WETrak:
Finger Tracking Using Wrist-Worn EMG Sensors

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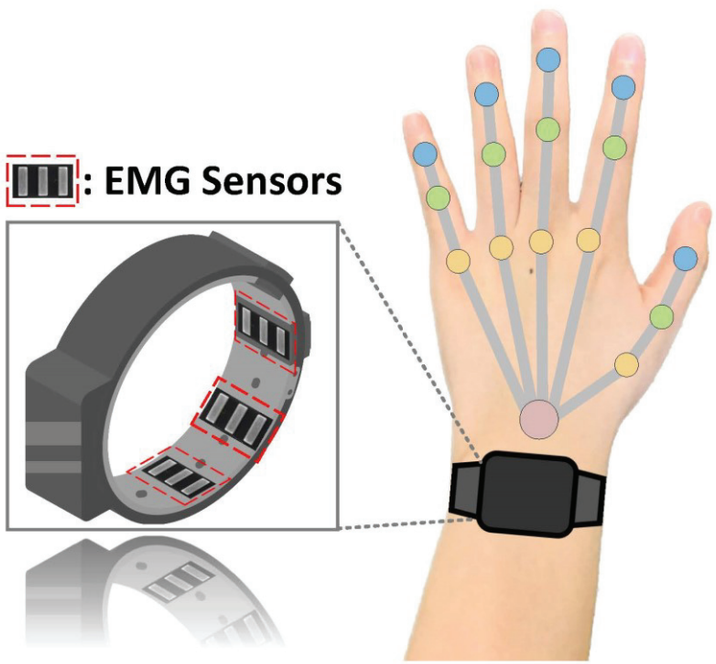
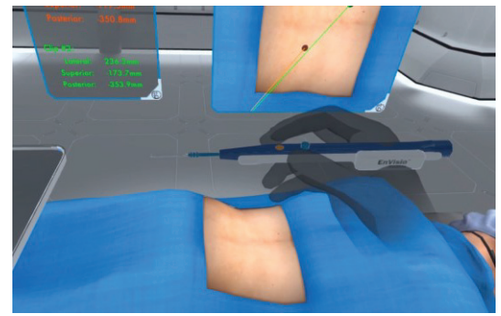
Motivation



Recovery treatment



Surgical training

AR/VR

SL translation

Existing Solutions

Camera/wireless-based approach:

Not portable

Environment

Limited area

Wearable-based approach:

Attach to you

Accumulate error

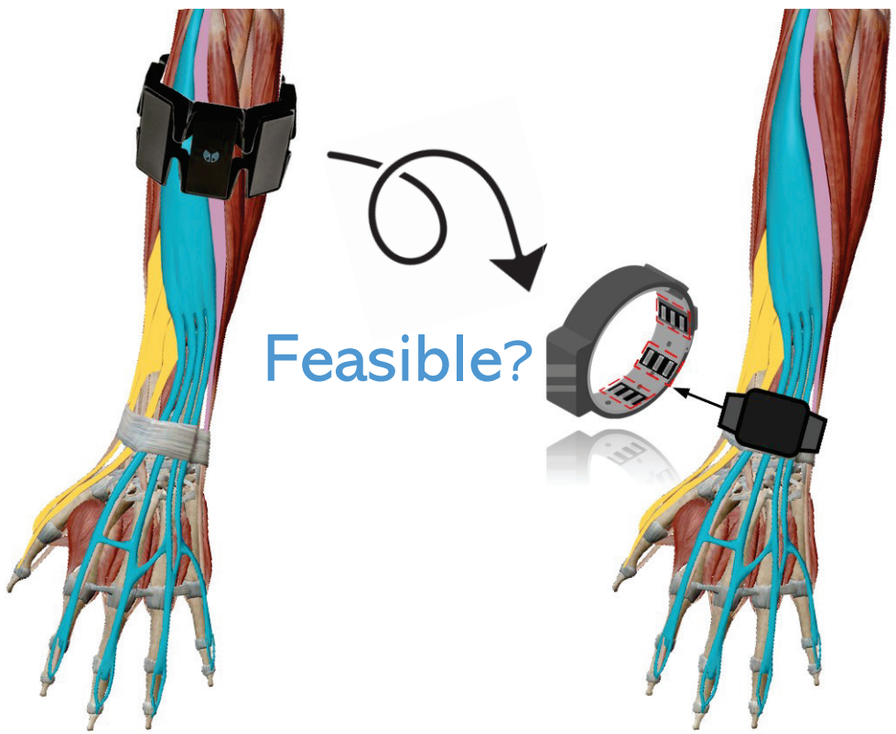
Key Problem

Using commercial EMG armband [1][2]:

Fine-grained motion

Wear on forearm

Only for tracking

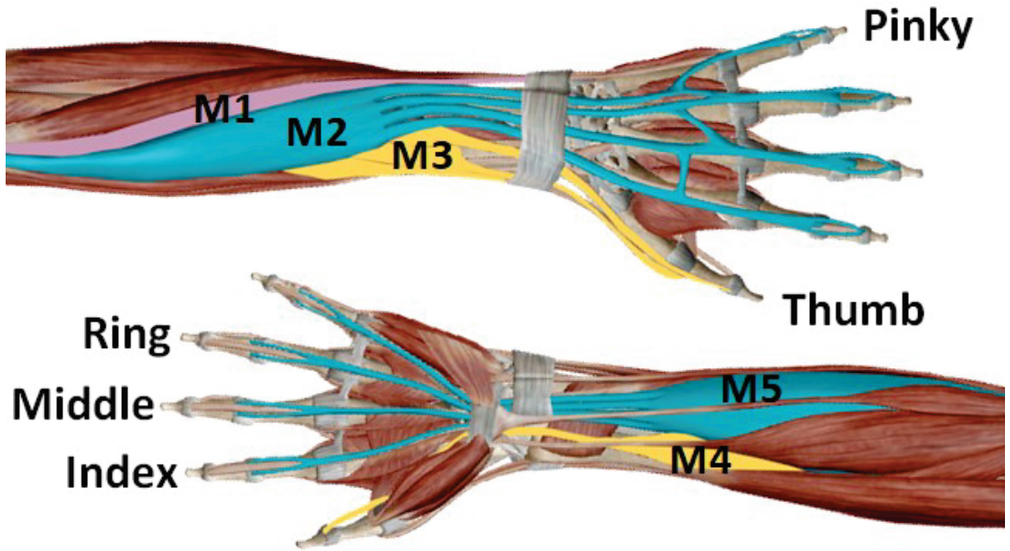


Sensor placement?

Weak signals?

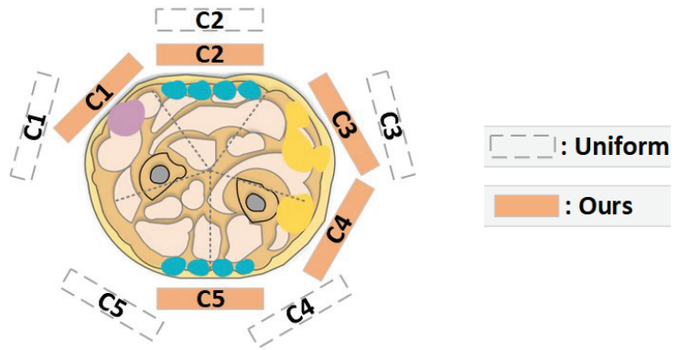
[1] Y. Liu, C. Lin, and Z. Li, “Wr-hand: Wearable armband can track user’s hand,” Proc. of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, 2021.
[2] Y. Liu, S. Zhang, and M. Gowda, “Neuropose: 3d hand pose tracking using emg wearables,” in Proc. ACM WWW, 2021.

Feasibility Study



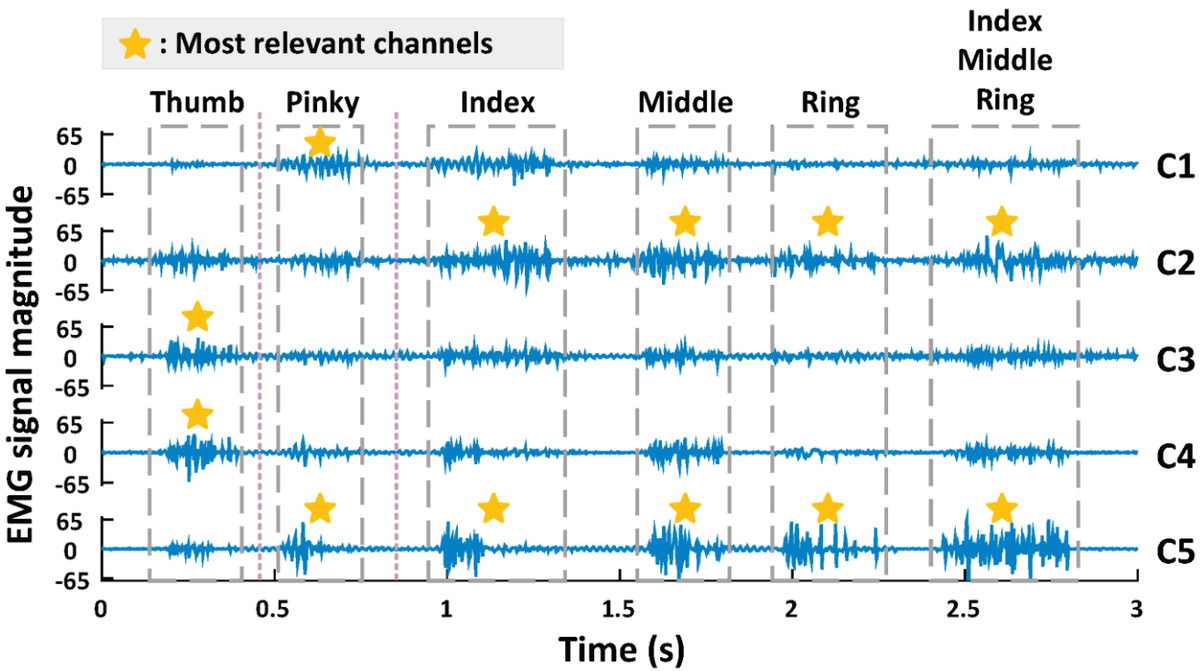
Thumb: M3 and M4
Index, Middle, Ring: M2 and M5
Pinky: M1 and M5

- Sensor placement:



- Finger groups:

Observation -1

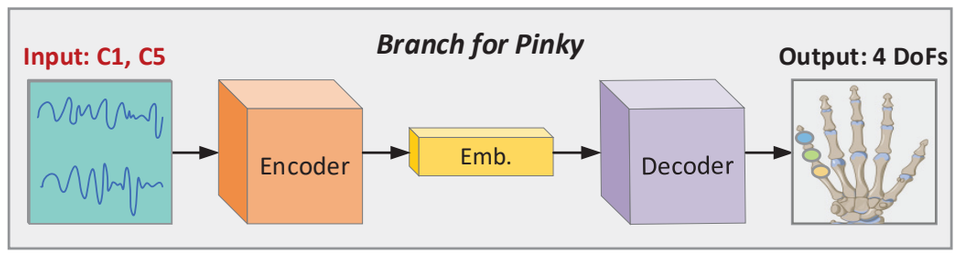


Thumb: M3 and M4

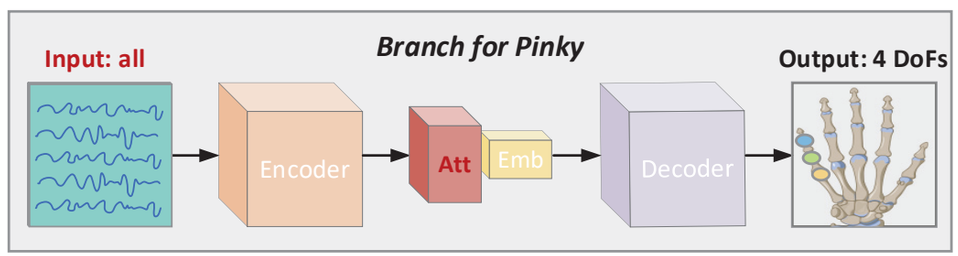
Index, Middle, Ring: M2 and M5

Pinky: M1 and M5

- Most relevant muscles have strong responses

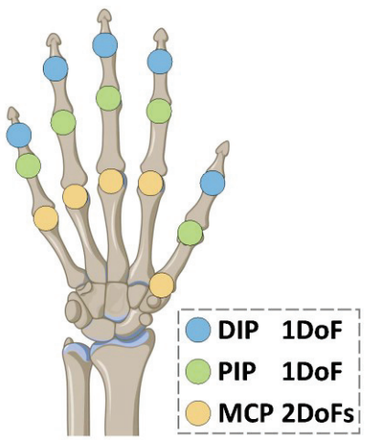


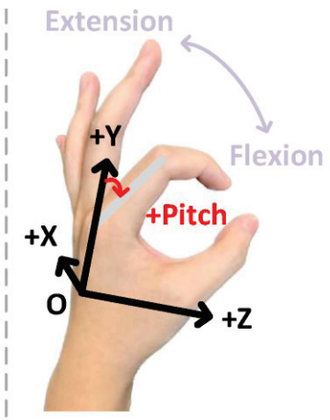
- Other muscles can generate certain signals

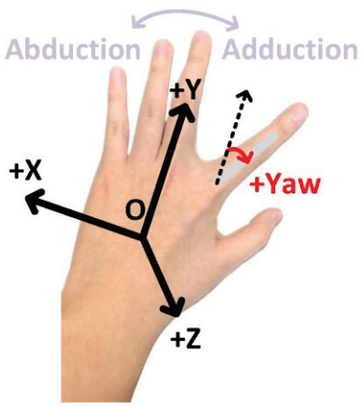


Dynamically adjust importance

Observation -2







	MCP_P	MCP_Y	PIP	DIP
Thumb	50°~90°	45°~60°	75°~80°	75°~80°
Index	90°	60°	105°	80°~90°
Middle	90°	45°	105°	80°~90°
Ring	90°	45°	120°	80°~90°
Pinky	90°	50°	135°	90°

Maximum range of movement

↓

Possible search space

However

- Not every finger moves at every moment

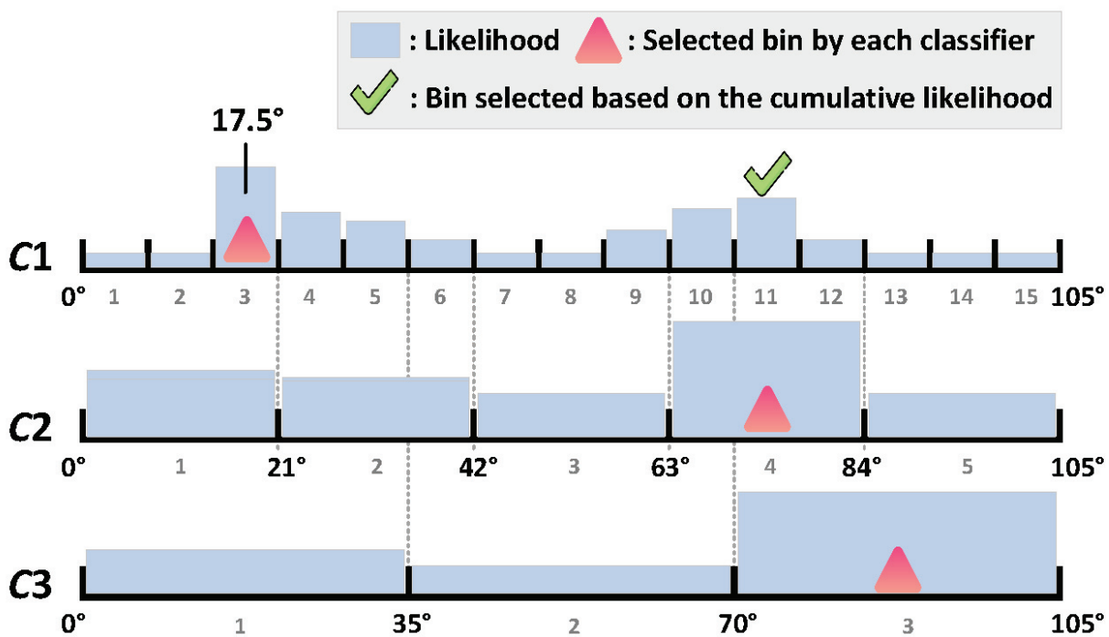
- Even if they do move, they may not reach their maximum value

Can we reduce the search space to adapt to different movements?

Observation -2

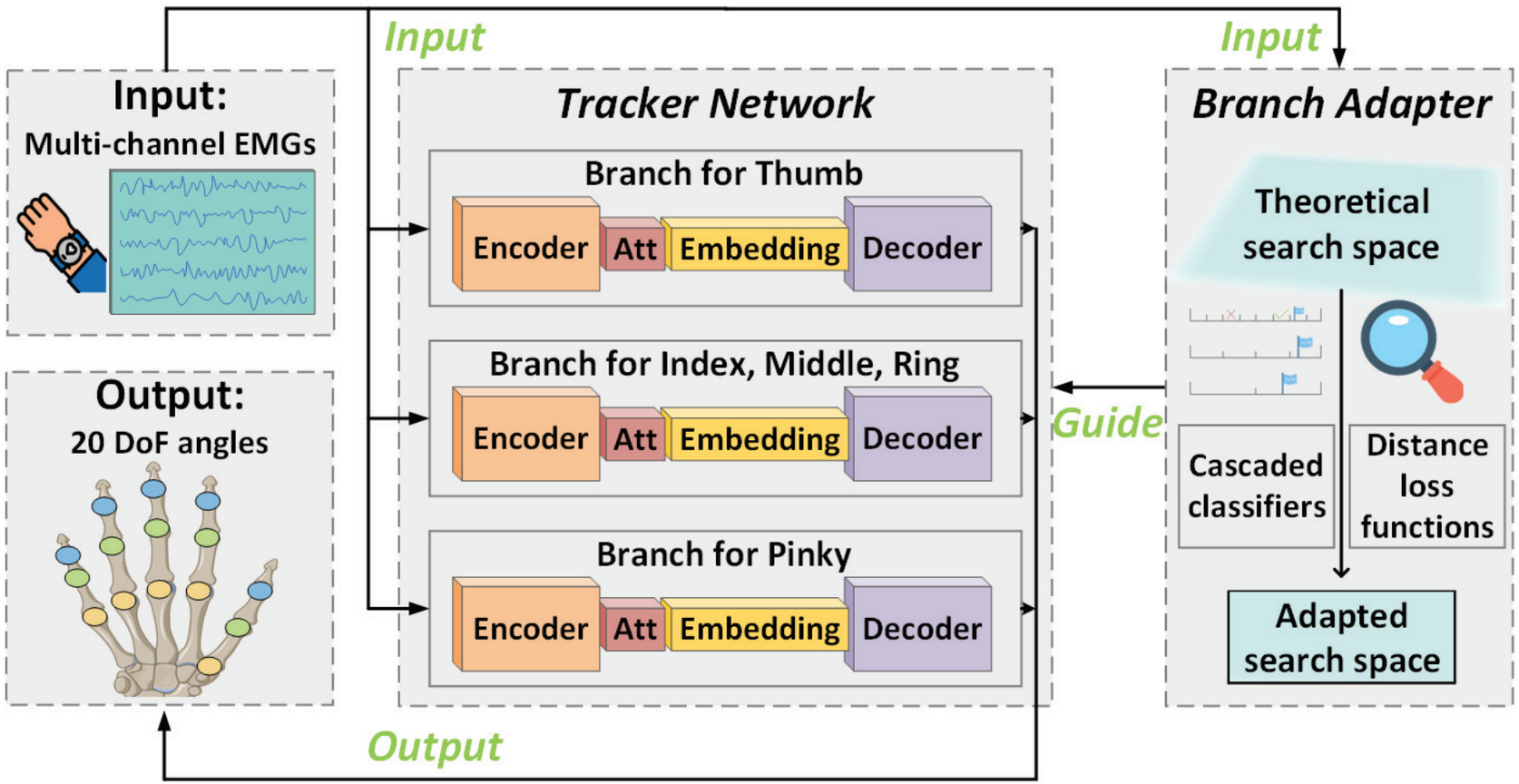
- Core idea of branch adapter:
  - Dynamically predict the actual maximum and minimum of movement

	MCP_P	MCP_Y	PIP	DIP
Thumb	50°~90°	45°~60°	75°~80°	75°~80°
Index	90°	60°	**105°**	80°~90°
Middle	90°	45°	105°	80°~90°
Ring	90°	45°	120°	80°~90°
Pinky	90°	50°	135°	90°



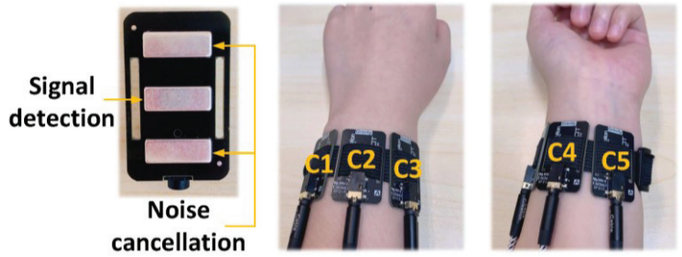
Maximum value of index's PIP.

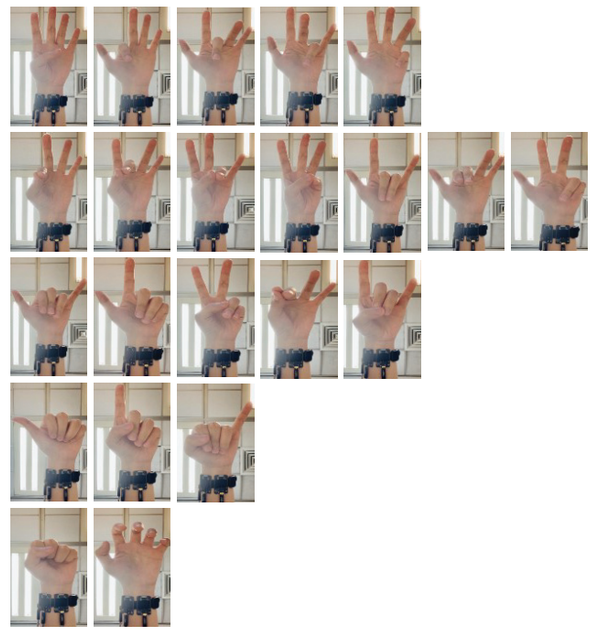
Our system: WETrak



Experimental Setup

- Tracking device:
  - A custom-made wristband that includes five EMG sensors
- Dataset:
  - 22 basic states covering all finger movements





One finger moves

Two fingers move

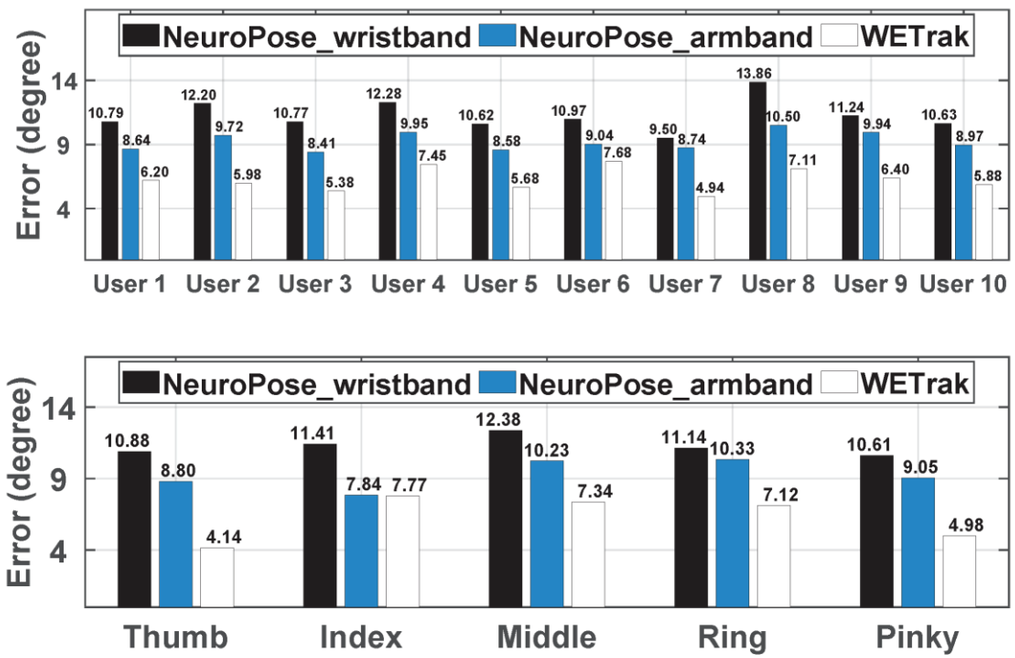
Three fingers move

Four fingers move

Five fingers move

Overall Performance

- Compare with:
  - NeuroPose [1] with our wristband
  - NeuroPose with its armband



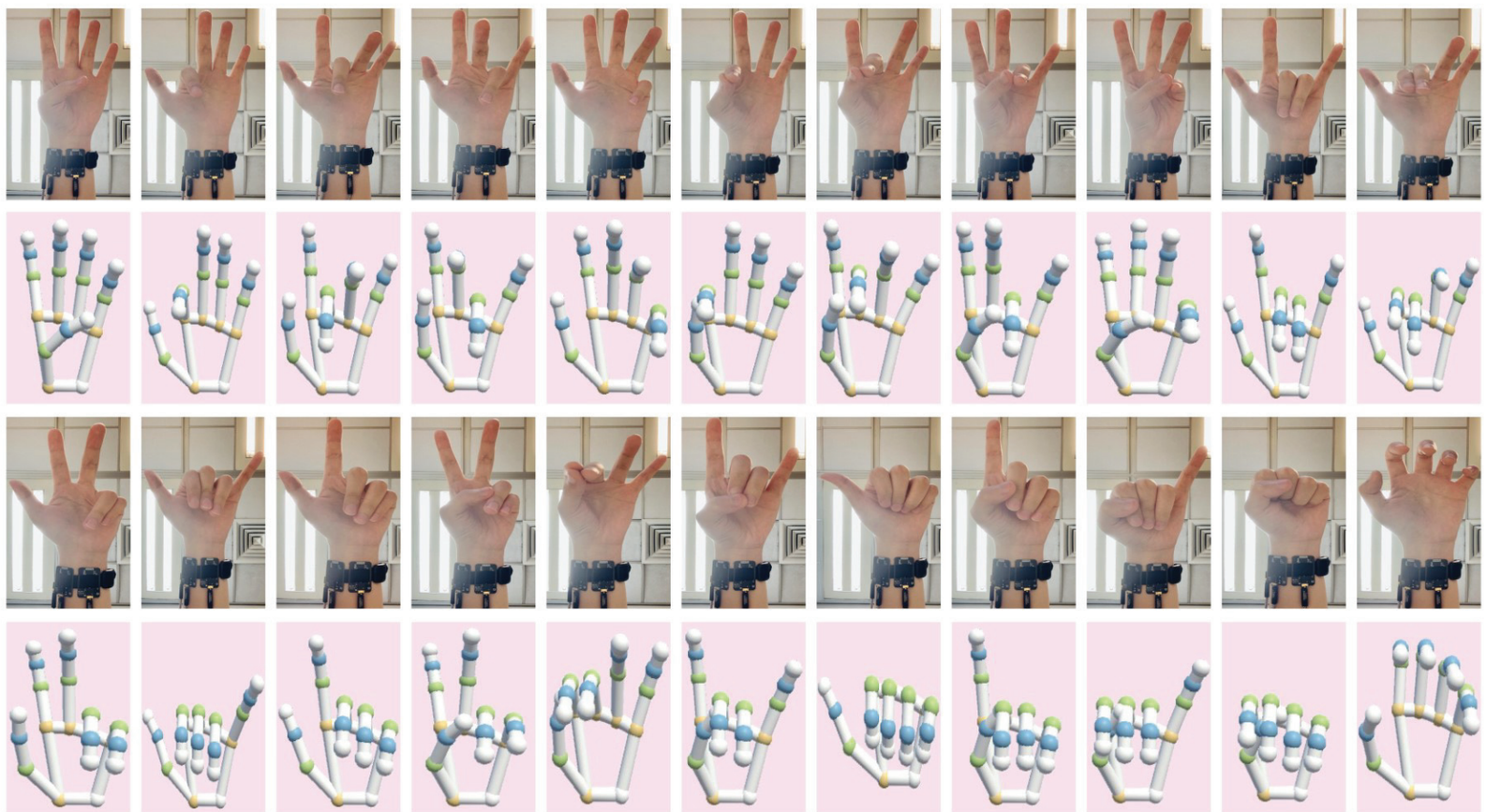
NeuroPose with wristband: 13.86~9.50°

NeuroPose with armband: 10.50~8.41°

Ours: 4.94~7.68°

[1] Y. Liu, S. Zhang, and M. Gowda, "Neuropose: 3d hand pose tracking using emg wearables," in Proc. ACM WWW, 2021.

Visualization Result



Conclusion 1,2,3

1. One goal:
   - Finger tracking only using wrist-worn EMG sensors

2. Two aspects:
   - Sensor placement
   - Accurate tracking

3. Three modules:
   - Feasibility study
   - Tracker network
   - Branch adapter

Thank you

Q&A

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