Fingertip Haptics and its Application in Typing on Flat Keyboards

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Outline

- Introduction
- Haptics R&D at Microsoft
- Keyclick feedback on flat keyboards
Touchscreens Everywhere

Ford SYNC

Slide courtesy of Joshua Xiang, STB
Yet Screens do not Touch Us Back

Video courtesy of Dr. Roland Johansson, Univ. Umea, Sweden
Haptics and High Information Capacity

Blind and deaf people have been using touch to substitute vision and/or hearing for a very long time, successfully.

12 bits/sec
HAPTICS R&D AT MICROSOFT
3D Haptic Touch

3-D Haptic Touch
(Mike Sinclair, Michel Pahud, Hrvoje Benko)
Ungrounded & In-the-Air Haptics

**GyroTab**
(Aakash Badshah, Sidhant Gupta, Daniel Morris, Shwetak Patel, Desney Tan)

**AirWave**
(Sidhant Gupta, Shwetak Patel, Dan Morris, Desney Tan)
Looking for the “Killer App”
Looking for the “Killer App” (cont.)
Fingertip Haptics

Feeling Objects on Touchscreens

Click-like Feedback on Touchscreens

“SlickFeel: Sliding and Clicking Haptic Feedback on a Touchscreen,” Xiaowei Dai, Jiawei Gu, Xiang Cao, J. Edward Colgate, and Hong Z. Tan, UIST 2012.
Examples of “flat” keyboards

Tactile feedback facilitates typing on flat keyboards
  - Fukumoto et al., CHI’01
  - Poupyrev et al., UIST’02
  - Brewster et al., CHI’07
  - Hoggan et al., CHI’08
  - Lee et al., CHI’09

What’s left to study?
  - Keyclick feedback for ten-finger touch typing
  - Haptic feedback that feels like key clicks
KEY-CLICK FEEDBACK ON FLAT KEYBOARDS (two studies)
Q1. When Does Global Haptic Feedback Feel Local?

“A masking study of key-click feedback signals on a virtual keyboard,” Jin Ryong Kim, Xiaowei Dai, Xiang Cao, Carl Picciotto, Desney Tan, and Hong Z. Tan, *EuroHaptics 2012.*
Experimental Apparatus

- Clear cover
- Piezo actuator
- FSRs
Average = 19.5dB
Average = 11.5dB
Q2. Does Keyclick Feedback Improve Typing?

- We compared typing performance with
  - Physical keyboard with full feedback
  - Visual letter feedback only
  - Visual + auditory beep feedback
  - Visual + localized keyclick feedback
  - Visual + global keyclick feedback

- Performance metrics
  - Typing speed (words per minute)
  - Keystroke per character (KSPC)
  - Error rates (corrected, uncorrected, total)

Localized Keyclick Feedback using Piezoelectric Actuators
Results: Words per Minute

- Full Feedback (Physical): 67
- Localized Haptic + Visual: 55
- Global Haptic + Visual: 52
- Auditory Beep + Visual: 50
- Visual only: 46
Results: Keystroke Per Character

- Full Feedback (Physical): 1.1
- Localized Haptic + Visual: 1.2
- Global Haptic + Visual: 1.2
- Auditory Beep + Visual: 1.2
- Visual only: 1.3
Results: Error Rate (%)
CONCLUDING REMARKS
Localized keyclick haptic feedback can be achieved through sufficient mechanical de-coupling and the masking effect.

**Physical keyboard** produces the highest **typing speed**, lowest **keystroke per character**, and lowest **error rates**.

The addition of **haptic keyclick feedback** (localized or global) and **auditory beep feedback** to **visual feedback** significantly improves **typing speed**, **efficiency**, and **error rates**.

Localized keyclick feedback leads to higher **typing speed** and lower **error rates** as compared to **global keyclick feedback** and **auditory beep feedback**.

*What is the performance/cost tradeoff for employing localized vs. global keyclick feedback in a flat keyboard?*
Collaborators

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