

Rethinking Inexpensive Wearables in the Era of AI: From Motion Analytics to Mobile Health

Hao Zhou

Ph.D. Candidate @ PennState



Revolution of Wearables

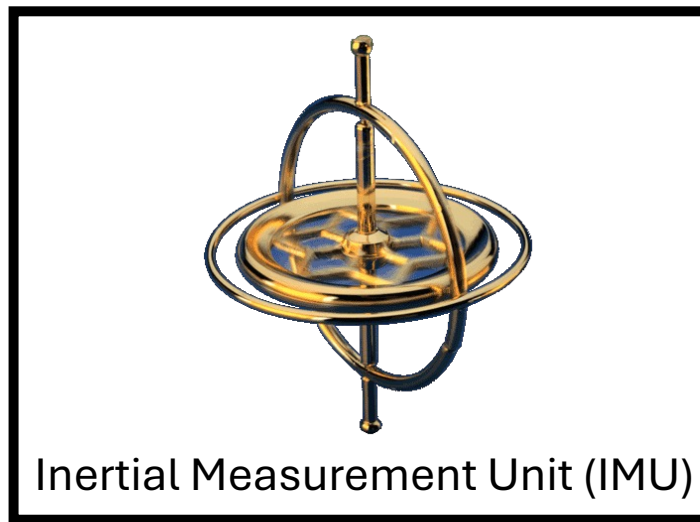


Communication



Communication + Entertainment + ...

Revolution of Wearables



Step Counter



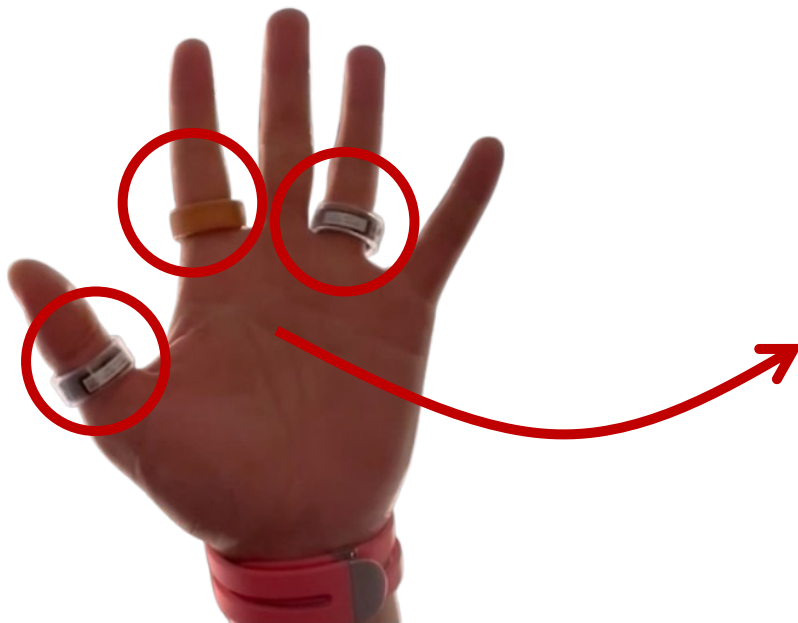
Human-computer
Interaction



Hand Pose
Tracking

Empowering the Fingers - Overview

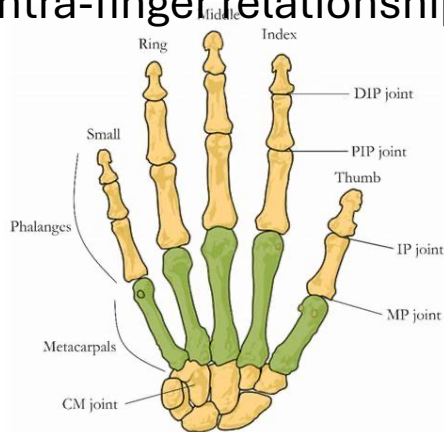
Fine-grained Motion Sensing from Low-Cost Rings



Empowering the Fingers – Challenges & Findings

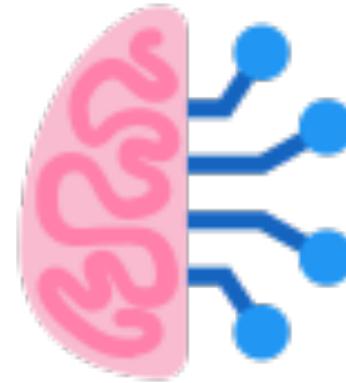
1. Sparsity of Sensors

- Inter-finger relationship
- Intra-finger relationship

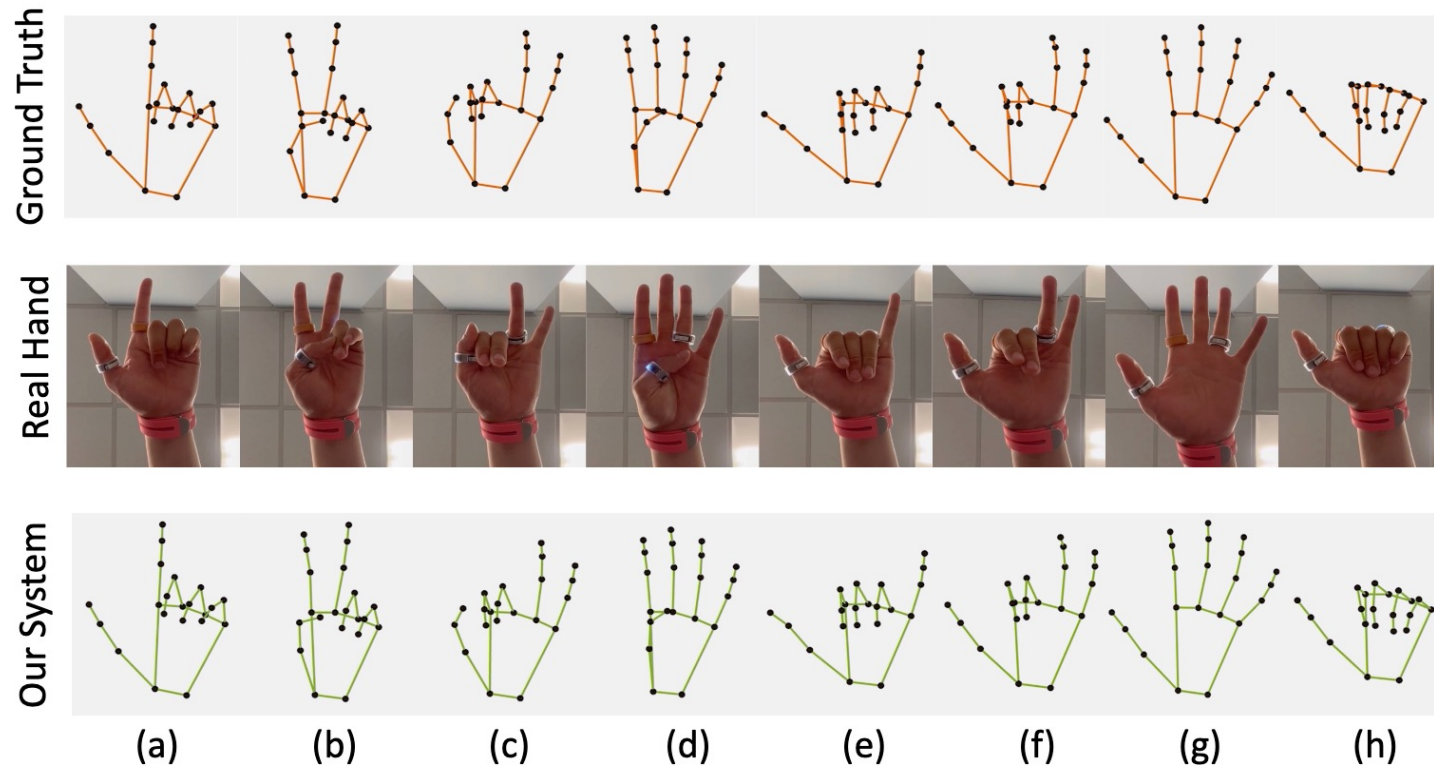


2. Limited Data

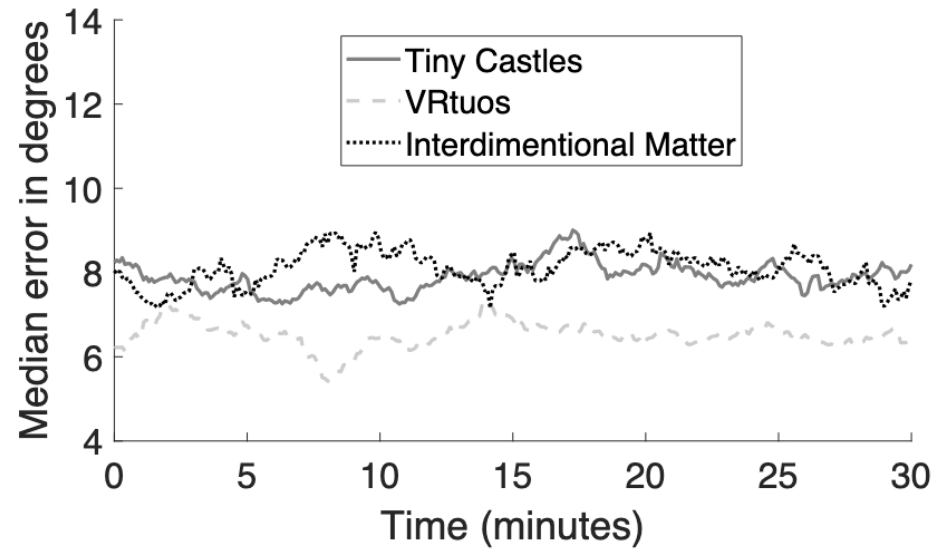
- Self-supervised Learning
- Synthetic data from videos



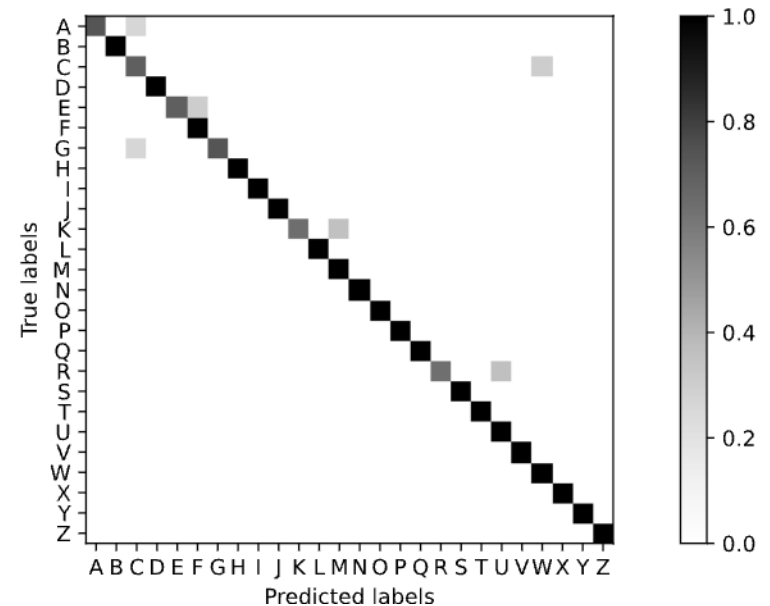
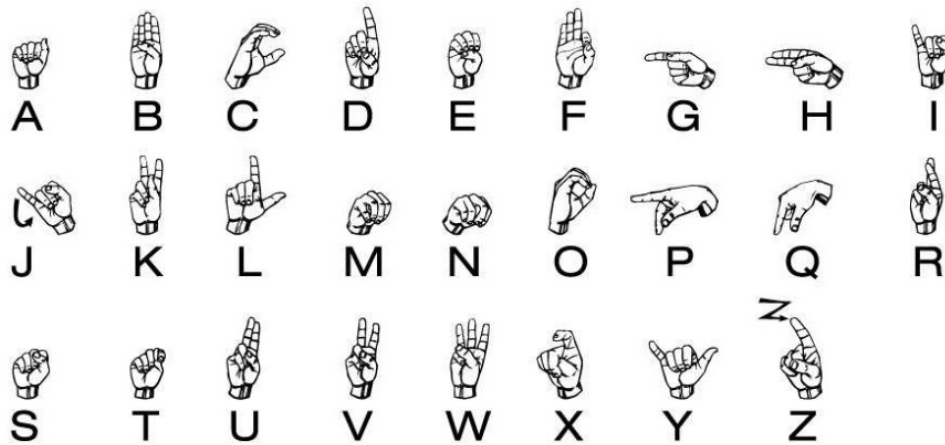
Empowering the Fingers – Results & Impacts

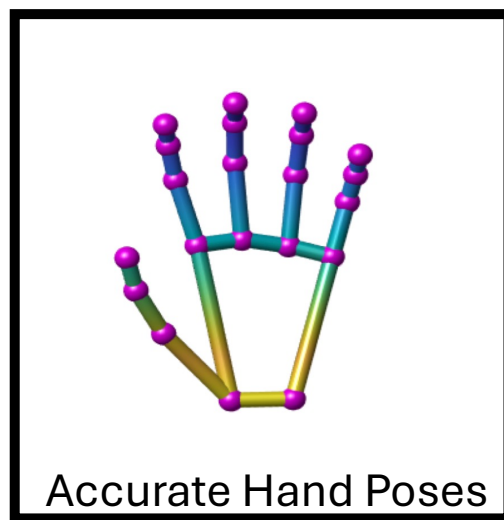


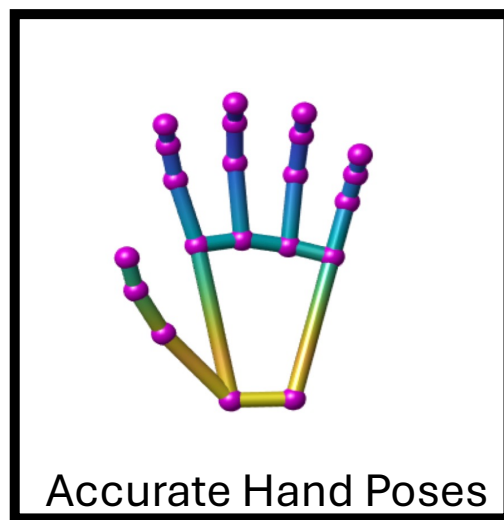
Empowering the Fingers – Results & Impacts



Empowering the Fingers – Results & Impacts







No Body Left Behind - Overview

Bridging Communication Gap for Hearing-impaired Individuals



INPUT:
A sequence of
signs

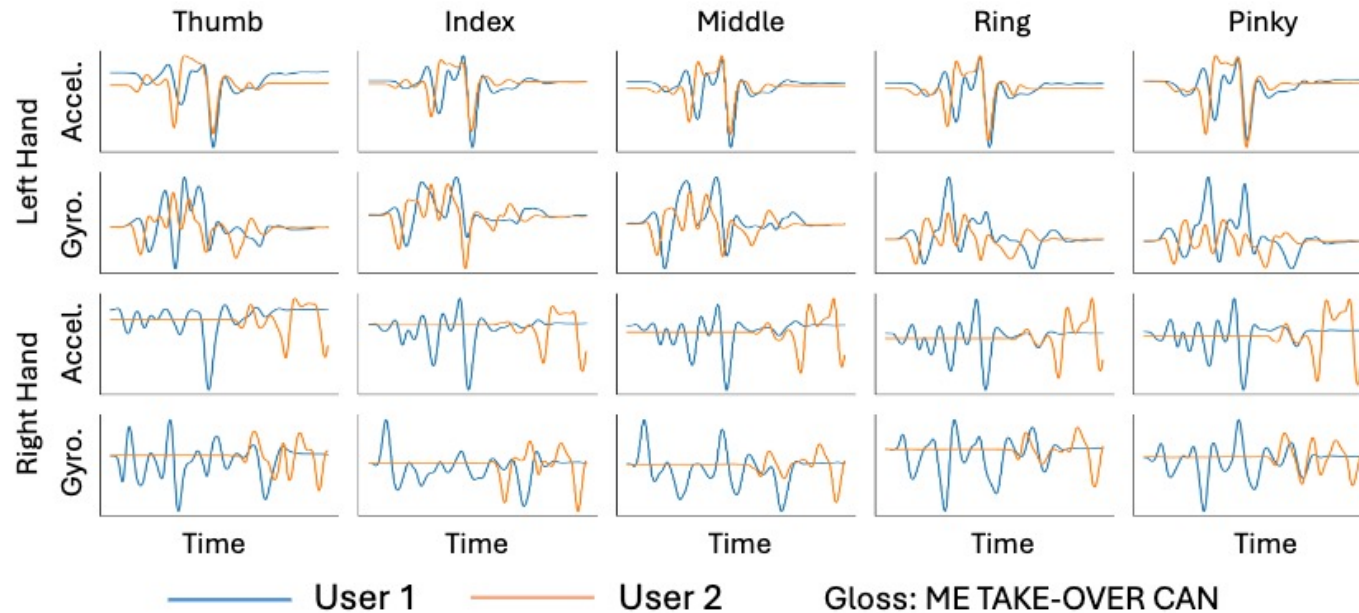


OUTPUT:
Corresponding
gloss

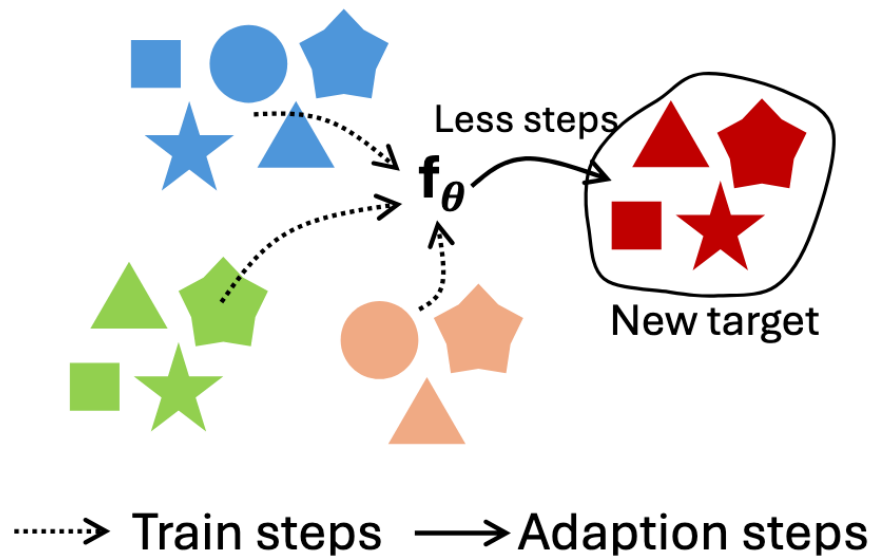
WEATHER SUNSHINE MATCH PERFECT BEACH

No Body Left Behind – Challenge

Sign language users also have “dialect” due to communities, cultures, styles, etc.



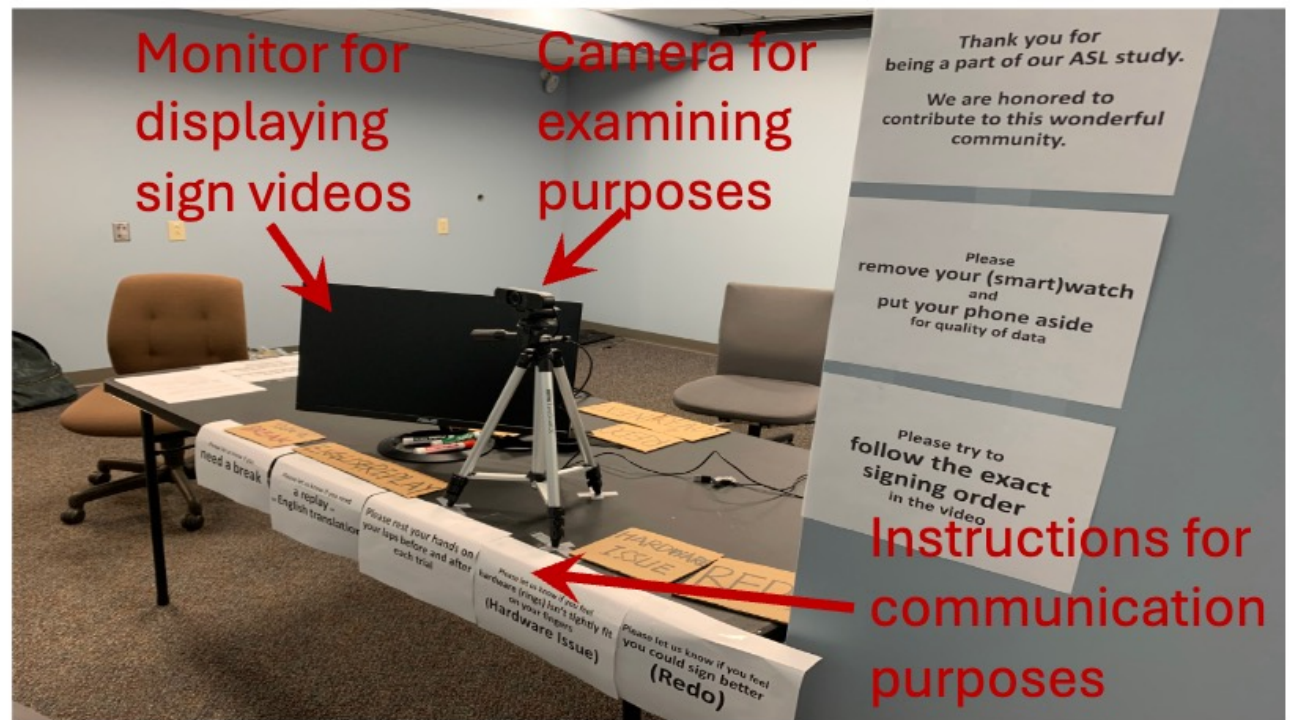
No Body Left Behind – Solution



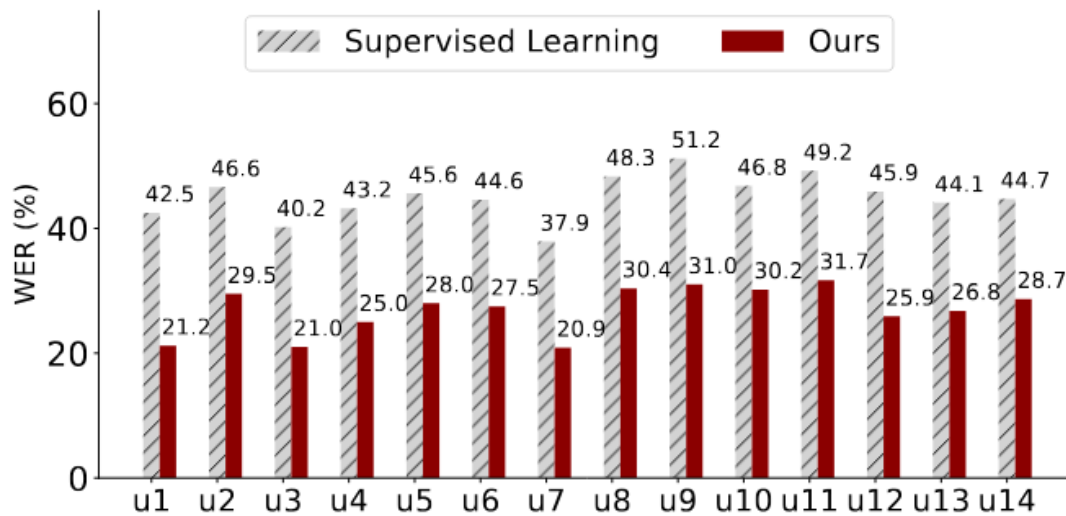
A meta-learning-based framework designed to mitigate inter-user variability.

No Body Left Behind – Collaboration with native ASL users

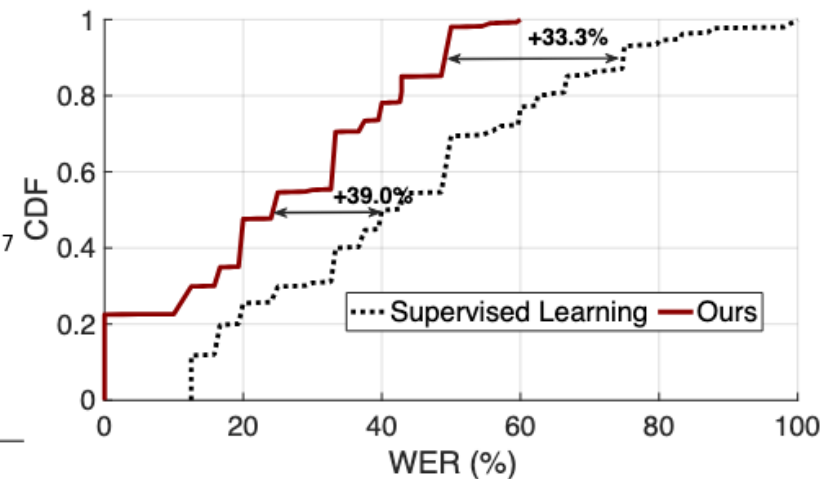
Native ASL users from
Pennsylvania and
Gallaudet University



No Body Left Behind – Results & Impacts

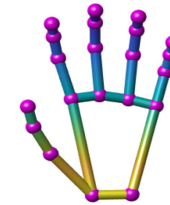
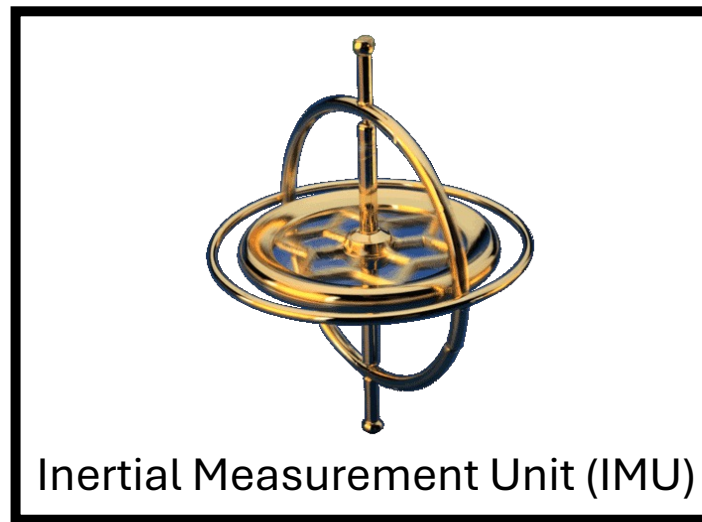


(a) Performance on unseen users



(b) WER distribution

Power of Inexpensive Inertial Sensors

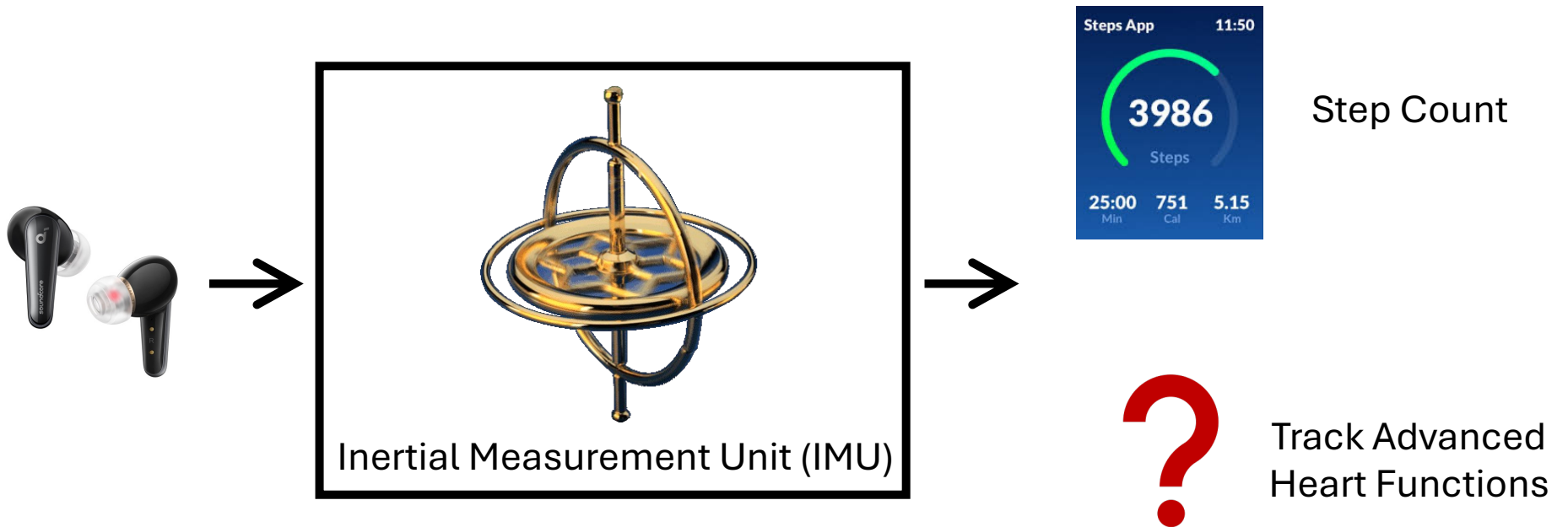


Hand Pose
Tracking



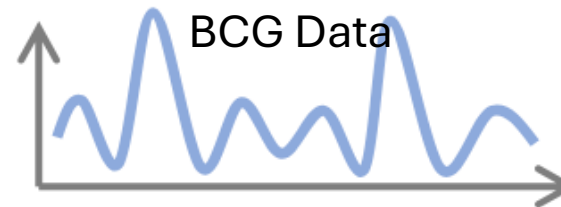
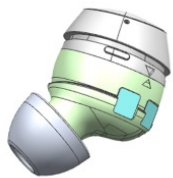
Sign Language

Power of Inexpensive Inertial Sensors



Know Your Heart Better - Overview

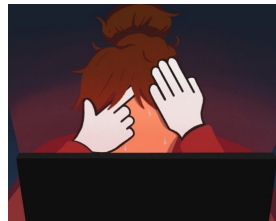
Unlocking Advanced Health Markers with Earbuds



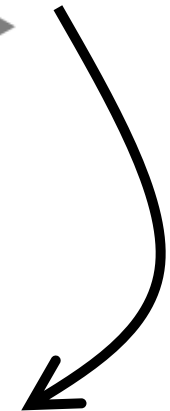
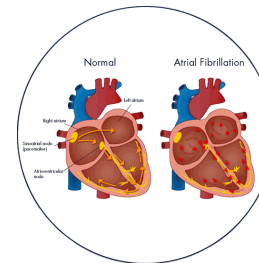
Heart Failure



Stress

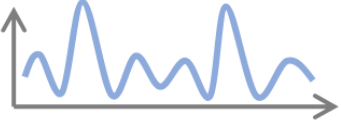


Atrial Fibrillation



Cardiac output

Know Your Heart Better – Challenges & Solutions


BCG Raw Signal

Morphological
Features

Pulse Amplitude

I-K Time Diff.

I-J Time Diff.

J-K Time Diff.

I Peak

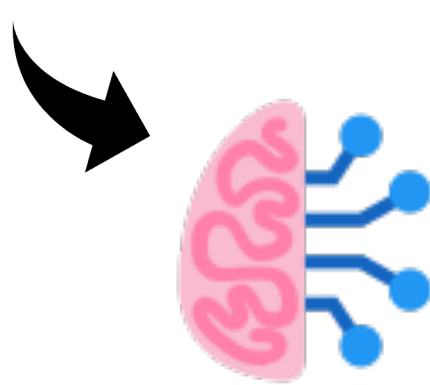
K Peak

I Peak

J Peak

J Peak

K Peak

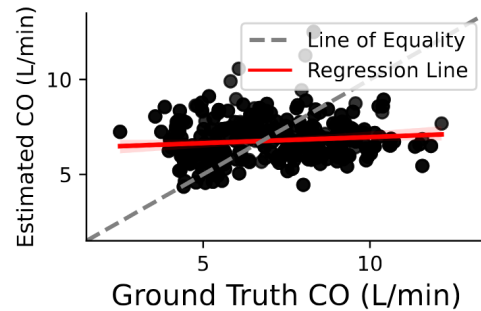


Feature Guidance Model

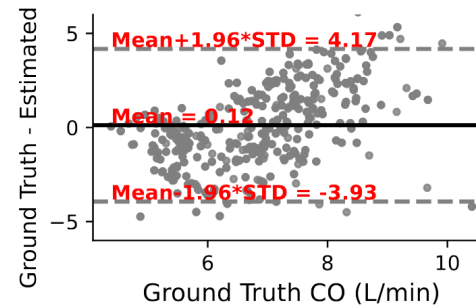


Cardiac Output

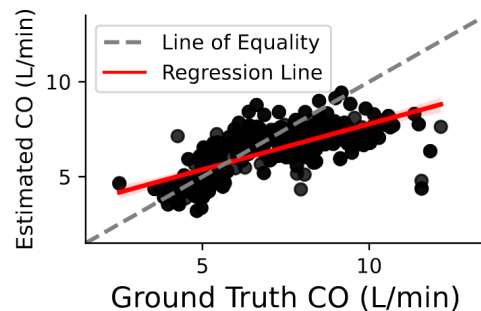
Know Your Heart Better – Results & Impacts



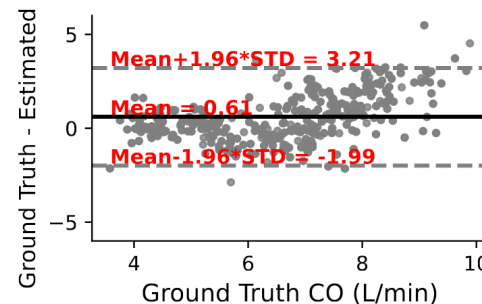
(a) Baseline Regression Plot



(b) Baseline Bland-Altman Plot



(c) EarCO Regression Plot



(d) EarCO Bland-Altman Plot

Conclusion

- Interpret signals from inexpensive wearables by efficiently designing task-driven AI models.
- Enable functionalities traditionally dependent on specialized or bulky hardware.
- Expand the capabilities and generalizability of everyday wearable devices Its impact through accessible, scalable applications in hand pose tracking, sign language, and advanced health monitoring.