EchoSign

Ricky Gao, Ria Balli, Somya Pathak

EchoSign - Introduction and Use cases

- **Problem:** Deaf people often struggle to communicate with non-deaf speakers

- Pair of gloves that translate ASL to English
- Machine learning to translate sensor input to words
- Speakers to allow non-deaf people to quickly understand signing
- Additional feedback system in glove
- Areas: Signals and Software (Embed)

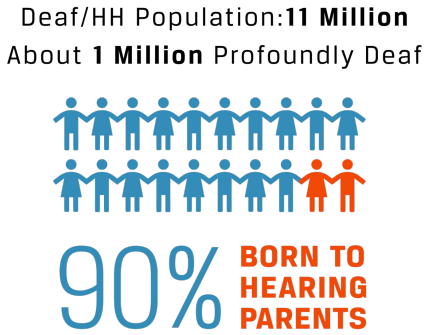
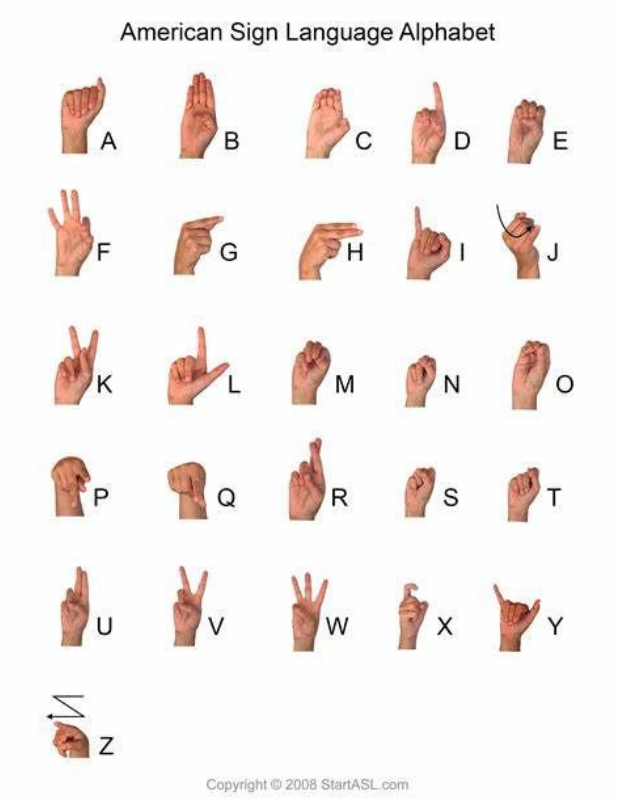


Image from BYU

Quantitative Requirements

- Latency - 0.5s from sign to speech
  - Inspired from an approximate estimate of average signing speed
- Vocabulary - 26 words
  - Need to balance sensor capability and complexity
  - Hope to create basic phrases
- Accuracy - 90%
- Glove weight - Around 100g
- Cost should be minimized
  - Maintain equality between ASL and non-ASL speakers



How Our Design is Different

- Two gloves instead of one
  - Past approaches primarily focus on singular glove designs (UCLA, GG)
- Flex sensors / IMU
  - Contrasts use of CV
- Wireless connectivity to compute
  - Contrasts wired connections to compute

Image from Computer Vision Zone

Technical Challenges

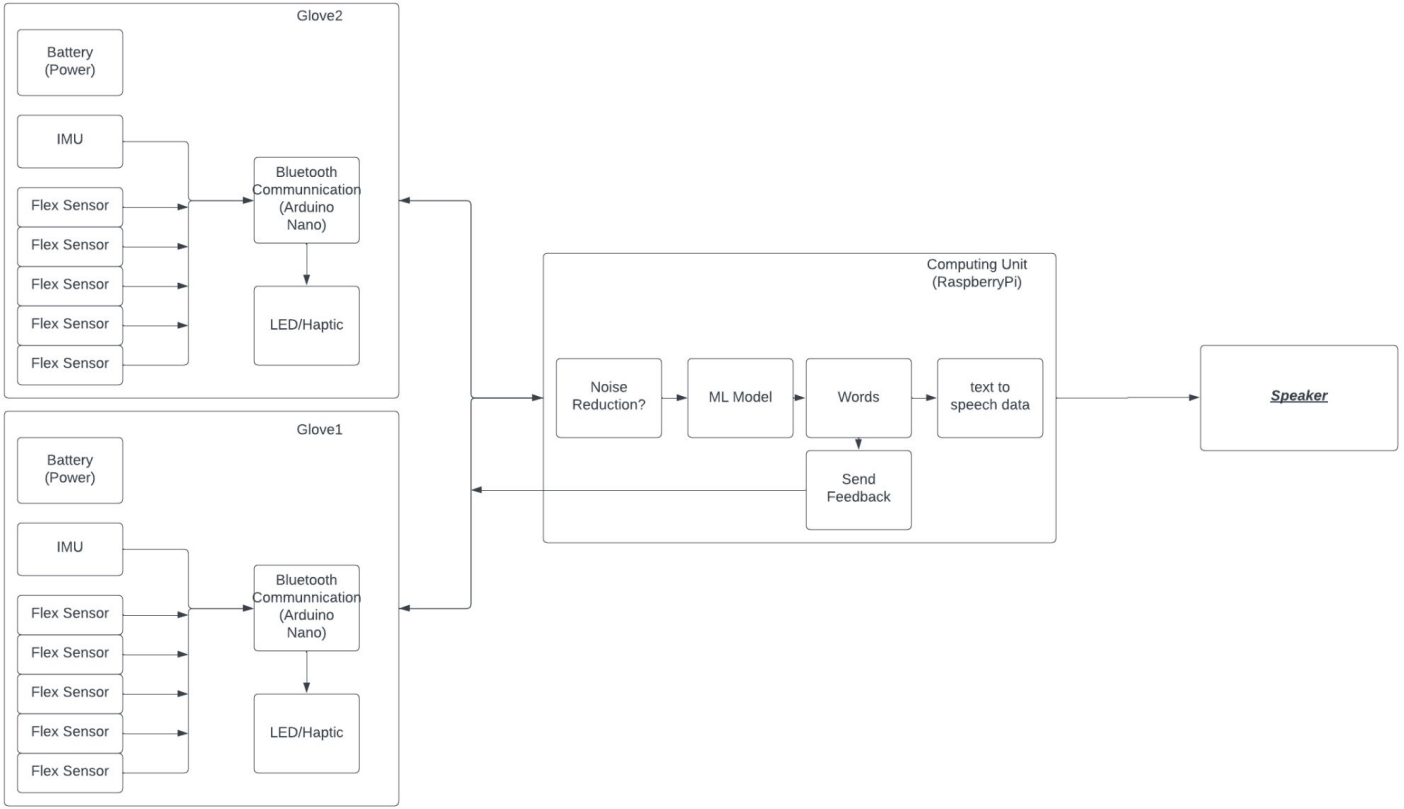
- Synchronizing data coming from both gloves on RaspberryPi (Speed)
- Capturing sufficient data to train ML (Speed/Accuracy)
    - Time constraint on sensor development
- How long does each word need to take to reset in between (Speed)
- Consider whether flex sensors/IMU will provide rich enough features (Speed/Accuracy/Vocab)
- Specific words might incorporate arm/facial movements (Vocab)

Qualitative Solution Approach

- Wireless gloves
  - Flex sensors woven into glove
  - Research attachment methods for IMU/Arduino
- Connection to a lightweight computing box/speaker setup

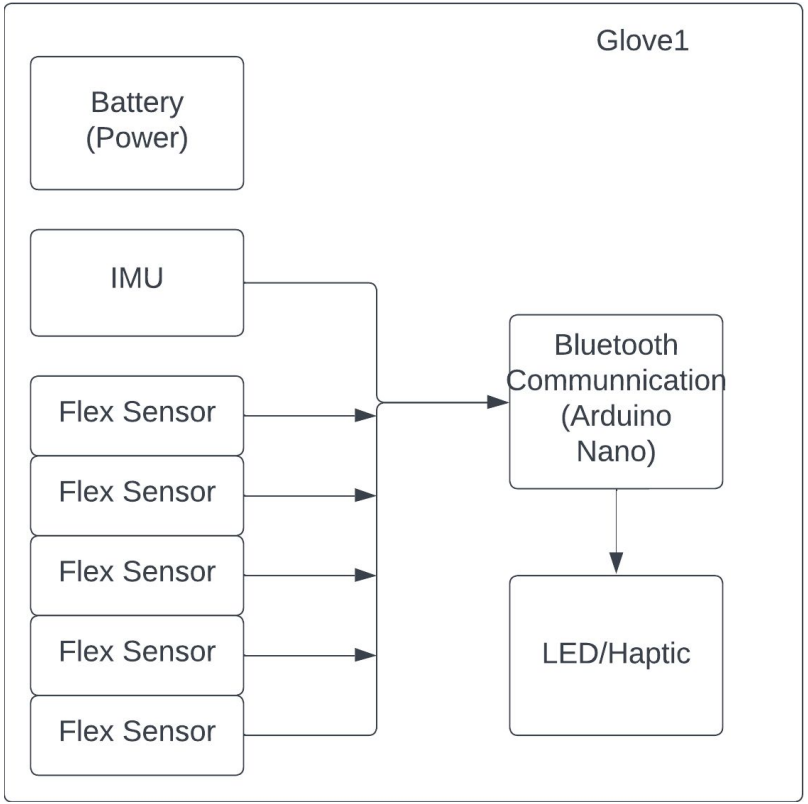
Image from UCLA

Overall Block Diagram



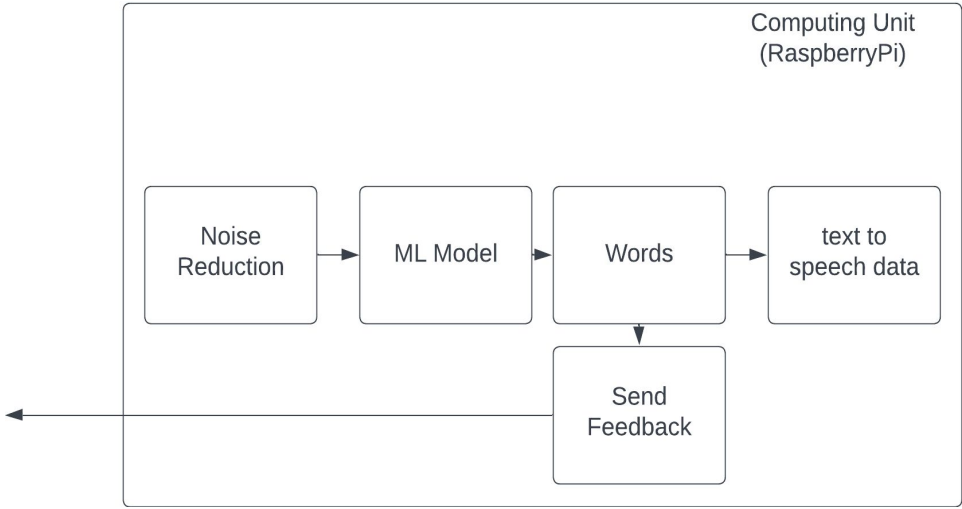
Glove Design

- Flex and IMU sensors to detect finger location and orientation
- Bluetooth communication to main computing unit
- Feedback coming back from computing unit



Computing Unit

- Noise reduction (DSP)
- Machine learning model
  - Neural network, kNN, more
- Feedback to glove sensors
- Processing words to speech output for speakers



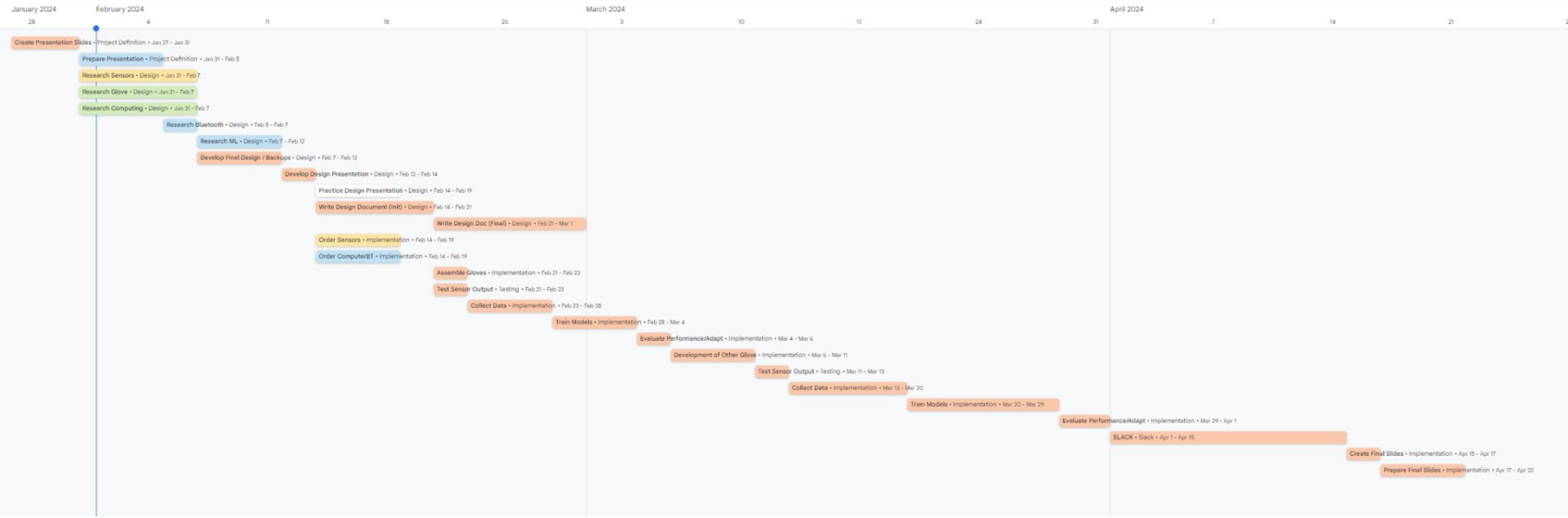
Testing

Testing	**Verification**	**Metrics**
Accuracy	Perform signings of vocabulary and compare predictions with ground truth	Should accurately predict with **> 90%** Accuracy
Latency	Perform signings of vocabulary and evaluate average time for speaker output	ML model should output result within **0.5 seconds**
User Experience & Generalizability	Bring in panelists to judge the ease of use and performance with other signers	The glove should be fully functional for everyone

Division of Labor

- Ricky
  - ML model training, model selection, signal processing
- Ria
  - Hardware assembly, evaluation, embedded software
- Somya
  - Sensor integration, bluetooth software, communication between glove
- Everyone
  - Integration / testing

Gantt Chart


January 2024
28
February 2024
4
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March 2024
3
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April 2024
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21
Create Presentation Slides • Project Definition • Jan 27 - Jan 31
Prepare Presentation • Project Definition • Jan 31 - Feb 5
Research Sensors • Design • Jan 31 - Feb 7
Research Glove • Design • Jan 31 - Feb 7
Research Computing • Design • Jan 31 - Feb 7
Research Bluetooth • Design • Feb 5 - Feb 7
Research ML • Design • Feb 7 - Feb 12
Develop Final Design / Backups • Design • Feb 7 - Feb 12
Develop Design Presentation • Design • Feb 12 - Feb 14
Practice Design Presentation • Design • Feb 14 - Feb 19
Write Design Document (Init) • Design • Feb 14 - Feb 21
Write Design Doc (Final) • Design • Feb 21 - Mar 1
Order Sensors • Implementation • Feb 14 - Feb 19
Order Compute/BT • Implementation • Feb 14 - Feb 19
Assemble Gloves • Implementation • Feb 21 - Feb 23
Test Sensor Output • Testing • Feb 21 - Feb 23
Collect Data • Implementation • Feb 23 - Feb 28
Train Models • Implementation • Feb 28 - Mar 4
Evaluate Performance/Adapt • Implementation • Mar 4 - Mar 6
Development of Other Glove • Implementation • Mar 6 - Mar 11
Test Sensor Output • Testing • Mar 11 - Mar 13
Collect Data • Implementation • Mar 13 - Mar 20
Train Models • Implementation • Mar 20 - Mar 29
Evaluate Performance/Adapt • Implementation • Mar 29 - Apr 1
SLACK • Slack • Apr 1 - Apr 15
Create Final Slides • Implementation • Apr 15 - Apr 17
Prepare Final Slides • Implementation • Apr 17 - Apr 22