Thumb Movement:

Designing for One-Handed Use of Small Devices

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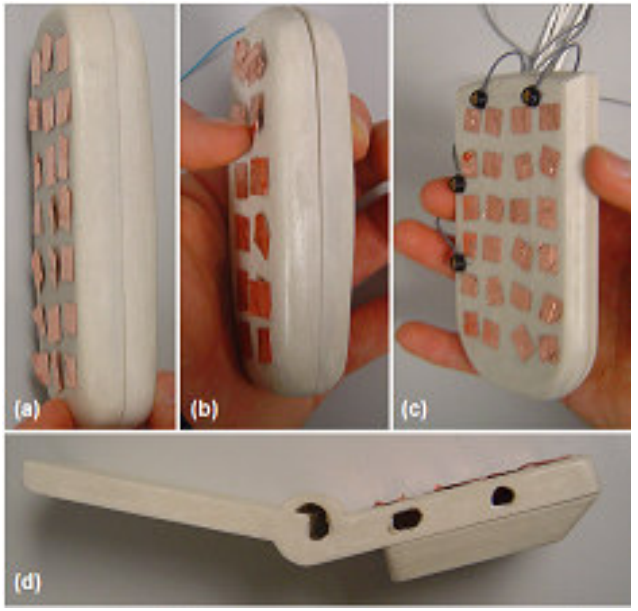


HCIL

Background:

Mobile Device Trends

- Increasing…

Power

Speed

Personalization

Storage

Services

Market Penetration

Functions

Background:

Mobile Device Trends

- Increasing…

Role in users' lives !

Background:

Device Styles & Use Patterns

- Cell phone style
  - Compact keypad
  - Display for output only

    ⇨ **One Hand**

- PDA style
  - Minimal buttons
  - Touch sensitive display

    ⇨ **Two Hands**

Motivation:

Single Handed Use

- Mobile Scenarios

- Web Survey: **Hands Used**

	Current	Preferred
Phone	1	1
PDA	2	1

www.cs.umd.edu/hcil/mobile/survey/

Motivation:

Case In Point

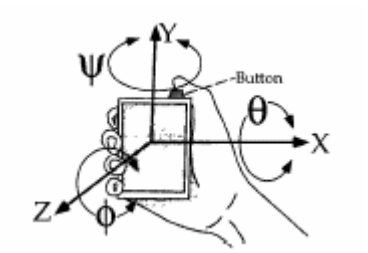
Standard data access applications can be unusable with thumbs

Pocket PC Contacts

Motivation:

One-Handed Device Research

- Spatial Orientation (e.g., tilt to scroll)
  - [Rekimoto, 1996]
  - [Harrison, Fishkin, et al., 1998]
  - [Hinckley, Pierce, et al., 2000]
  - [Widgor and Balakrishnan, 2003]



From [Rekimoto, 1996]

- Minimal Attention Interfaces
  - [Kristoffersen and Ljungberg, 1999]
  - [Pascoe, Ryan, et al., 2000]
  - [Brewster, Lumsden, et al., 2003]
  - [Pirhonen, Brewster, et al., 2002]

From [Pascoe, et al., 2000]

Approach:

Foundations in Thumb Movement

- Goal: Capture thumb capabilities
- Measure: Tapping Speed
- Hypotheses: Performance depends on…
  - Device **Size**
  - Movement **Direction**
  - Interaction **Location**

Approach:

Device Sizes

- Four typical devices
- Varying sizes and shapes

Small Candy bar

Flip Phone

Large Candy bar

PDA

Increasing Size

Approach:

Device Sizes

- Four typical devices
- Varying size and shape

Increasing Size

Study:

Device Models

- Models remove tactile features




Study:

Capturing Thumb Movement

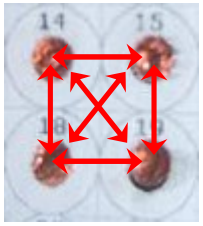
Light Emitting Diodes

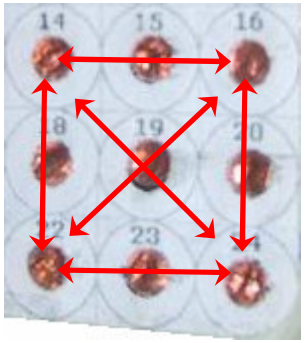
3D spatial positions tracked with a motion analysis system

Study:

Formal Study Design

- Participants: 20
- Devices: 4
- Tasks: Reciprocal Tapping
  - Directions: ↕ ↔ ⤢ ⤡
  - Locations: All Possible
  - Distances:



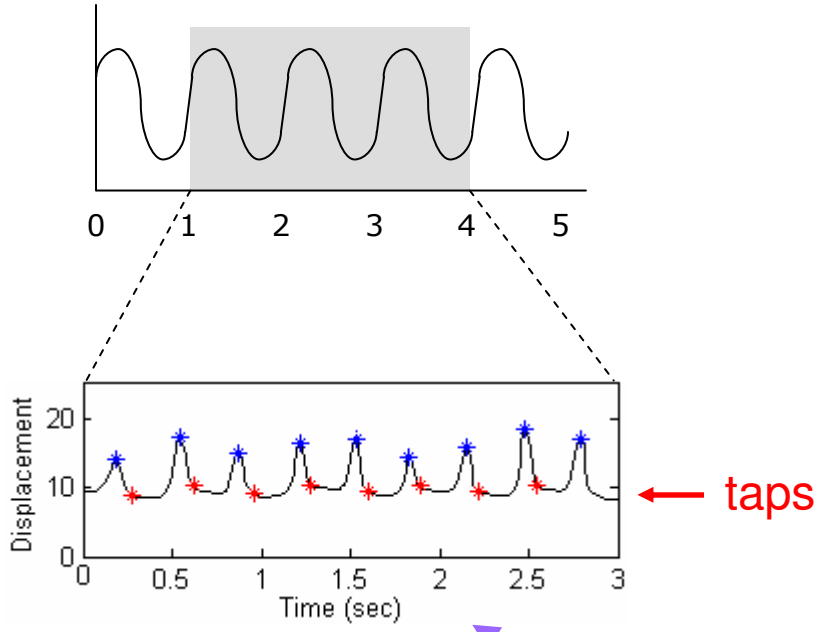


- Measures: Tap **Speed**
  Easy and **Hard** input areas

Analysis:

Deriving Tap Speed

- Middle 3 seconds
- Low points as taps
  - Automated
  - Verified by hand

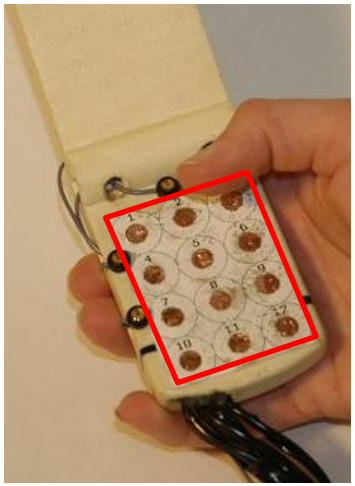


Avg. Tap Speed = $\frac{\text{Time of Last Tap - Time of First Tap}}{\text{Total Taps - 1}}$

Results:

Does **device size** affect performance?

- No time diff. between comparable areas



- Still, we are cautious about large devices:
  - Heavier devices $\rightarrow$ more strain over time?
  - Observed much more grip re-adjustment

Results:

Does **movement direction** affect performance?

↕ ≈ ↔




↗ 11%-14% **faster** than ↘

Results:

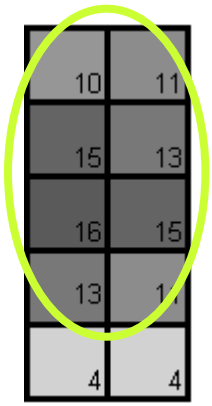
Does **movement direction** affect performance?

Note: participants were all **right** handed

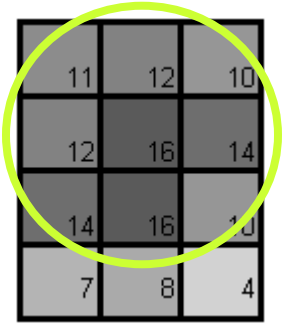
Results:

Does **interaction location** affect performance?

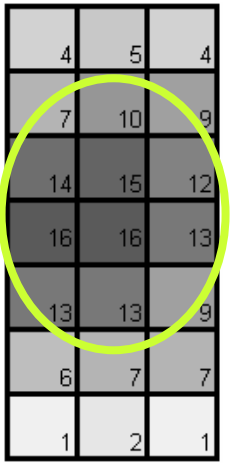
Subjective Preferences



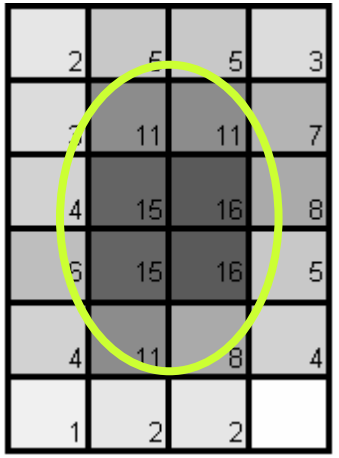
Small Candy bar



Flip Phone



Large Candy bar

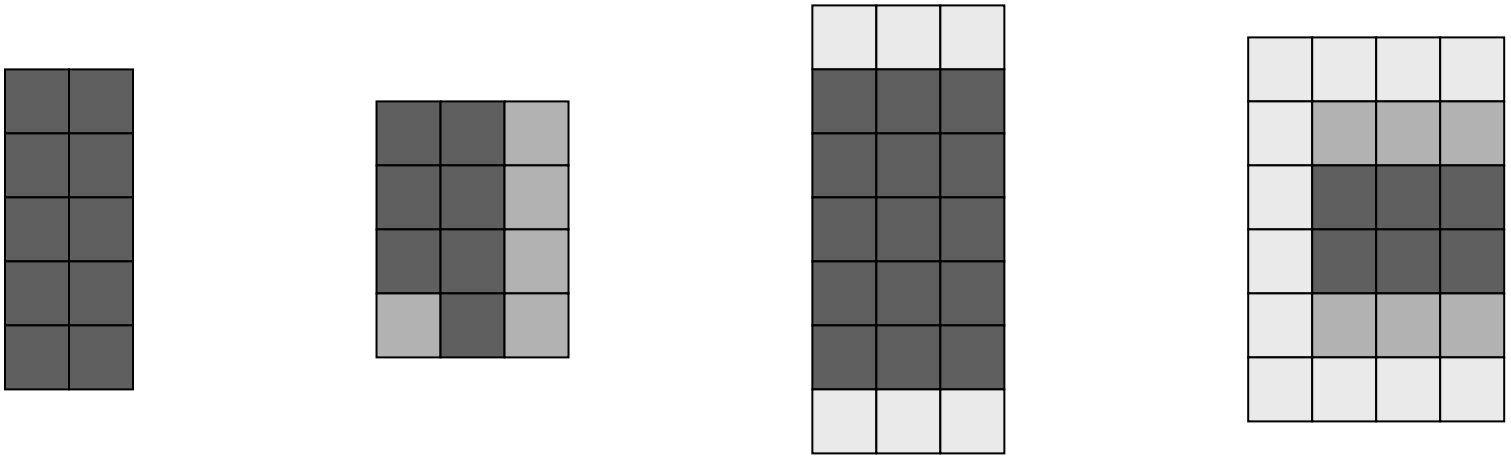


PDA

Easiest **Hardest**

Results:

Does **interaction location** affect performance?



Small Candy bar

Flip Phone

Large Candy bar

PDA

Fastest **Slowest**

Fastest regions 7%-12% faster than slowest regions, per device.

Examples:

Better One-Handed Interfaces?

- Application navigation

LaunchTile

AppLens

www.cs.umd.edu/hcil/mobile/

- Hardware

Compact navigation & control

Palm Treo 700w

Lessons

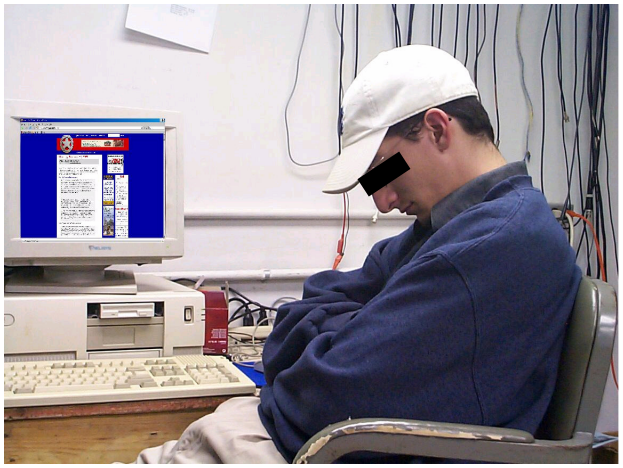
- For **all** devices
  - Avoid diagonal movement for **repetitive** tasks


Supports left **and** right handed use

- For **larger** devices
  - Strive for interaction targets toward the **center** of the device
  - To minimize re-gripping, keep total interaction area **compact**

Special Thanks To:

- François Guimbretière — CS, HCIL
- Kent Norman — Psychology
- Study Participants



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Questions?

- Contacts
  - **Amy Karlson** **(akk@cs.umd.edu)**
  - Ben Bederson
  - Jose Contreras-Vidal
- Resources
  - One-handed application navigation
    www.cs.umd.edu/hcil/mobile/
  - Device usage survey
    www.cs.umd.edu/hcil/mobile/survey/