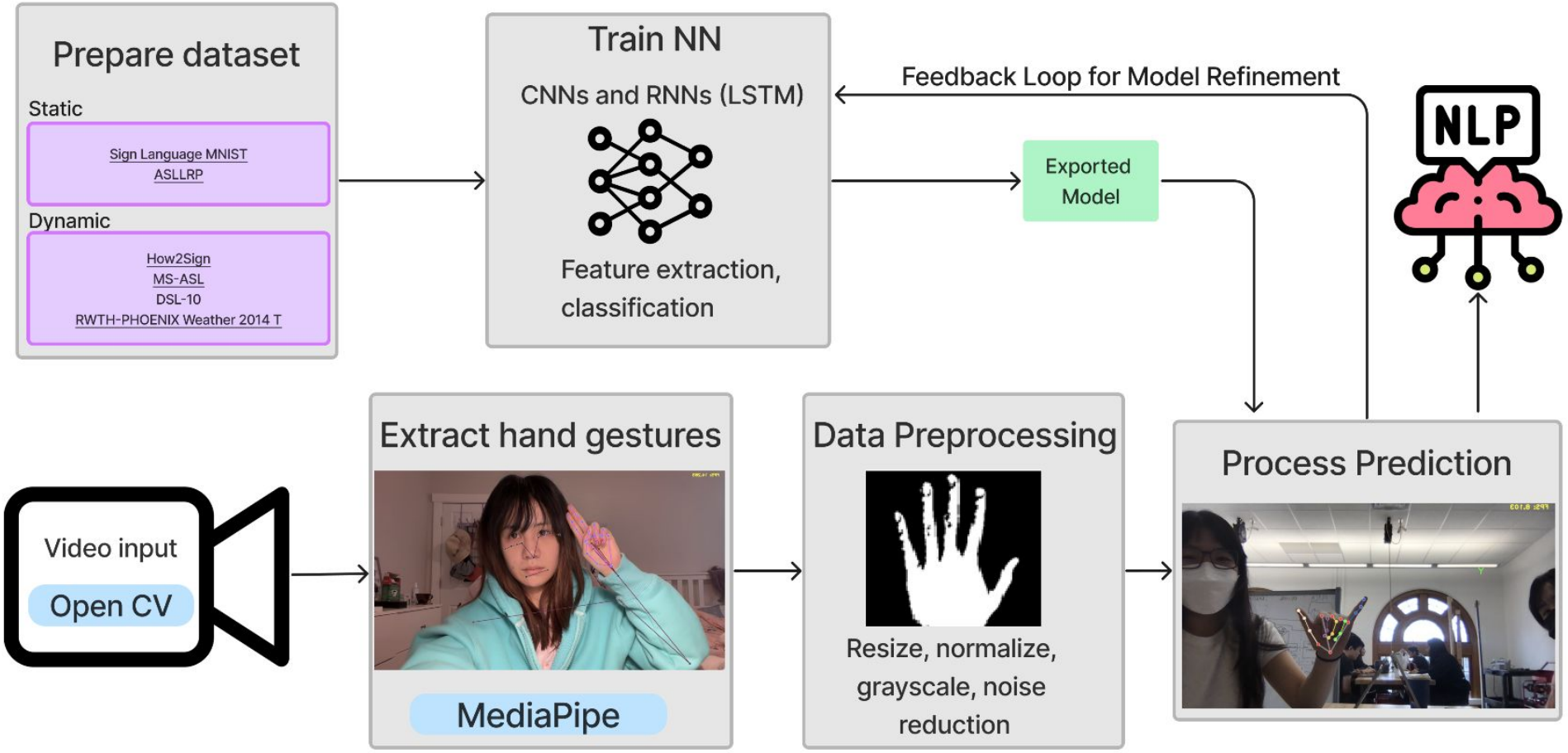
① **Arduino**
- Model: Nano 33 BLE
- Bluetooth connected to SW

② **OLED screen** (Alternative: LCD)
- Diagonal size: 2.42”

③ **Li-Ion battery**
- 3.7V 1600mAh Rechargeable

④ **Phone attachment**
- 3D printing prototype
- Adjustable

Software Implementation



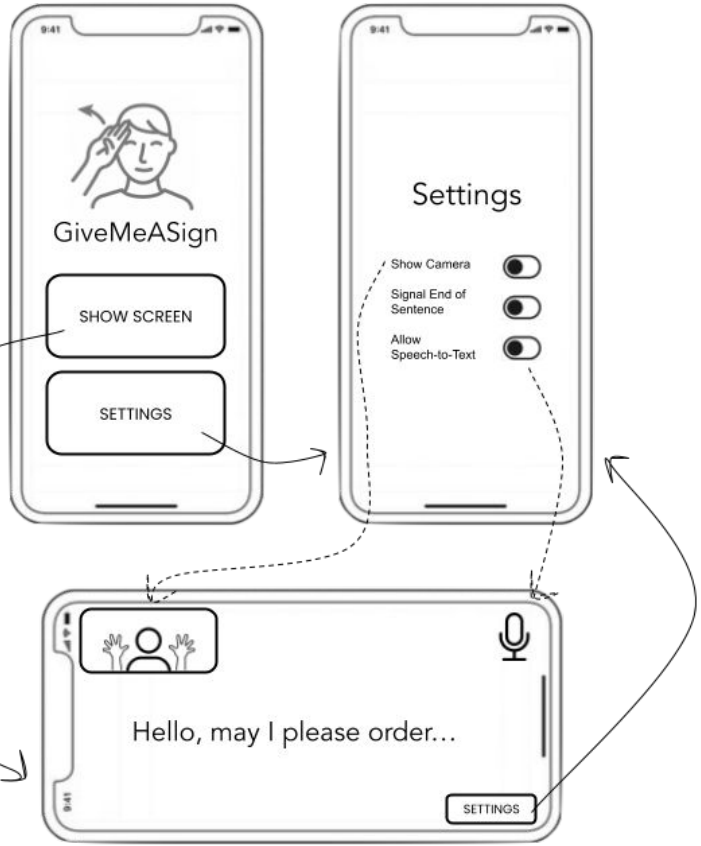
Integration Plan

- Mobile App
  - Swift/SwiftUI on Xcode
    - ✓ Unified ecosystem
    - ✓ Easy-to-learn

Android App & Java/Kotlin?

- Cloud Deployment
  - AWS (Amazon Web Services)
    - ✓ Low network latency (TTFB <500ms[4][5])
    - ✓ Compatible with iOS development

Google Cloud Firebase?



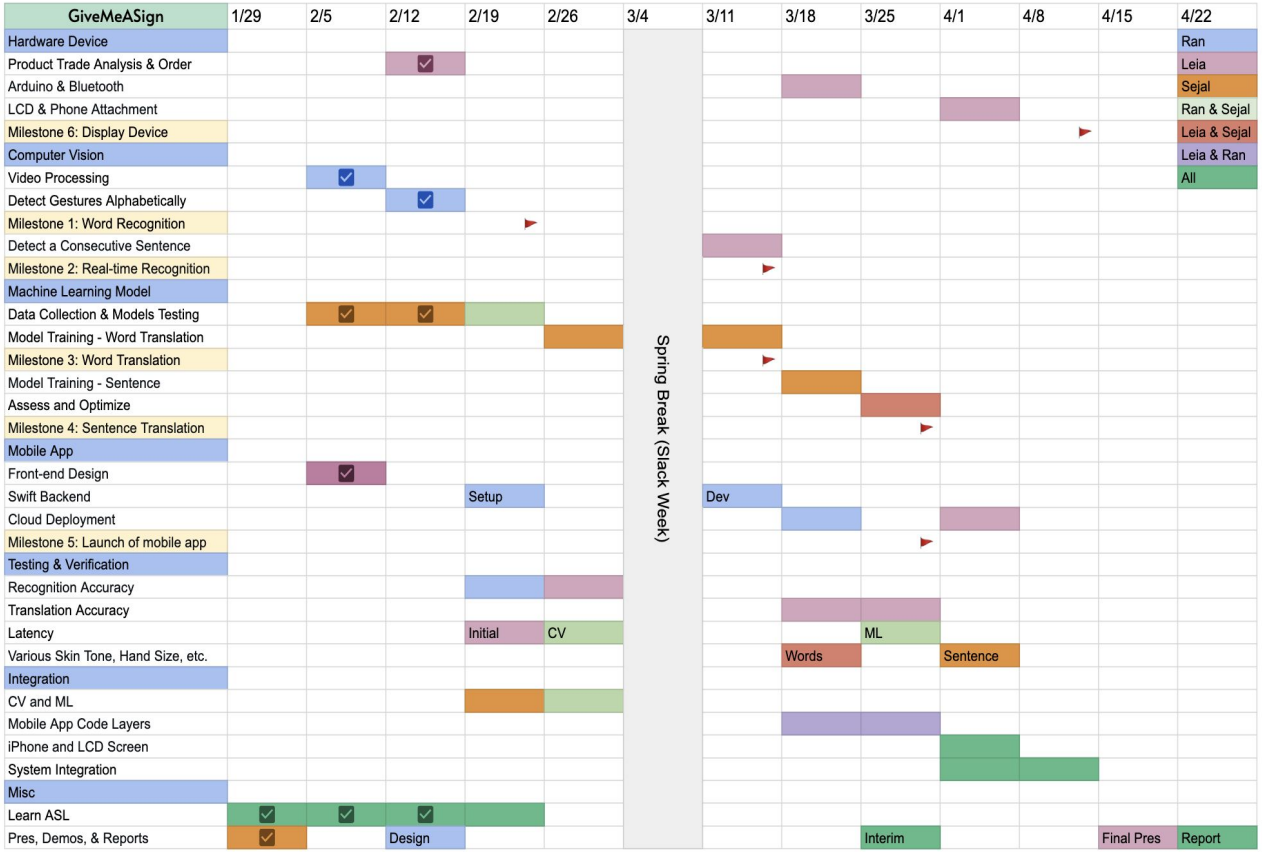
Test, Verification & Validation

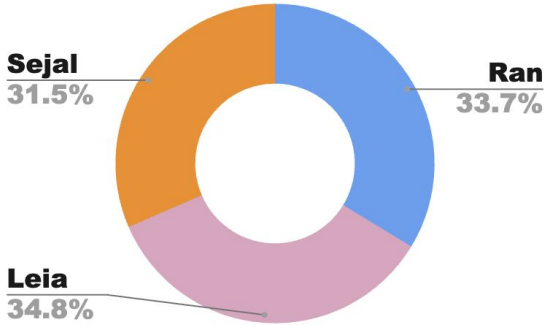
Use-Case Metric	How to test	Passing Metric	Risk Mitigation
Signing to occur 1-3.9ft from the camera	→] live signing & pose into camera at different distances ←] landmarks	Proper landmarks should appear at <3.9 ft	- Investigate potential factors (camera resolution, lighting conditions, etc.) and adjust accordingly
High accuracy (~95%) for gesture detection	→] live signing & pose into camera w/ various distractions, lighting, backgrounds ←] landmarks	CV/MediaPipe should display proper landmarks of the hands and upper body 95% of the time	- Optimize MediaPipe params - Enhance noise reduction - Provide user guidance on optimal signing conditions
High accuracy (~95%) for sign language translation	→] live signing of singular words & complex sentences ←] English text	English text should appear and be 95% accurate in semantic meaning	- Refine translation algorithms - Expand the training dataset

Test, Verification & Validation (continued)

Use-Case Metric	How to test	Passing Metric	Risk Mitigation
Low latency (1-3s) in translation	→] live signing / recording into camera ←] time (ms) elapsed before the translation appears	Translation should appear 1000-3000ms after a gesture	- Experiment on and assess different algorithms before implementation - Test cloud transmission speed on dynamic data
Product user satisfaction >= 90%	→] invited sign language users ←] oral feedback & survey results	90% user satisfaction	- Redesign the UI to improve clarity and intuitiveness
Ease of phone attachment use	→] invited sign language users ←] oral feedback & survey results	90% user satisfaction	- Redesigning attachment mechanism to improve comfort and convenience * Pivot: Laptop-based app

Project Management





Ran

Video processing with openCV
Hand & pose detection with mediaPipe

Sejal

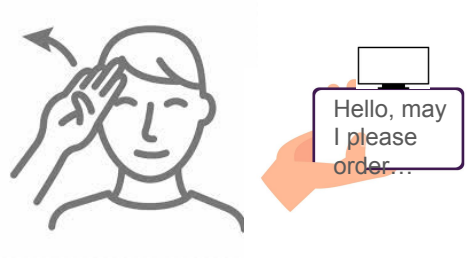
Word translation ML model
Sentence structuring and optimization

Leia

LCD screen integration
Device fabrication
Mobile app front end design

Conclusion

Through a simple and sleek phone attachment and combined mobile app, we can break down language barriers and ensure accessibility for deaf and hard of hearing community



References:

[1] https://greenbusinesslight.com/resources/lighting-lux-lumens-watts/

[2] Amit, M. L., Fajardo, A. C., & Medina, R. P. (2022). Recognition of real-time hand gestures using mediapipe holistic model and lstm with mlp architecture. *2022 IEEE 10th Conference on Systems, Process & Control (ICSPC)*, 292–295. https://doi.org/10.1109/ICSPC55597.2022.10001800

[3] Zhu, H., Deng, C., & Zhu, Y. (2023). Mediapipe based gesture recognition system for english letters. *Proceedings of the 2022 11th International Conference on Networks, Communication and Computing*, 24–30. https://doi.org/10.1145/3579895.3579900

[4] *What is time to first byte & how to improve it*. (n.d.). Sematext. Retrieved February 18, 2024, from https://sematext.com/glossary/time-to-first-byte/

[5] https://web.dev/articles/ttfb#:~:text=As%20a%20rough%20guide%2C%20most,on%20the%20metrics%20that%20matter