MagicInput: Training-free Multi-lingual Finger Input System using Data Augmentation base on MNISTs

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Background and Motivation

Device-free Finger Tracking Our Idea: Convert MNISTs to 1D Traces Data Augmentation Finger Input System Design Evaluation Conclusion

Traditional Text Input Systems

Touchscreen



Inconvenient when wearing gloves



Watch's screen is too small

Voice to text input



- > User privacy leakage issues
- Recognition rate for dialects is not high enough
- ▶ ...

Novel Sensing Technologies

Vision-based method

RF-based method

Acoustic-based method













Tracking User's Finger Directly







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Strata: Device-free Tracking Technology

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Tracking algorithm of Strata:

 $Current_{distance} = Initial_{distance} + \sum Distance_{change}$

> Calculate distance changes (based on channel impulse responses of a moving finger):



Complicated calculation!

2D Tracking



1D Tracking



Preliminary Study: 1D Trajectory Classification



Challenge and Opportunity

Collect training data for each unseen user is unrealistic...



- Handwriting recognition is a popular research topic
- MNIST datasets online can be utilized!



ABCDEFGHIJKLMNOPQRSTUVWXYZ ABCDEFGHIJKLMNOPQRSTUVWXYZ

情情情情	LEFF	事事事事	确确确确
나 나 나 나	对对对对	同同同	物物物物
+ + + +	在在在在	白白白白	可可
12 76 76 70	的的的	是是是是	转转转
能能能能	论论论	也也也也	IIII
和和和和	TFF	类类类类	比比比比

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MNIST to TrackMNIST



Two Steps:

- 1. Restore the stroke order information when writing a letter
- 2. Simulate the distance changes between the finger to the mobile

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Restoring Stroke Order Sequences

Obtain reference (from teaching video)

Particle swarm-based algorithm: traverse the handwritten image

Output: Living particle trad



Different writing habits on the same letter



Like Print 'f'



Like Looped 'f'





Print 'f'





Looped 'f'





From Gif to 1D Tracking Trace



Simulate Finger Jumping Traces



Our Algorithm Can Support Other Languages



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Evaluation



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Conclusion

MagicInput enables finger input applications:

- Training-free system with data augmentation based on MNIST-series datasets.
- ✓ Support multiple languages.
- ✓ Outstanding letter classification accuracy.
- ✓ Low power consumption.