WR-Hand: Wearable Armband Can Track User’s Hand

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Human Hand Tracking

SL Translation  HCI  Gaming

Smart Home  Smart Car  AR/VR
Existing Works

Leap Motion
Wearable thermal cameras

Soft glove
Isolated EMG sensors

Not portable
Limited service area
Ambient condition
User Unfriendly
Our System: WR-Hand

Armband
EMG Sensors

Existing bio-medical models:

- Sensing **specific spots**
- **Strong** signals
- **Isolated** signals

Using armband:

- Sensing **cross-section**
- **Weak** signals
- **Mixed** signals
Primary Hand Pose Recovery

- Bio-models meet armband data?
  - Recursive functions → **Ineffective**

- RNN-enhanced model
  - Following bio-model **suggested steps**

1. EMG Data Pre-processing
2. Muscle Activation Level
3. Muscle Contraction
4. Hand Pose Recovery

**S_{EMG}** → **Norm.** → **F-LSTM** → **Concat**

**D_{EMG}** → **Norm.** → **B-LSTM** → **Concat**
Upgraded Hand Poses

- Place poses in a **global** coordinate system
- Forearm **orientation**

**Feature Extractor**
- Pre-processing and Calibration
- $S_{EMG}$, $D_{EMG}$, $S_{GYR}$, $D_{GYR}$
- B-LSTM block
- Normalization
- Muscle Activation
- Orientation Feature
- Block-I, Block-II
- Attention
- LSTM

**Hand Pose Estimator**
- Multilayer Perceptron
- Coordinates Poses
- Output
- Different importance
- EMG signal
- Gyo. signal

- Place poses in a **global** coordinate system
- Forearm **orientation**
Practical Issue #1: New Users

- Remove the **user-dependent** features
- **Skip training** for new users (plug-and-play)

\[
L_{loss}(\theta_f, \theta_e, \theta_d) = L_{tra}(\theta_f, \theta_e) - \lambda \times L_{dis}(\theta_f, \theta_d)
\]
Practical Issue #2: Armband Position

- Armband wearing-position differences
  - Distance difference → Normalization
  - Rotation difference → Virtual re-ordering

1. Doing warm-up gesture
2. Find “strongest” channel
3. Compute the rotation offset
Evaluation

- **Two armbands**
  - Myo data for **training** and **testing**
  - gForce data for **testing only**

- **18 subjects**
  - Data from **10 subjects** for **training** and **testing**
  - Data from other **8 subjects** for **testing only**

- **Our performance**
  - 2.57cm error using Myo
  - 2.61cm error using gForce
  - >58% error reduction
Conclusion

• Topic:
  • Human hand tracking using a commercial armband

• Design considerations:
  • Hand tracking of 14 skeleton points with arm orientation
  • Plug-and-play version for new users
  • Compensation for armband wearing position
Thank you

Q&A

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