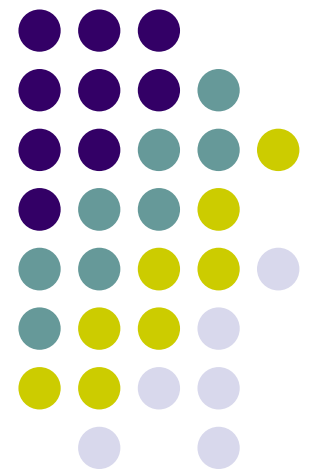


Ubiquitous and Mobile Computing

CS 528: Using Mobile Phones to Write in Air

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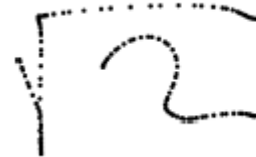
Introduction

- PhonePoint Pen

1. Assistive Technology for Impaired Patient

2. One-Handed Use

3. Equations and Sketching



4. Mashing with Cameras

5. Emergency Operations



Introduction

The basic idea of writing-in-air can be generalized to other devices and applications, like a TV remote control





Vision

- PhonePoint Pen (3P)

Use the in-built accelerometer in modern mobile phones as a quick and ubiquitous way of capturing (short) written information.

MORIS

PEN

Vision



PEN

- Character recognition
- Recognize from one Character to another to form a word
- Miscellaneous features
- Display the results on the phone's screen with 2-3 seconds latency

Related Work



Leap Motion





Related Work

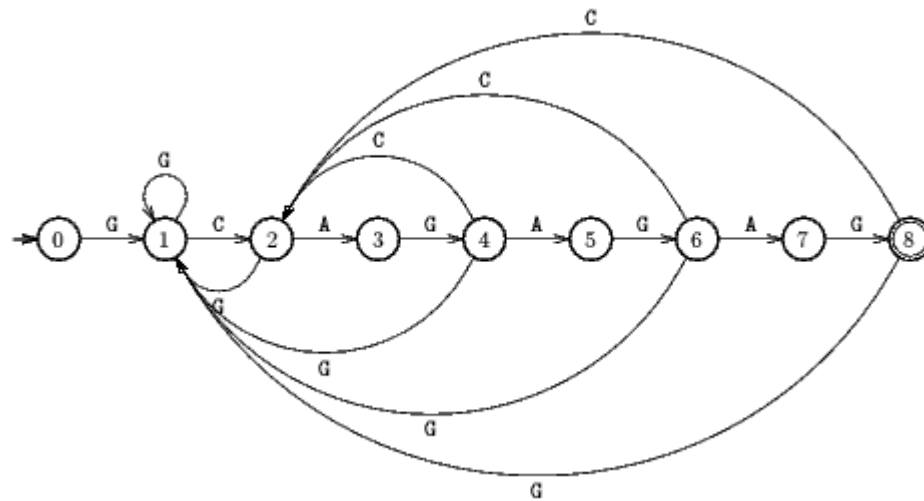


<http://research.microsoft.com/apps/video/default.aspx?id=143225&l=i>

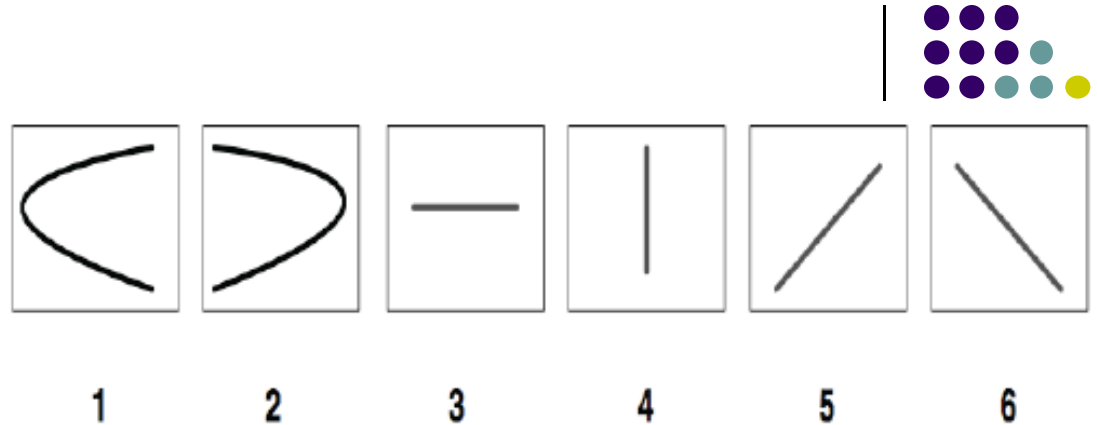
Methodology



Stroke -- > Character --> Words --> Sentence



Methodology



● Stroke Detection

1. Characters can be viewed as a sequence of strokes
2. Correlate the human-strokes against each of the basic strokes



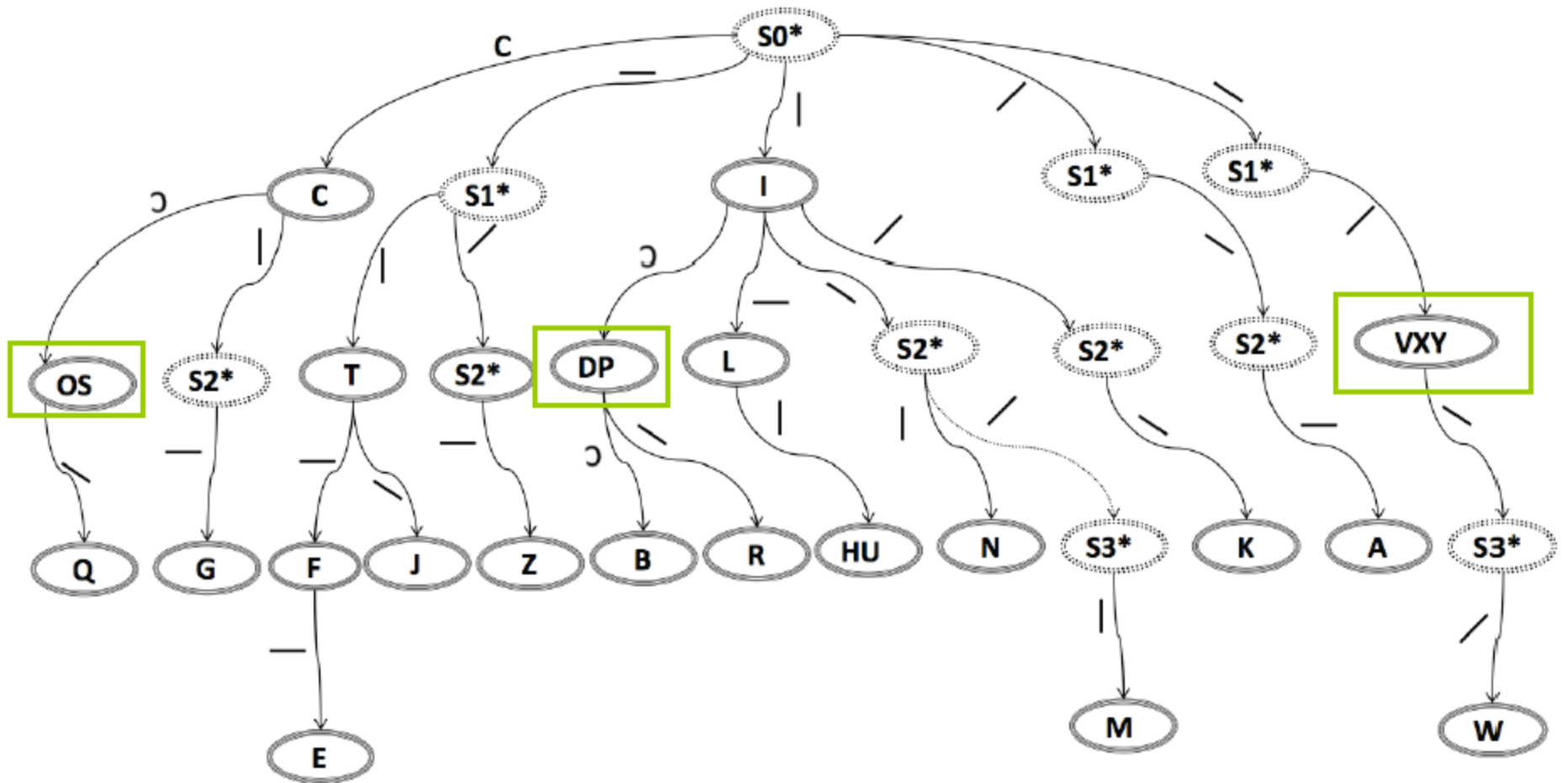
Methodology

- Character Recognition

1. Observe the logical juxtaposition of strokes to deduce the character that human is trying to write
2. A stroke grammar for English alphabets and digits



The grammar is essentially a tree, and express the valid sequence of strokes to form an alphabet



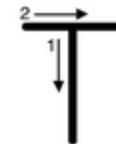
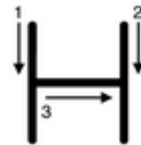
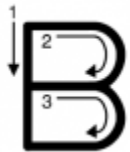


Methodology

- **Word Recognition**

- Recognizing the juxtaposition of characters

- **How to recognize "B" and "13" & "H" and "IT"?**



Methodology



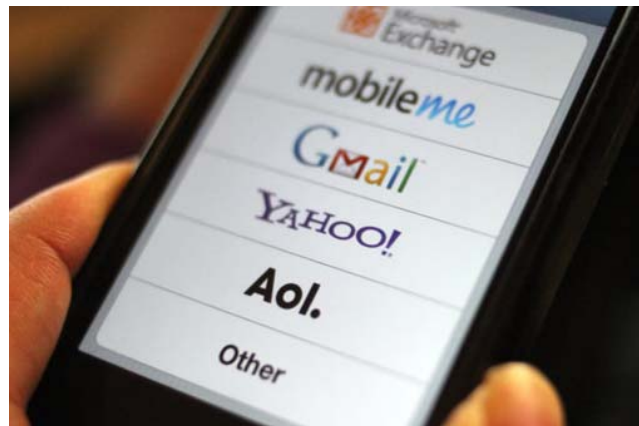
- **Solution**

- 1. Longer Pause between two characters**
- 2. Hands move to a leftward horizontal direction**
- 3. Gesture a "dot" between characters**
- 4. Anticipate next stroke from a specific set of strokes**



Methodology

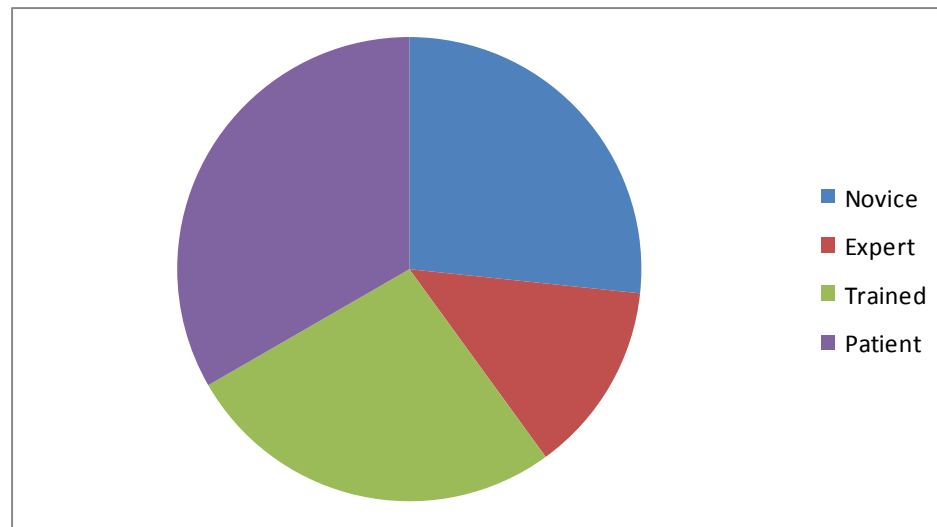
- **To Write Short Phrase -- Control Gestures**
 - 1. write short phrase, words need to be separated by spaces -- long horizontal movement or two dots**
 - 2. the characters may need to be deleted -- shake their hands at least fort times briskly**
 - 3. eamil the content -- draw a check mark in the air**



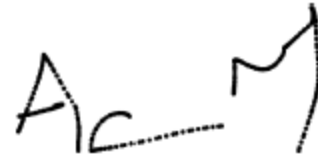


Evaluation

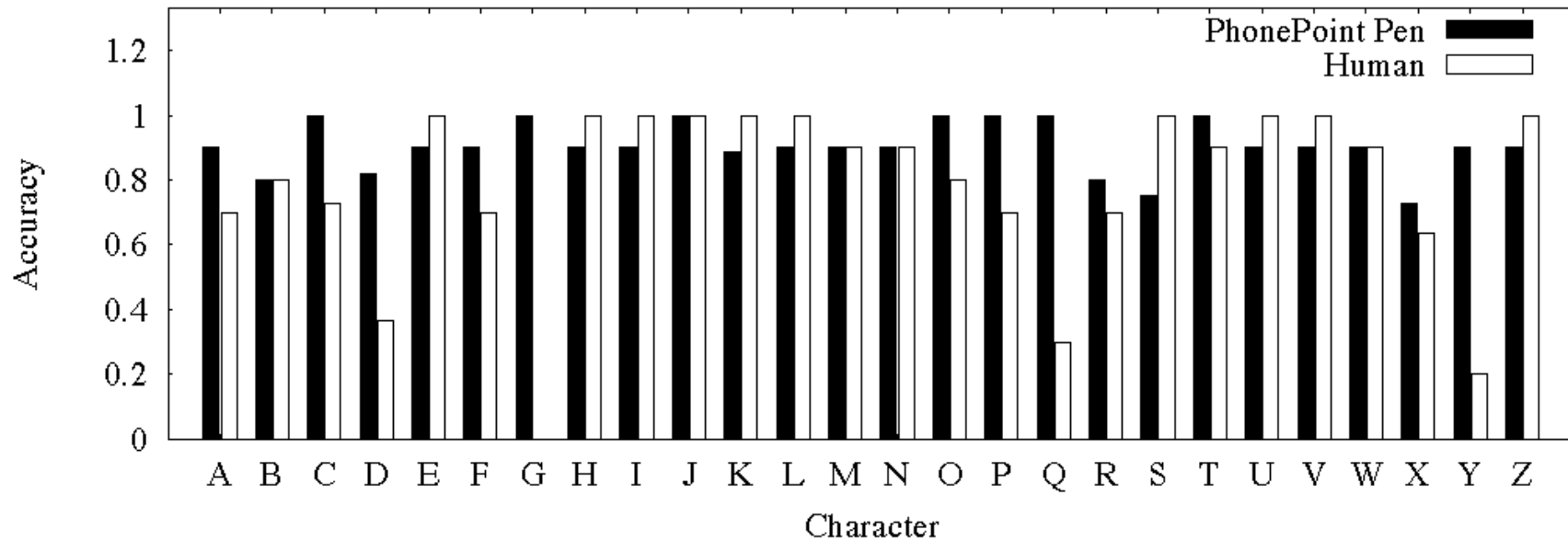
- Test Group consists of
- 2 students wrote around 75 characters
- 4 students wrote around 26+ characters
- 4 students are novice
- 5 patient from Duke Hospital



Evaluation



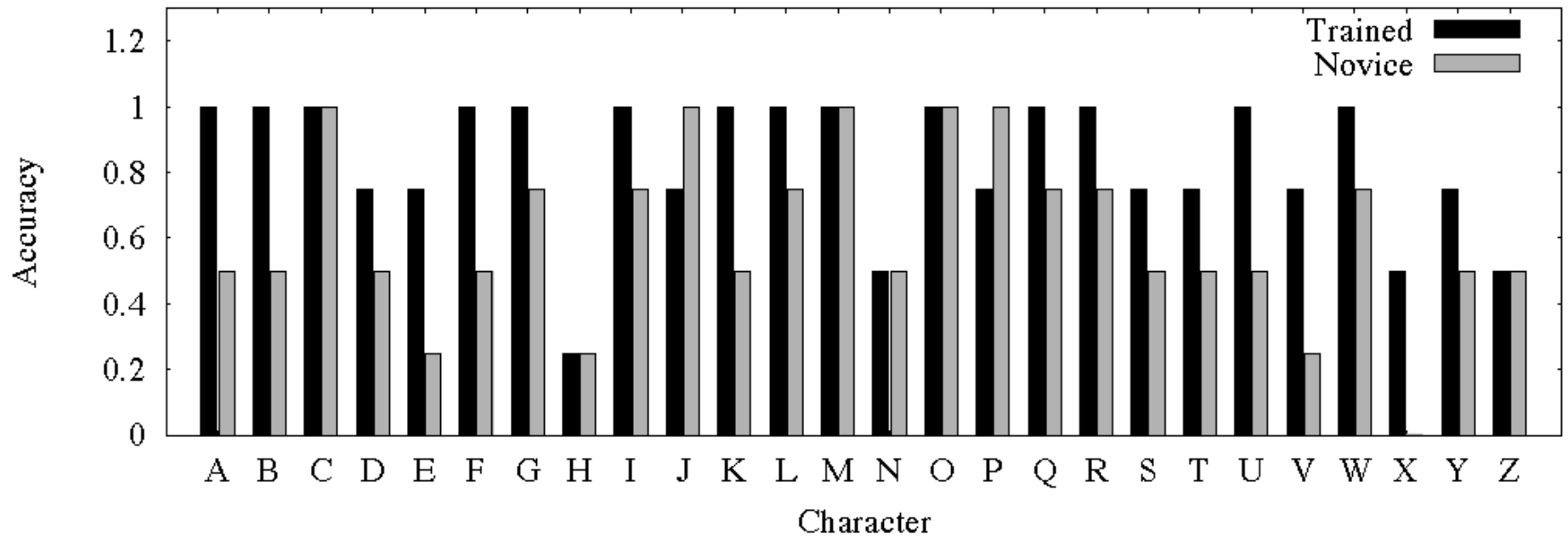
- **P3 90.15%**
- **HCR 77% -- HCR(Human Character Recognition)**



Evaluation

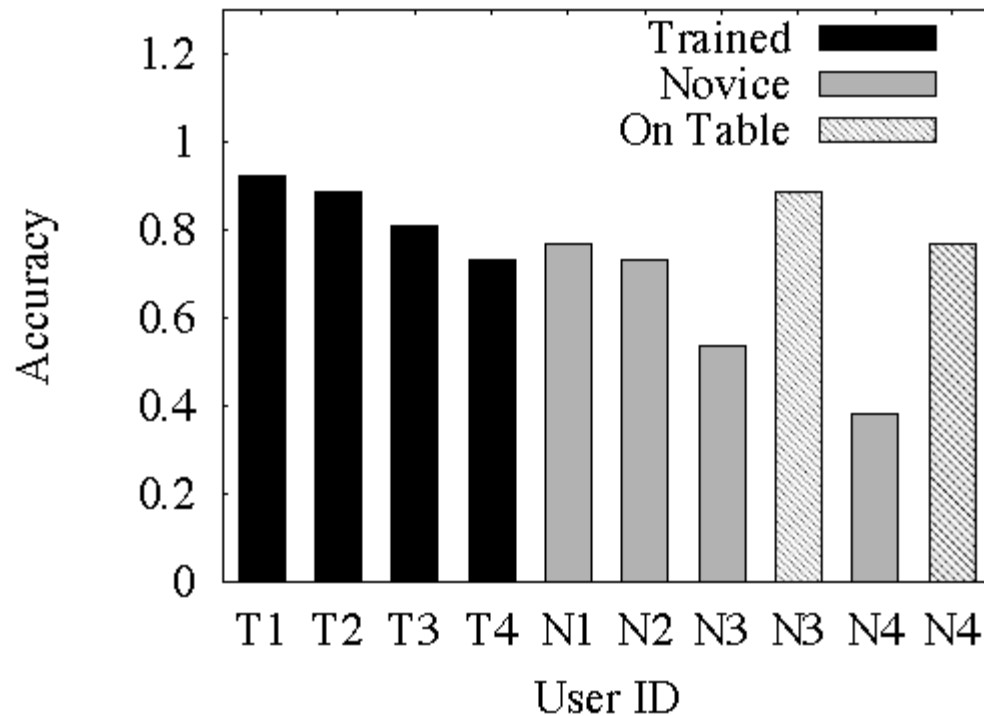


- per-alphabet accuracy



Evaluation

- **Average Accuracy per User**
- **Trained 83.6%**
- **Novice 60.5%**



Evaluation



- **Word length and Accuracy**

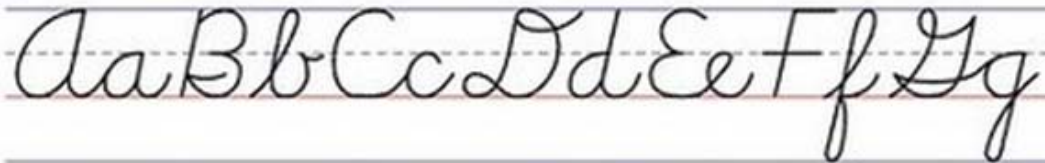
Word Length	PhonePoint Pen	Spell Check	Human
2	9/10	9/10	5/10
3	9/10	10/10	5/10
4	6/10	9/10	5/10
5	7/10	7/10	9/10

LOL WIN GO ALIVE



Conclusion

- **Limitations**
 1. **Drawing and writing long words**
 2. **Writing while moving**
 3. **Cursive Handwriting**
 4. **Survey and testing population**





Conclusion

- **Assistive Technology for Impaired Patient**



Conclusion



- **Comments**
 - **Clear paper structure**
 - **Detailed description in each section**
 - **Proposed interesting questions and solve them**
 - **Convincing experimental results**



References

- ***Agrawal S, Constandache I, Gaonkar S, et al. Using mobile phones to write in air[C]//Proceedings of the 9th international conference on Mobile systems, applications, and services. ACM, 2011: 15-28.***
- ***Gaida D, Stuhlsatz A, Meier H G. Fusion of visual and inertial measurements for pose estimation[J]. dynamics, 2008, 1: 2.***



Thank you!!

