EchoSign - Design Review

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EchoSign - Introduction and Use cases

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

- **Solution:** Pair of gloves that translate sign language to audible English

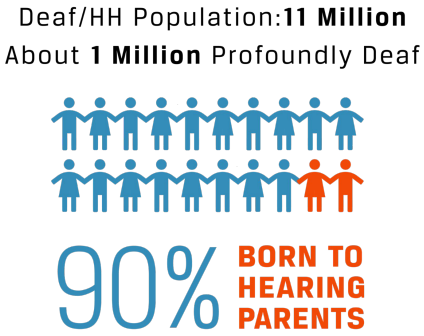
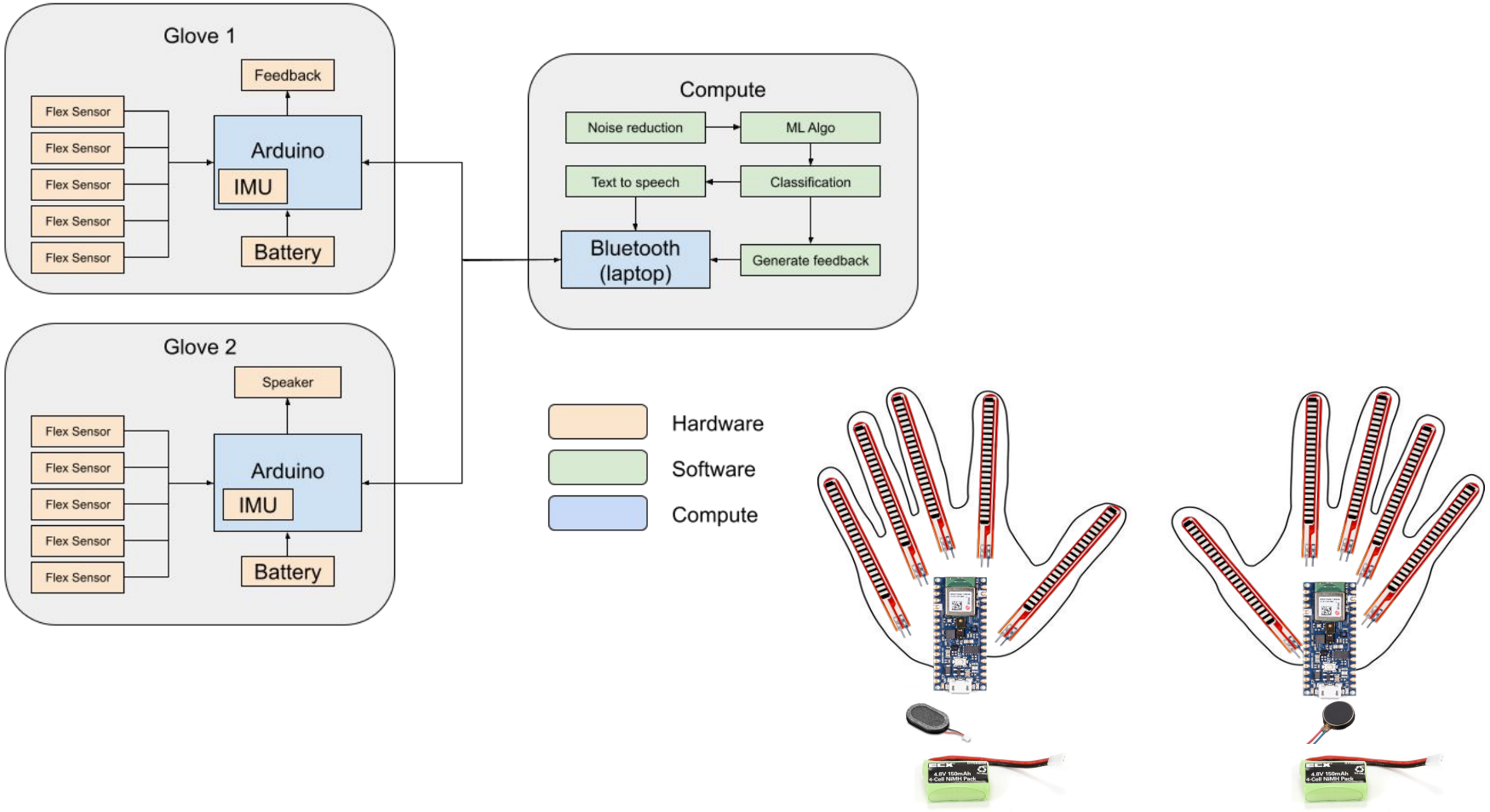
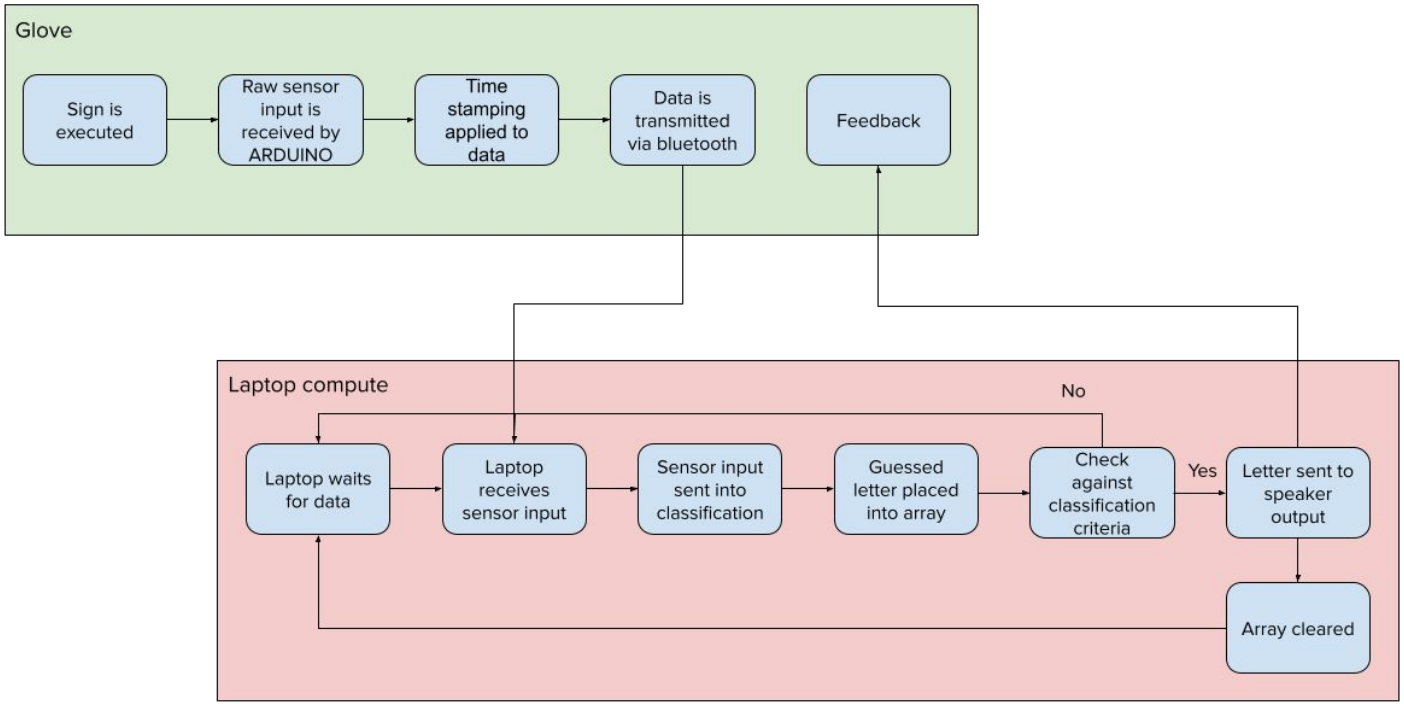


Image from BYU

Qualitative Requirements	Use Case Requirement
Maintain normal signing **speed**	.5 second latency
Glove should be **reliable**	85% sign prediction accuracy
Portable and can withstand daily activity	100g weight limit per glove
Lasting battery life	2 hours of battery life


Glove 1
Feedback
Flex Sensor
Flex Sensor
Flex Sensor
Flex Sensor
Flex Sensor
Arduino
IMU
Battery
Compute
Noise reduction
ML Algo
Text to speech
Classification
Bluetooth (laptop)
Generate feedback
Glove 2
Speaker
Flex Sensor
Flex Sensor
Flex Sensor
Flex Sensor
Flex Sensor
Arduino
IMU
Battery
Hardware
Software
Compute

Sign to speech pipeline



Compute

We want:

- Need at least 5 digital output pins
- Minimum 16 MHz clock frequency
- On board IMU with triaxial accelerator
- Bluetooth capabilities

For MVP: **Arduino Nano 33 BLE Sense**

- On board 9 axis IMU
- Clock speed: 64 MHz
- Bluetooth capabilities

If bluetooth doesn't satisfy MVP latency requirements... Arduino Nano 33 IoT

- On board 6 axis IMU
- Clock speed: 48 MHz
- WIFI capabilities

Flex Sensors

We want:

- Consistently appx. 2x resistance at 90° for sensitivity requirements
- Long enough to go around knuckle for maximum gesture information conveyed
- Lightweight, low cost, tried and tested

For MVP: SpectraFlex Flex Sensor - 95 mm

- Improved version of the Original Flex Sensor (minimized drift, more lightweight, higher sensitivity)
- 95 mm length, ideal for going over all three finger joints for varied hand sizes

Power and Feedback

We want:

- 2 hours of battery life
  - Each IO port is 15 mA
  - Total current draw 75mA
  - Need 150 mAh
  - Compute needs max 5V
- Audible speaker
  - Target 8 ohm 1 watt speaker for human audibility
  - Small and lightweight
- Feedback
  - LED for testing (on Arduino!)
  - Small vibrating motor with simple interfacing

For MVP:

1. ECX 4.8V 150 mAh battery (.32 oz) with Switch
2. Dc Mini Magnet Vibrating Motor
3. Mini Oval Speaker on Glove with amplifier

Classification Method

Model	**Training Data**	**Training Time**	**Performance**	**Prediction Speed**
Neural Net	High	High	High	Slow
SVM	Low	Medium	Medium	Fast
Decision Tree/Forest	Low	Low	Medium	Fast
kNN	Low	Low	Medium	Medium

Testing, Verification, Validation

Requirement	Verification	Metrics
Accuracy	● Evaluate accuracy on separate test data ● Evaluate accuracy on real-time performance	Should accurately predict real-time with **> 90%** accuracy
Latency	● Evaluate time from glove sensor to laptop reception ● Evaluate time for ML prediction	Cumulative time from signing to speaker output should be **< 0.5 seconds**
Vocabulary	● Classification of a variety of hand signs	RP1: **10 singlehand signs** RP2: **26 doublehand alphabet**

Prototype 1

Phase 1:

- Create one glove with battery and all sensing capabilities
- Wired connection to laptop for compute

Phase 2:

- Train the ML model for 10 letters in the ASL alphabet
- Add speaker and haptic feedback

Prototype 2

Phase 1a:

- Duplicate glove

Phase 1b:

- Create a wireless glove that can transmit data through bluetooth

Phase 2:

- Train the ML model for the British double handed alphabet

MVP

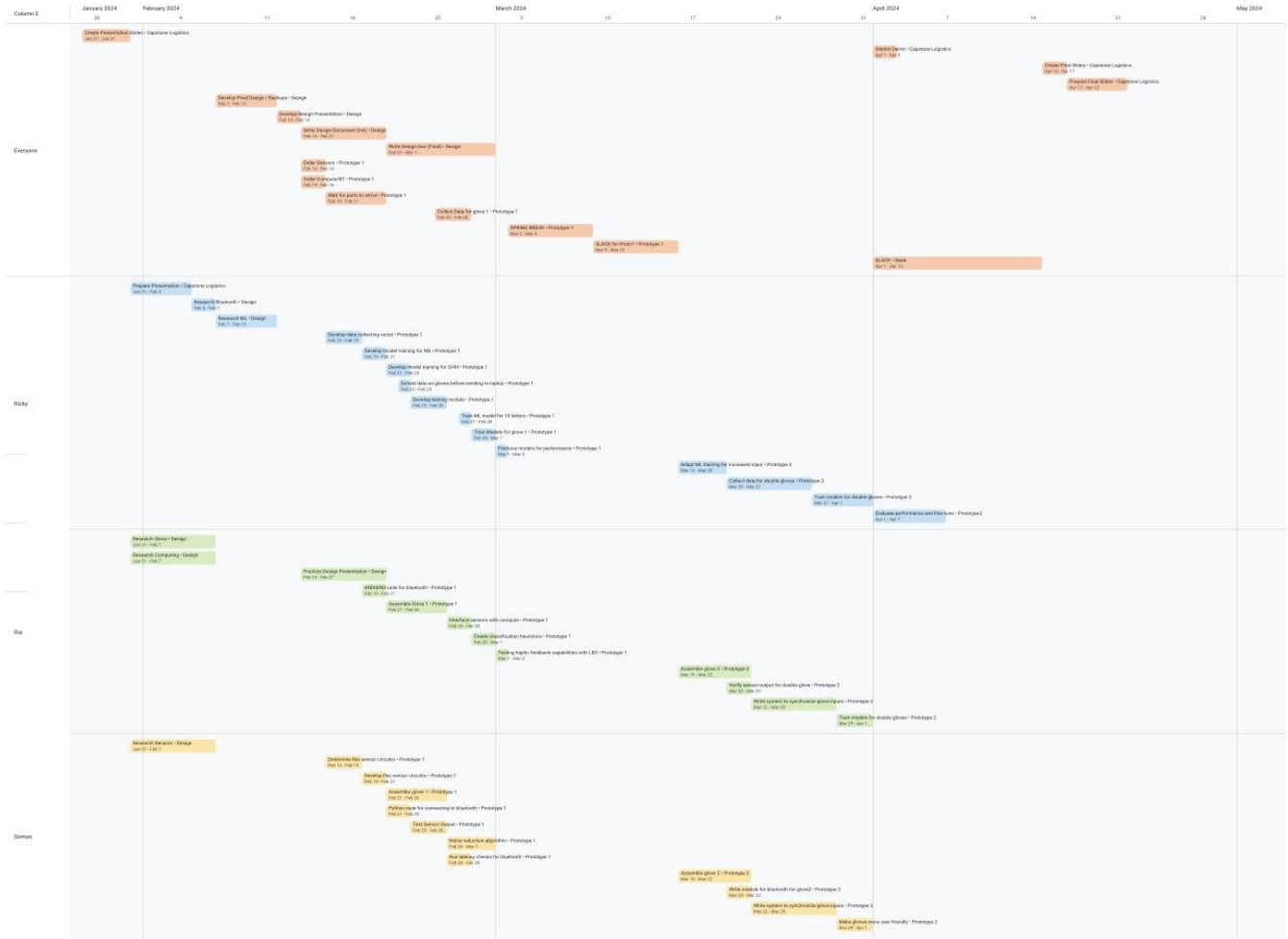
Prototype 3

Phase 1a:

- Turn this into a distributed system with wireless communication between them
- No reliance on laptop after model is trained and uploaded onto gloves

Phase 1b:

- Expand the vocabulary to gestures with movement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