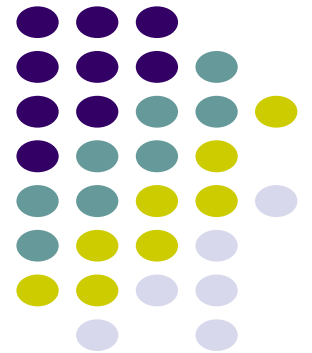


Using Mobile Phones to Write in Air

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Zapatka, Ryan Orlando



Introduction



- PhonePoint Pen (P3) is a solution to using a keyboard for text input
- Digital notes are better than pen and paper (Internet of things)

Vision

- Phone as a Pen
- Older Generations
- Restrict Motion Patients

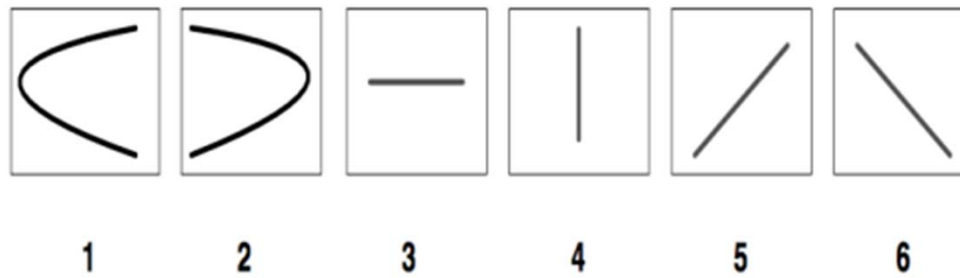


Methodology



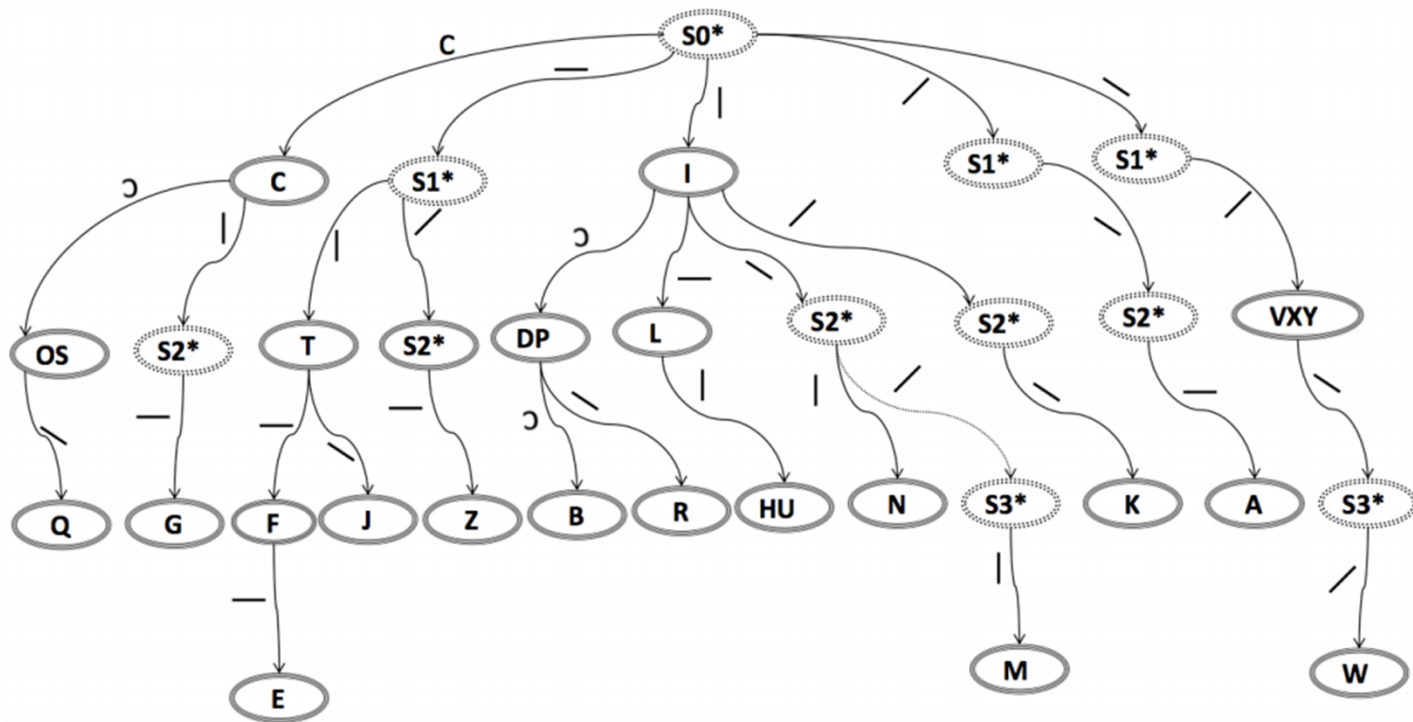
- Multi-phase alphabet recognition
 - Stroke detection
 - Character recognition
 - Word recognition
 - Spelling correction
- Python & MATLAB implementations

Stroke Detection



- Running variance check
 - Check for continuous motion
- Correlate human stroke against each ideal stroke

Character Recognition



Word Recognition



- Naturally longer pause when transitioning between words
- Leftward motion denotes start of a new character
- Gesture a dot (“.”) between characters (B vs 13)
- Spelling correction

Core Challenges

- Lack of gyroscope
- Background vibration
- Computing displacement
- Differentiating letters from shapes
- Character Transitions



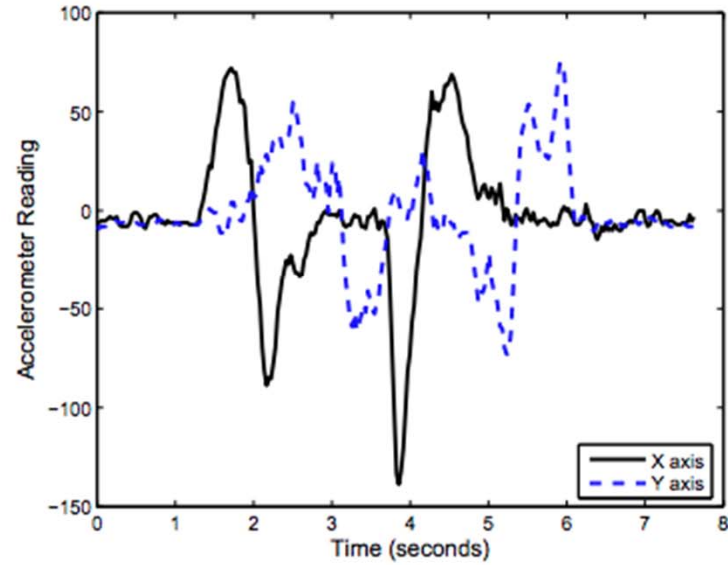
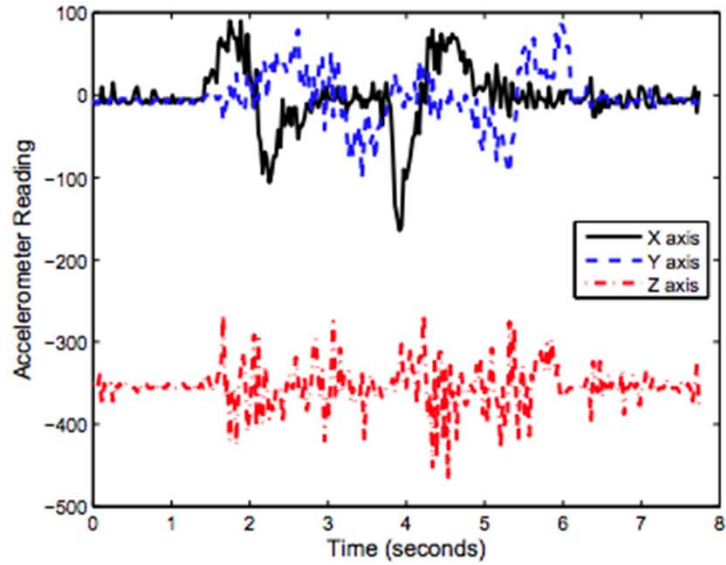


Lack of Gyroscope

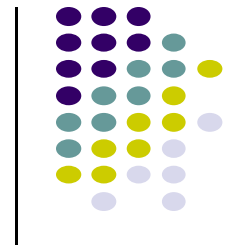
- Accelerometer detects linear acceleration
 - Can't detect rotational acceleration
- Must hold phone with non-rotational grip



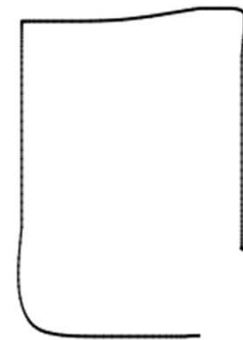
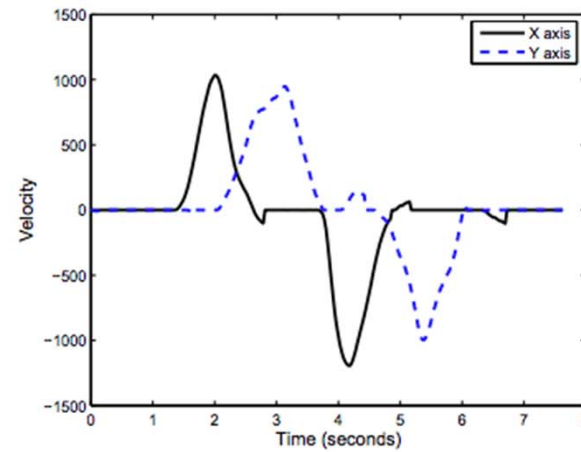
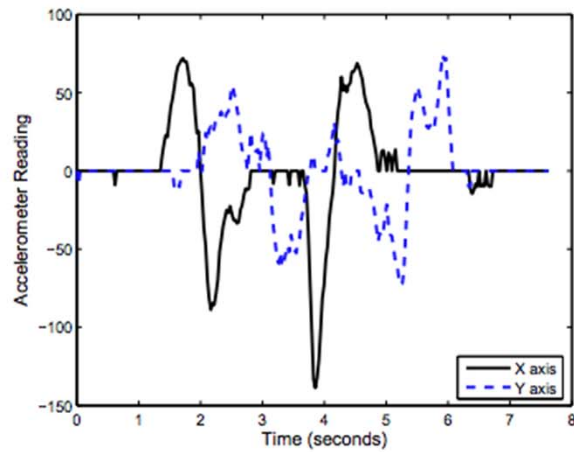
Background Vibration



Computing Displacement



$$\delta = \int (\int a dt) dt$$



Letters & Shapes

/ + \ + — = A or Δ

- Check for upward impulse after / \
- If “pen” is lifted/repositioned, use



Character Transitions



B vs 13

- Special gesture between characters
- 13 written as |.ככ
- B written as |ככ

Related Work

- Gesture Recognitions
- Writing like a Pen with Technology



Gesture Recognition



- Air Gesture
- Video based Gesture Recognition
 - Tiny Motion
 - Write in Air
- Wii Motes

Writing with Technology



- Styles
 - Electronic Napkin
 - Xerox
- Smart Pen

Metrics

- Character Recognition Accuracy (CRA)
- Word Recognition Accuracy (WRA)
- Human Readability Accuracy (HRA)



Results



- HRA around 83-85% (single letter)
- 2-4 minutes of training improves CRA by ~14% (from 78% to 92%)
- WRA decreases with word length (80% WRA, 70% HRA for 5 letter words)

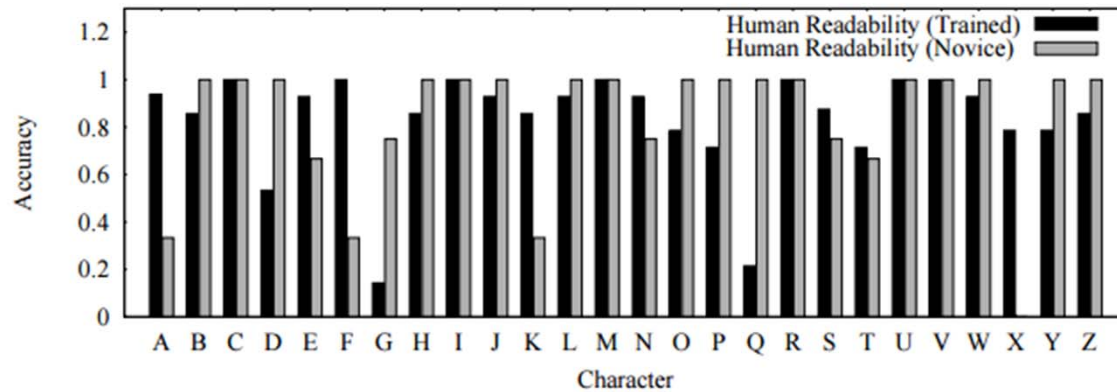


Figure 9: Human Readability Accuracy (HRA) for Trained and Novice users. Human's powerful cognitive abilities result in comparable recognition performance, even though the Novice's characters were qualitatively observed to be more distorted.

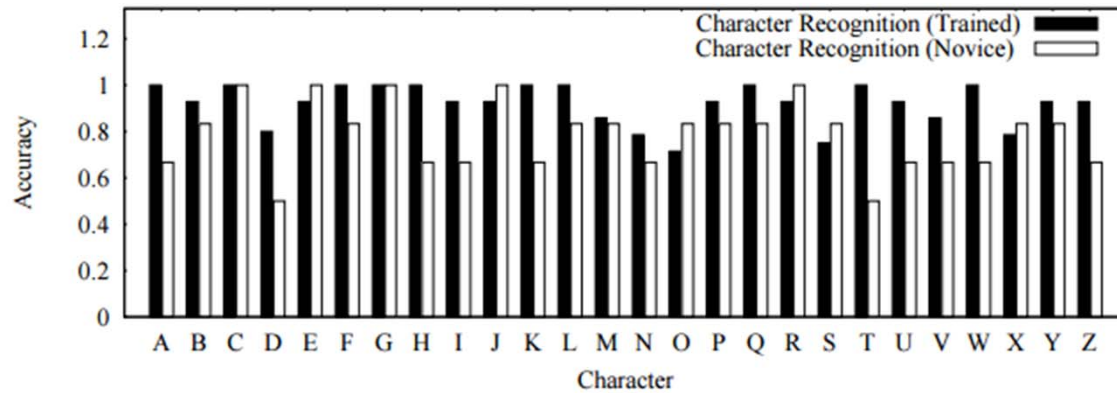
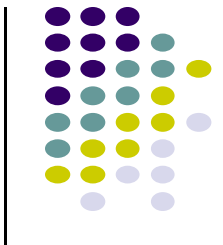


Figure 10: Character Recognition Accuracy (CRA) for Trained and Novice users per-character. The stroke grammar achieves a reasonably high accuracy, especially with Trained users.



Hospital Patient Results



- Low metrics, but promising future
- Suggested improvements to app
 - Eliminate start button
 - Reduce range of motion

Future Improvements

- Quicker Writing
- Longer Words and Pictures
- Cursive
- Writing while Moving



References



- Agrawal, Sandip, et al. "Using mobile phones to write in air." *Proceedings of the 9th international conference on Mobile systems, applications, and services*. ACM, 2011.