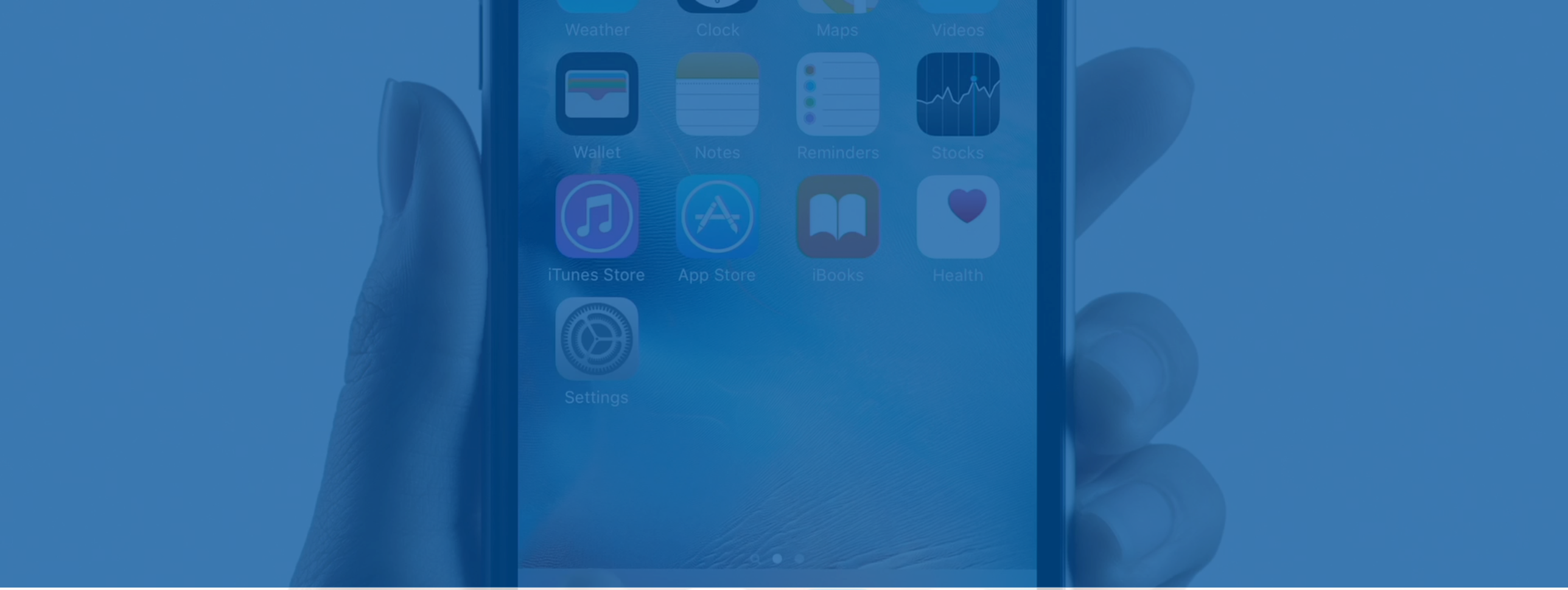

Current Topics in Media Computing and HCI

S6: Force Input on Mobile Devices

Christian Corsten
SS 2018
hci.rwth-aachen.de/cthci

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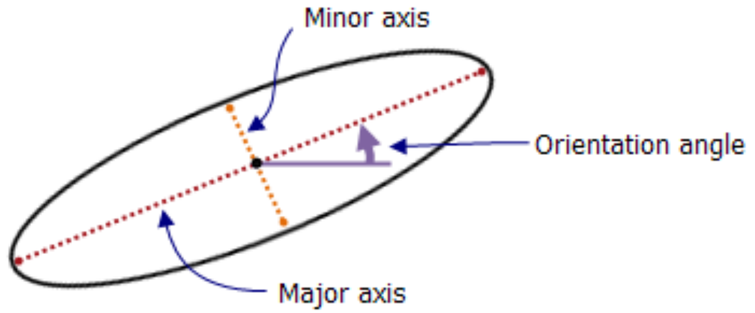
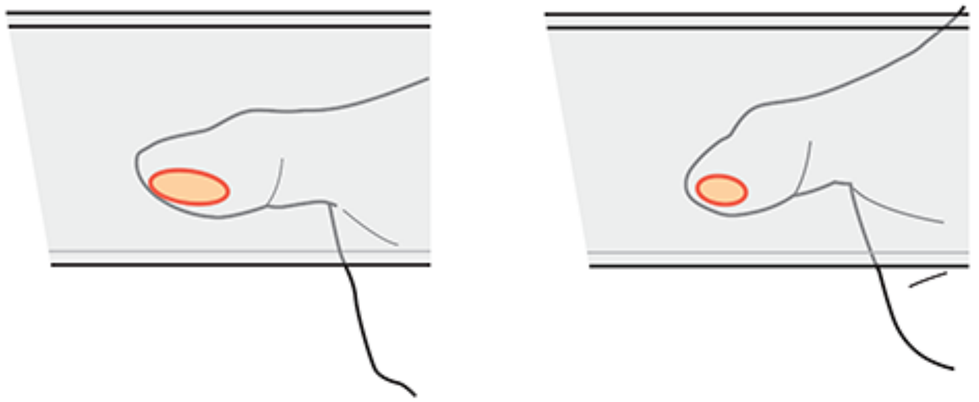
Touch Input: Properties

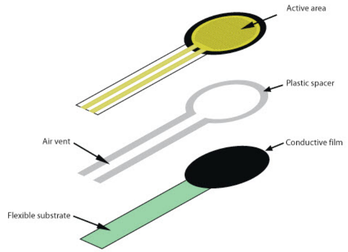
- Usually binary (finger on the surface vs. off the surface)
- Location (x, y)
- Contact size (radius)
- Orientation (angle)
- What else?
  - Distance to the (capacitive) touchscreen?
  - Force?

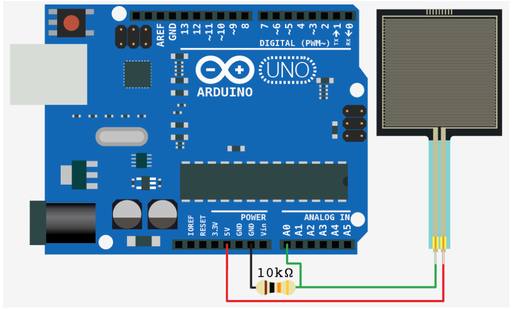


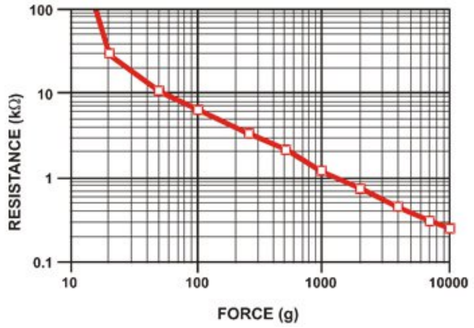


Force Input: How to Detect?

- By contact size?
  - Benko et al.: *Precise Selection Techniques for Multi-Touch Screens,* CHI ’06
  - Boring et al.: *The Fat Thumb*, MobileHCI ‘12
- By time? – bad estimate!
- Force-sensing resistors







Force (lb)	Force (N)	FSR Resistance	(FSR + R) Ω	Current thru FSR+R	Voltage across R
None	None	Infinite	Infinite!	0 mA	0V
0.04 lb	0.2 N	30KΩ	40 KΩ	0.13 mA	1.3 V
0.22 lb	1 N	6 KΩ	16 KΩ	0.31 mA	3.1 V
2.2 lb	10 N	1 KΩ	11 KΩ	0.45 mA	4.5 V
22 lb	100 N	250 Ω	10.25 KΩ	0.49 mA	4.9 V


Studio (Version 12.0 License expires: 01-mar-2005)
File Edit Delete Layouts ObjectDisplay DisplayTgls Layers Canvas Windows Preferences Utilities Help
Use mouse or enter name of item to pick / unpick: [Left Toggle] [Middle Replace] [Right Remove]
object
DefaultLayer
Paint Shelf Options
File
Image_Edit
Color_Swatches
Ready
Palette
Pick
Transform
Paint
Curves
Curve Edit
Object edit
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WACOM


Gallery


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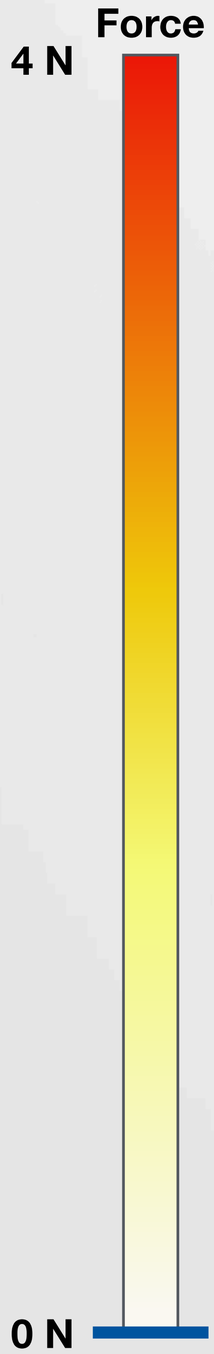
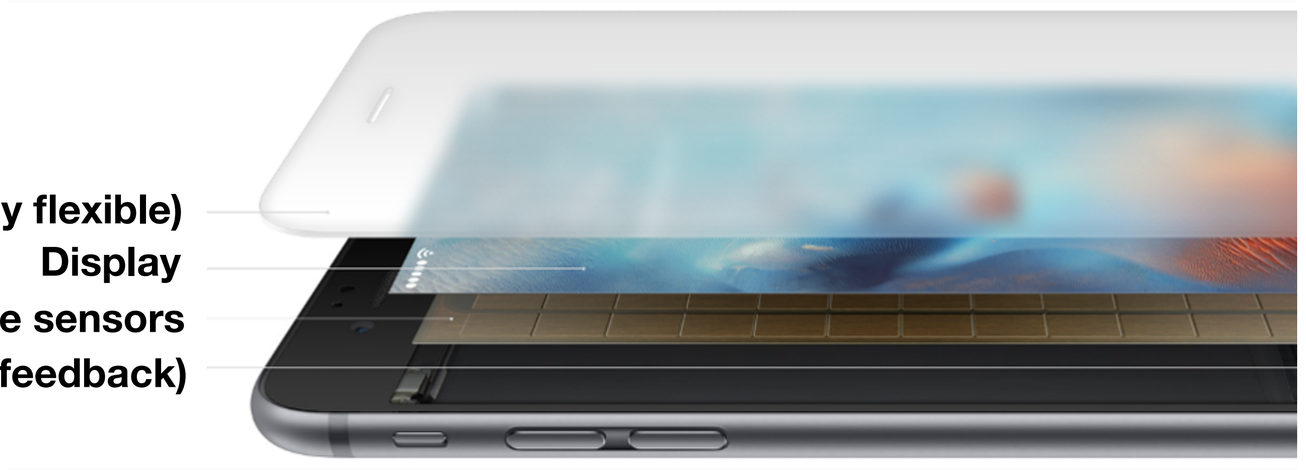
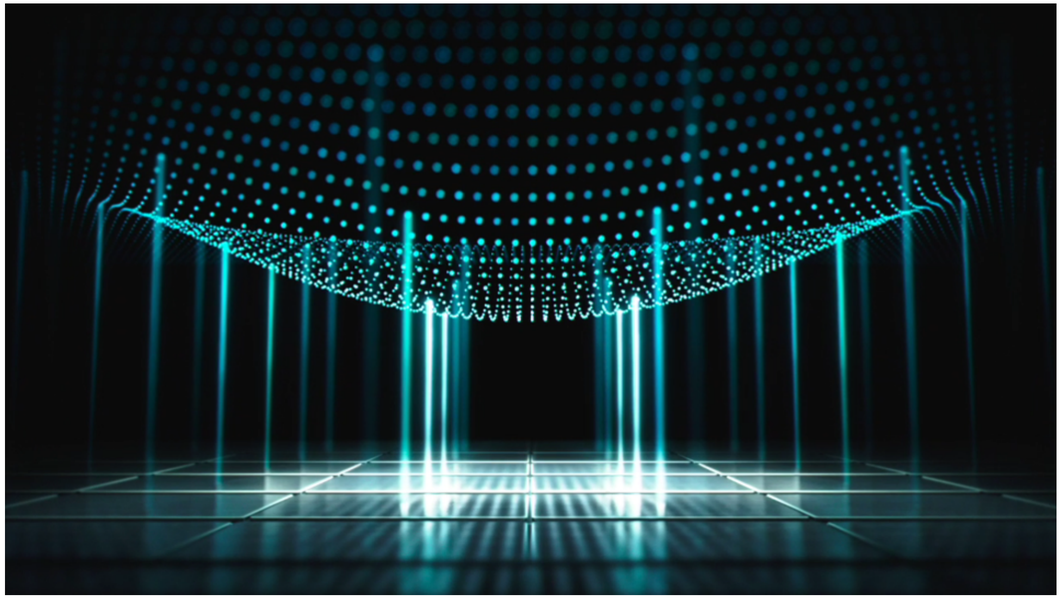
Force Input on iPhone



Force Sensing on iPhone 6S

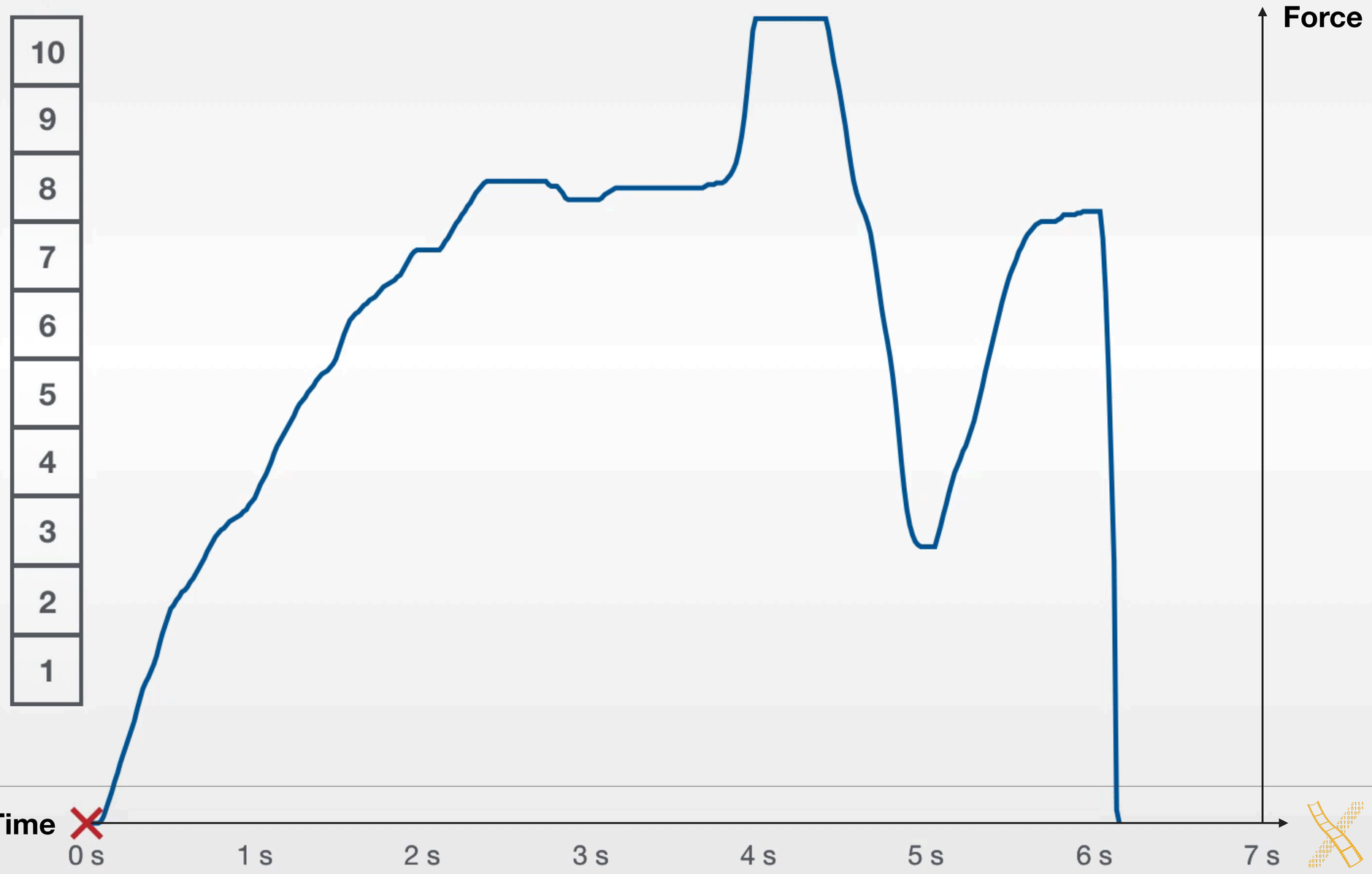


“[…] with each press, these sensors measure microscopic changes in the distance between the cover glass and the backlight." – Apple Inc.

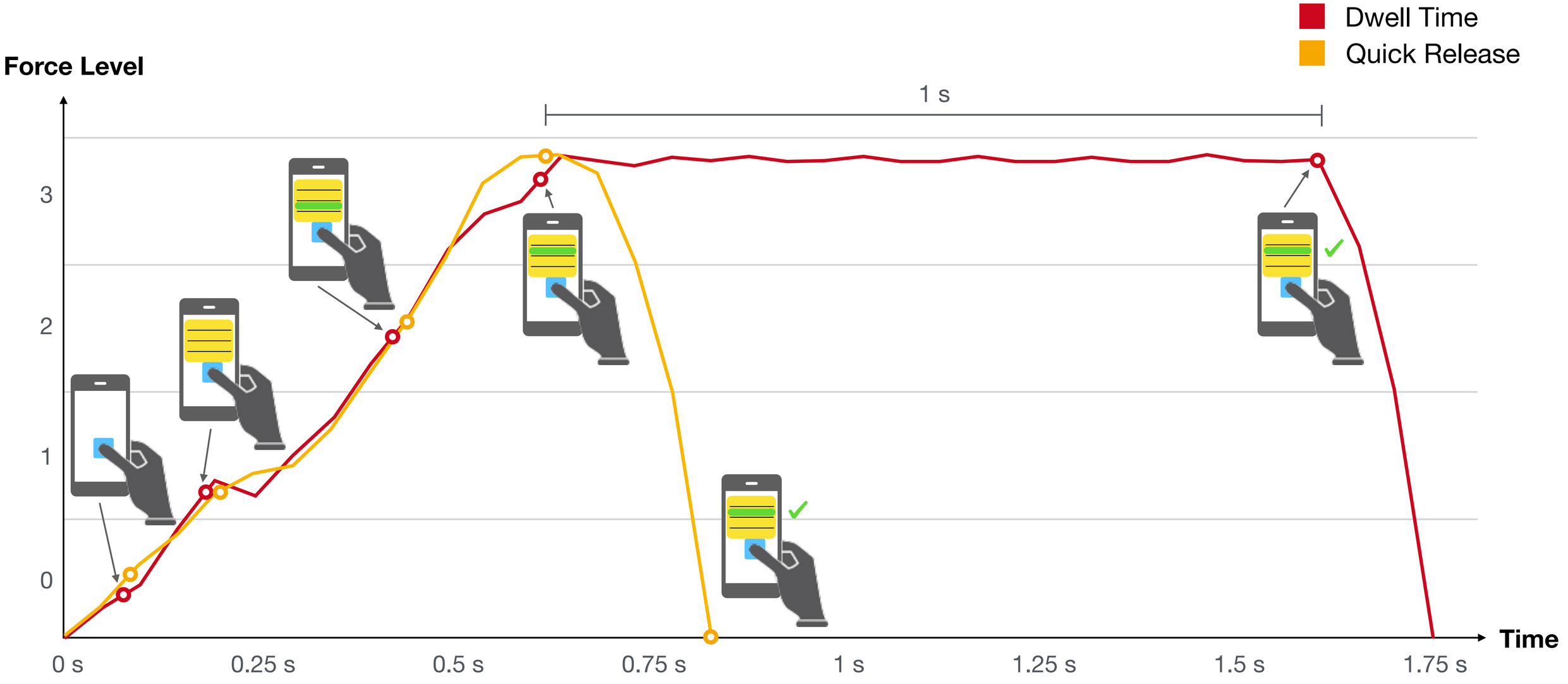


Full article:

Pressure-Based Linear Targeting (PBLT)



Confirming Value Selection



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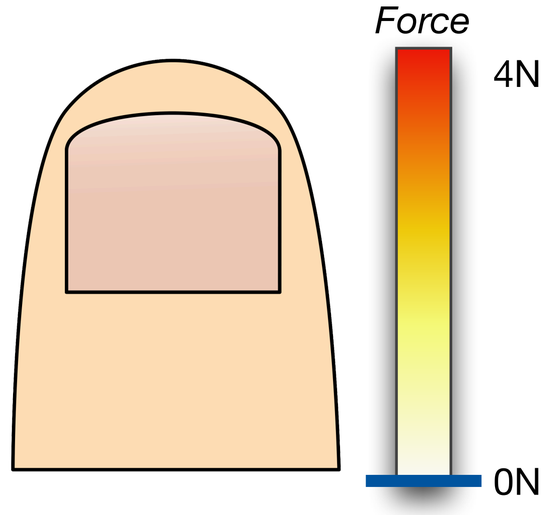
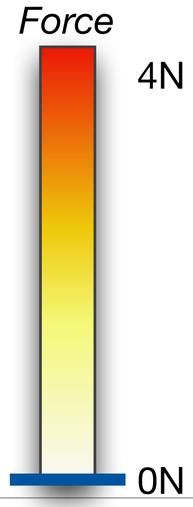
Control Mechanisms

Positional Control

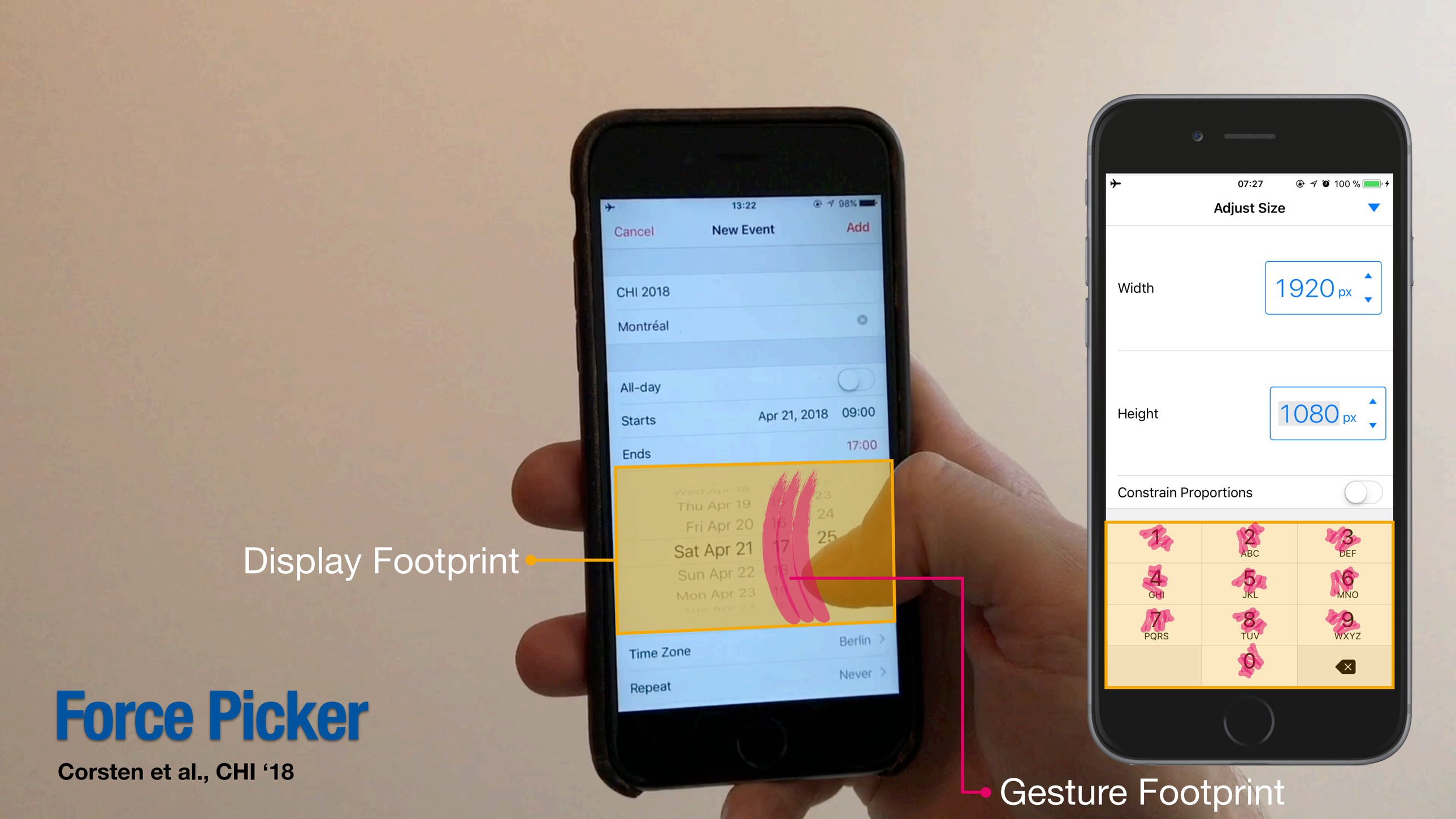


Rate-based Control



How to *decrease* the value?


Force Picker
Corsten et al., CHI ‘18
Cancel
New Event
Add
10:55
80%
CHI 2018
Montréal
All-day
Starts
Ends
Repeat
Travel Time
Apr 21, 2018 09:00
09:00
Never
None
Calendar
None
Time to Leave

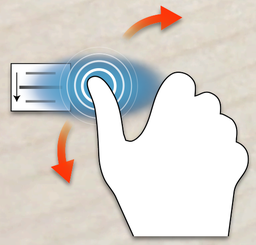


Force Picker

Corsten et al., CHI ‘18

Force Picker

Corsten et al., CHI ‘18



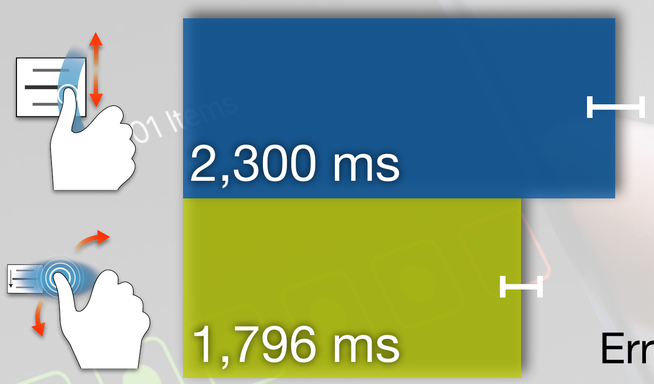
Force Picker

Corsten et al., CHI ‘18

Force Control Performance: How To Quantify?

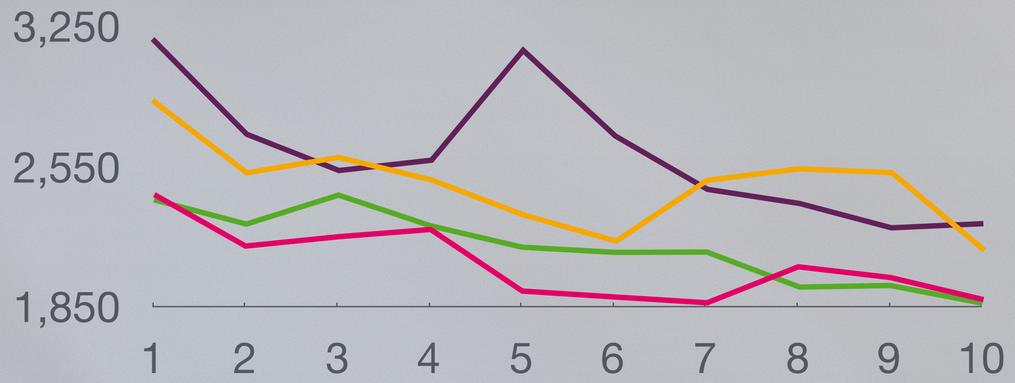
- Task completion time (measured in ms)
- Error rate (How often did the user *not* select the correct item?)
- Number of crossings
- Pressure variance/jitter

Time after Training

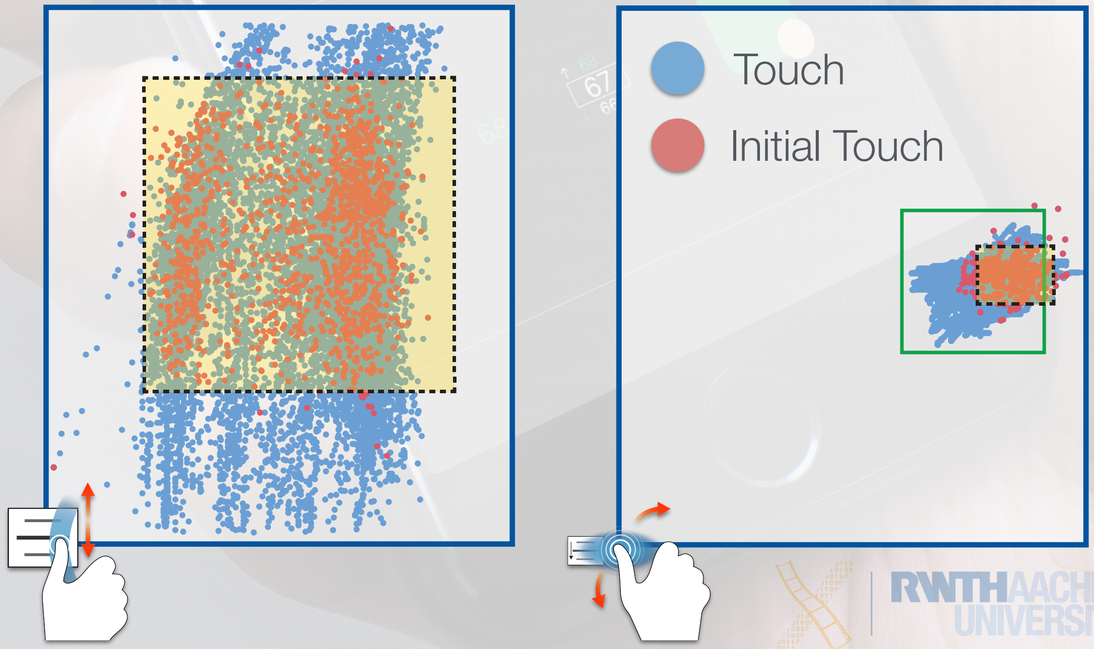


Error bars: 95% CI

Time over Training Sessions



Gesture Footprint after Training



Force Picker: Study

Corsten et al., CHI ‘18

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Force Picker

Corsten et al., CHI ‘18

ForceEdge: Controlling Autoscroll on both Desktop and Mobile Computers using the Force

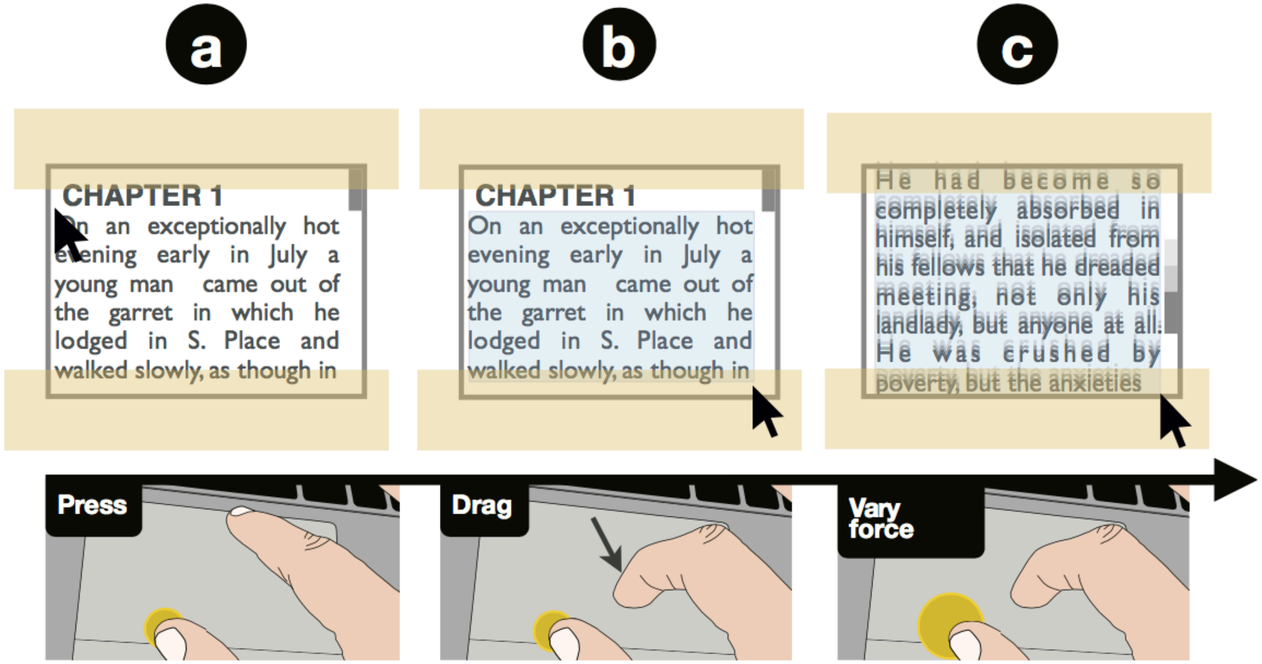
Axel Antoine, Sylvain Malacria, Géry Casiez

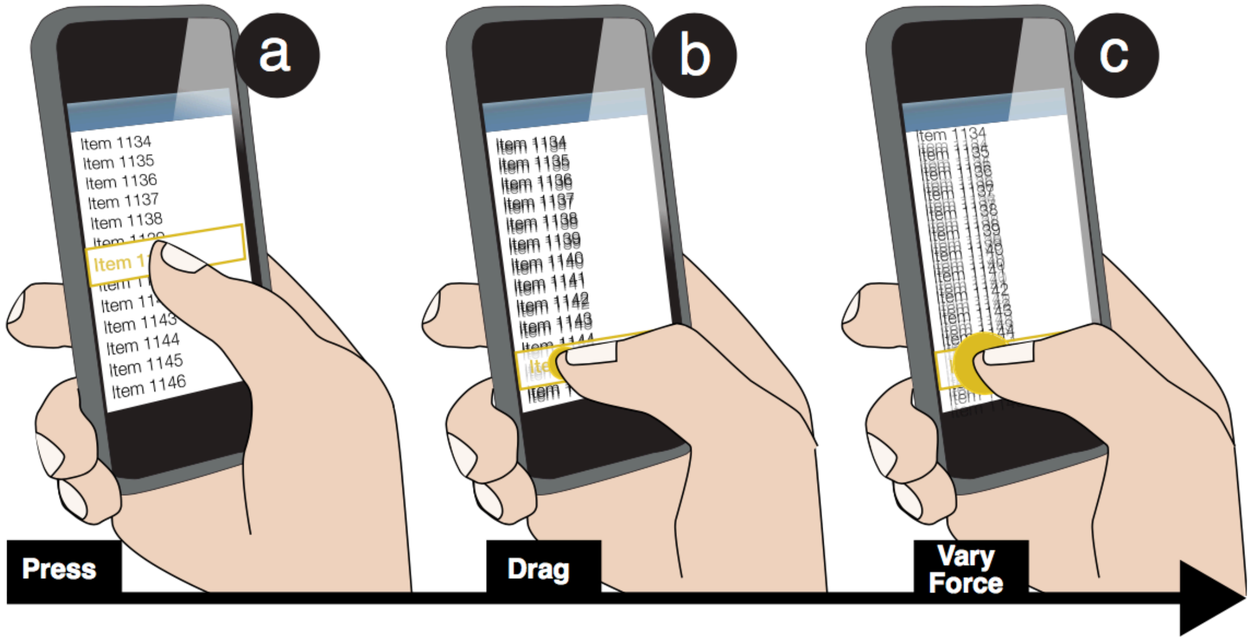
https://www.youtube.com/watch?v=tnkqfT1leqo

CHI 2017 Video Preview

Force Edge

Antoine et al., CHI ‘17





Force Control Performance: Influencing Factors

- Number of targets/menu size, levels of pressure
- Feedback (visual, partly visual, audio only, …)
- Selection mechanism (Dwell Time, Quick Release, …)
- Sensor range
- Discrete vs. continuous control
- Direction (up vs. down) – increase vs. decrease force
- Transfer function (usually: go for linear)
- Control mechanism (position-based vs. rate-based)
- Motion
- Fingers

BackXPress: Using Back-of-Device Finger Pressure to Augment Touchscreen Input on Smartphones

Christian Corsten – Bjoern Daehlmann – Simon Voelker – Jan Borchers

Chair for Computer Science 10 (Media Computing and Human-Computer Interaction)

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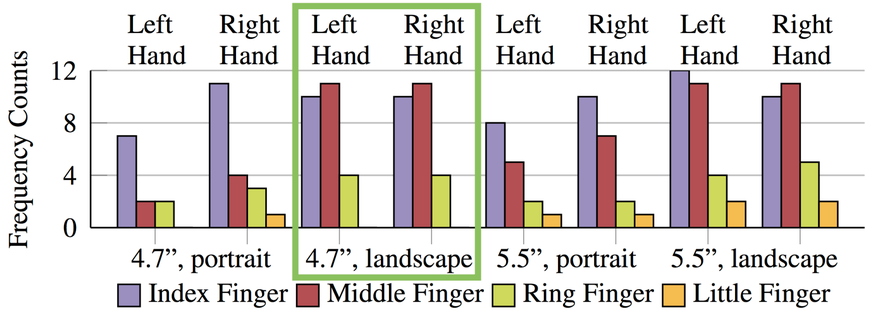
https://www.youtube.com/watch?v=tSxH5__MhKE

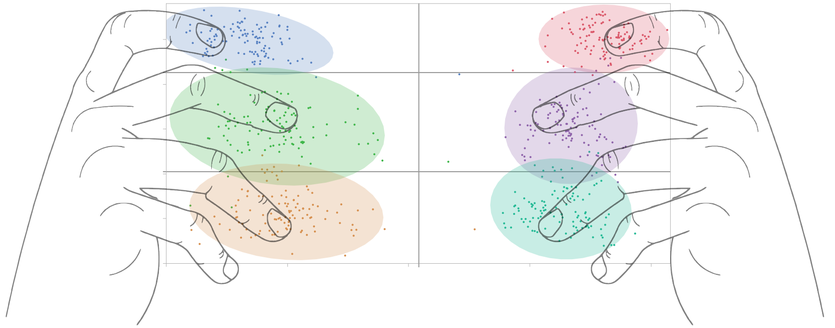
www.hci.rwth-aachen.de

BackXPress: Research Questions

With which fingers can users comfortably exert BoD pressure?



Where at the BoD do users exert pressure with these fingers?



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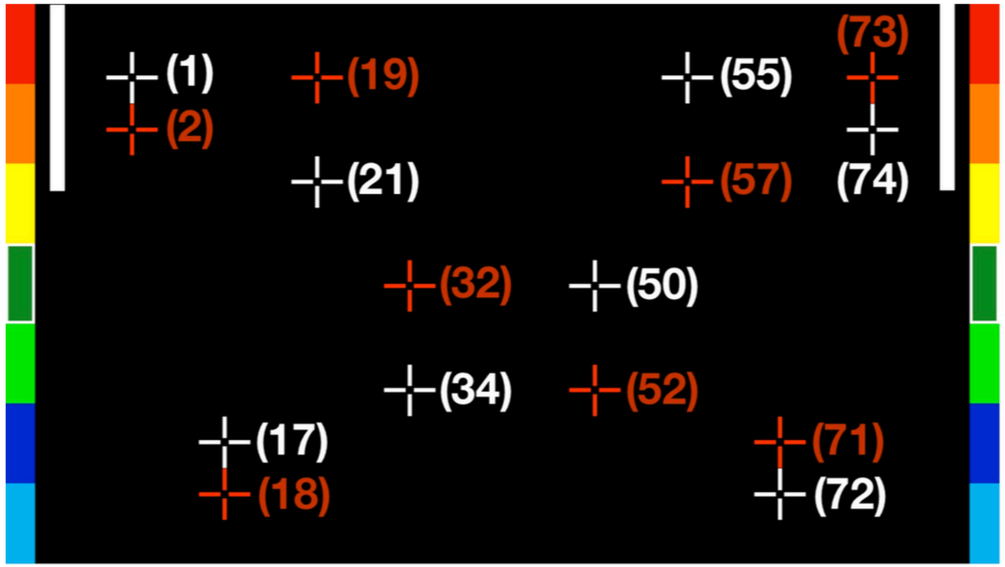
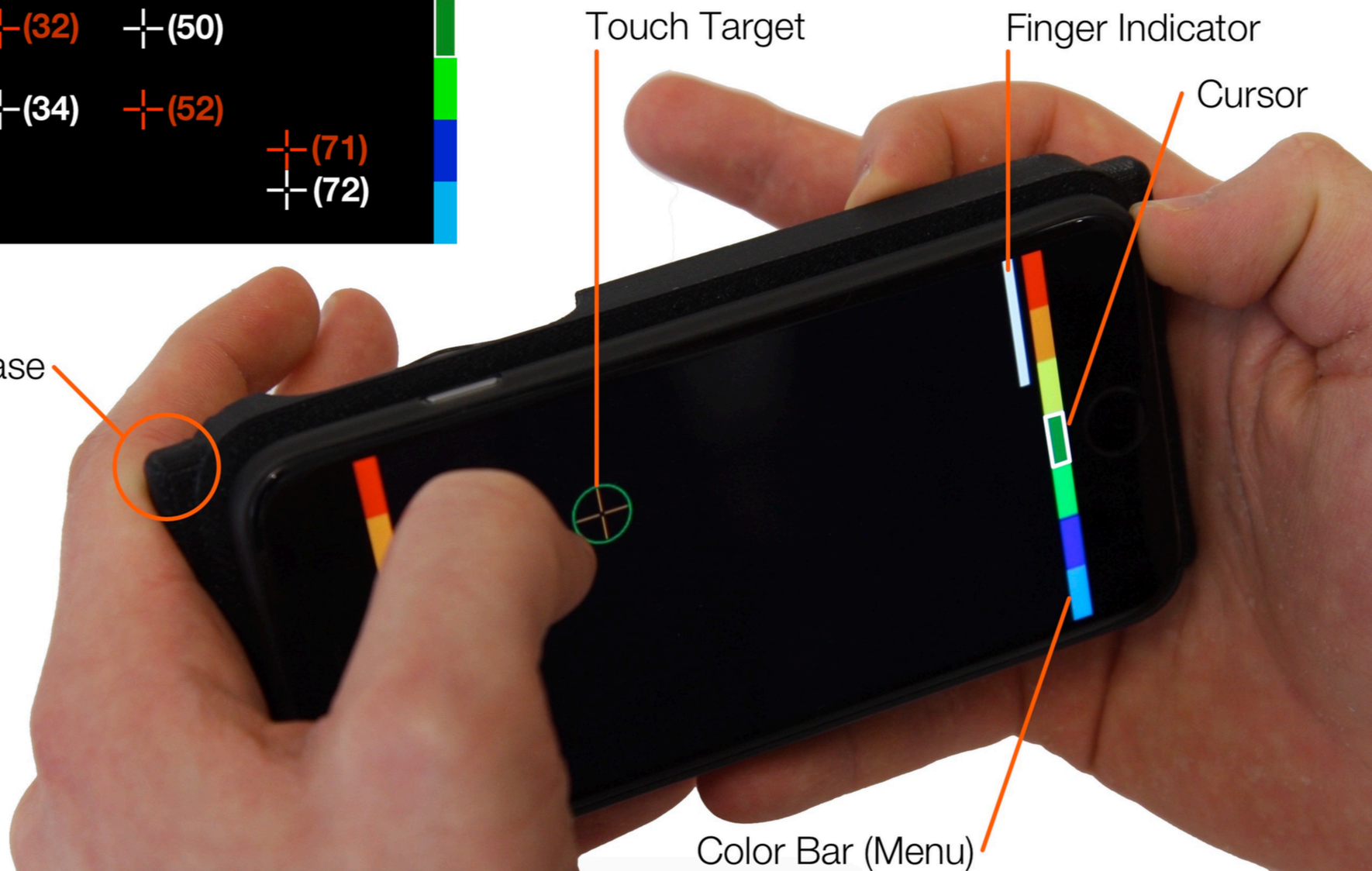


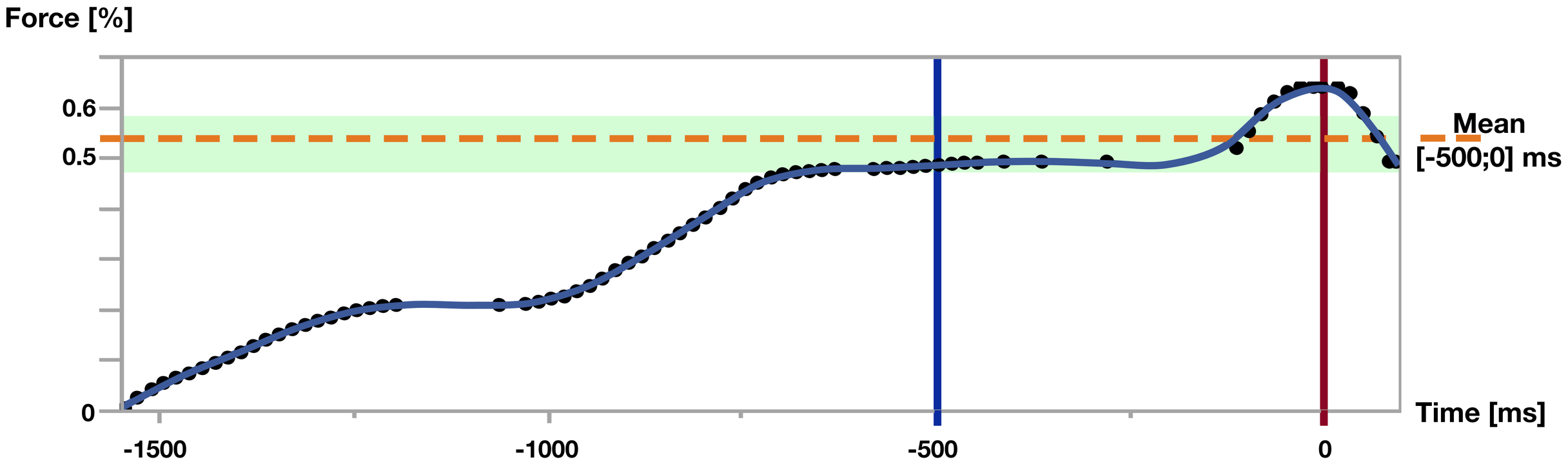
How accurately can users apply BoD force while tapping at the front?



BackXPress

Corsten et al., CHI ‘18

BackXPress: Improvements



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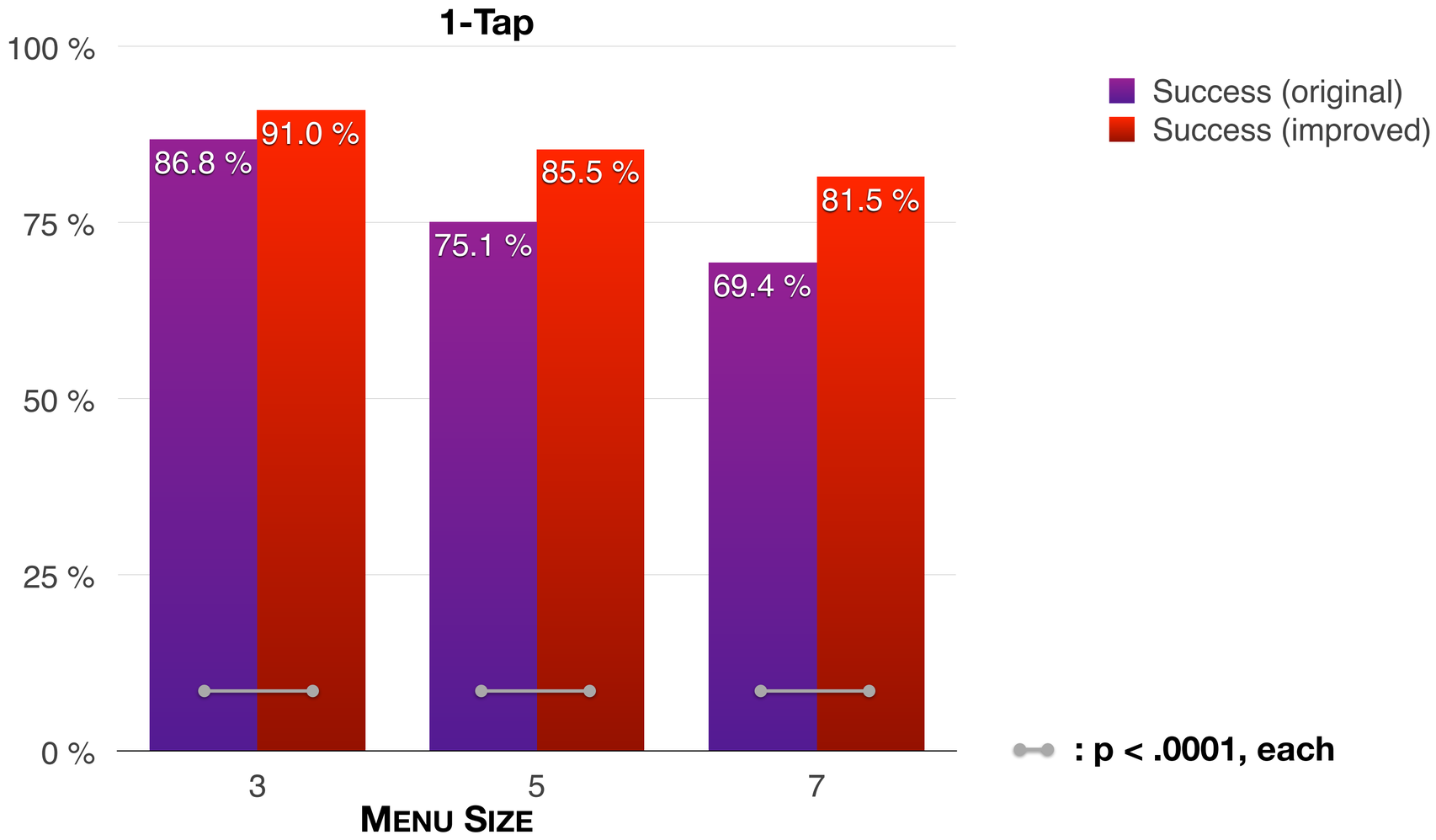
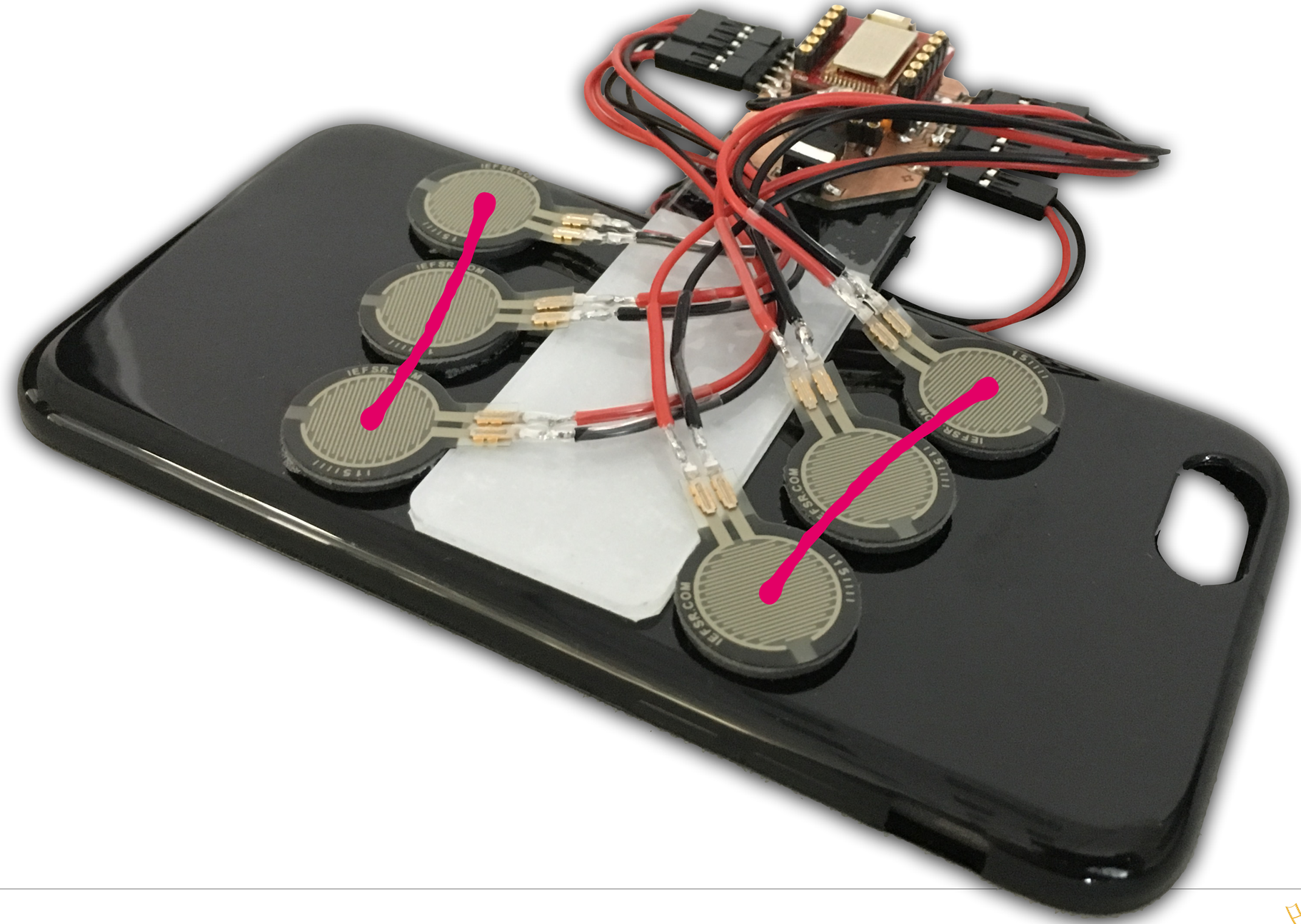
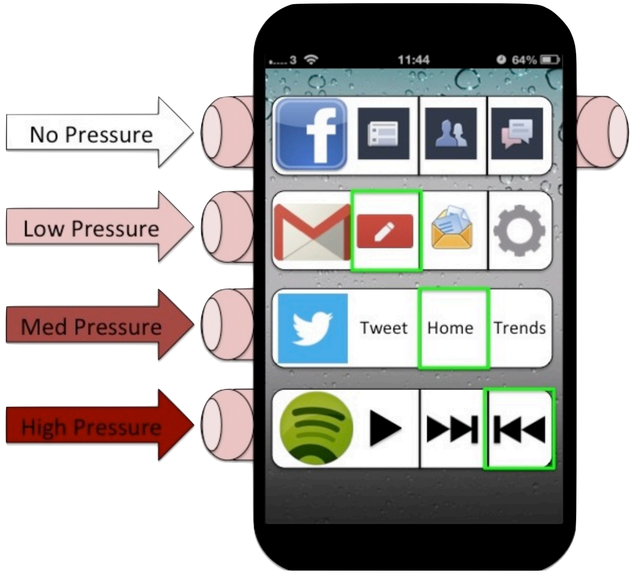
BackXPress: Improvements

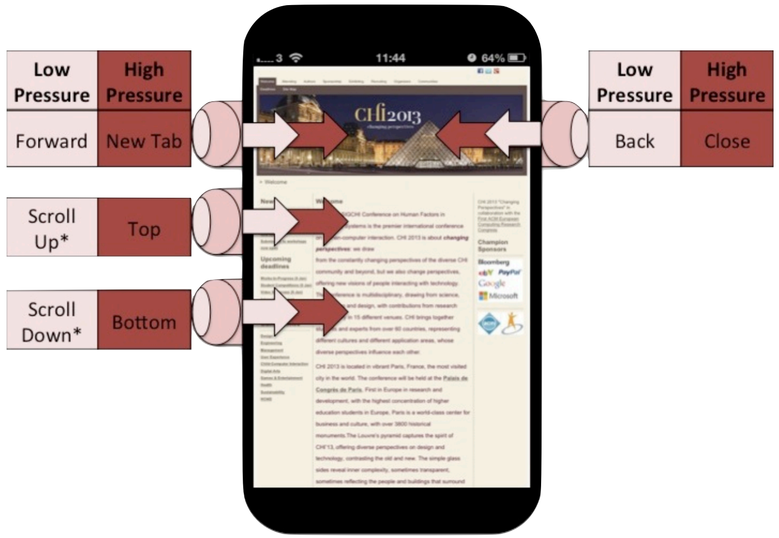




Towards Utilising One-Handed Multi-Digit Pressure Input

Wilson et al., CHI EA '13





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https://www.youtube.com/watch?v=_sPGvRXhDHE

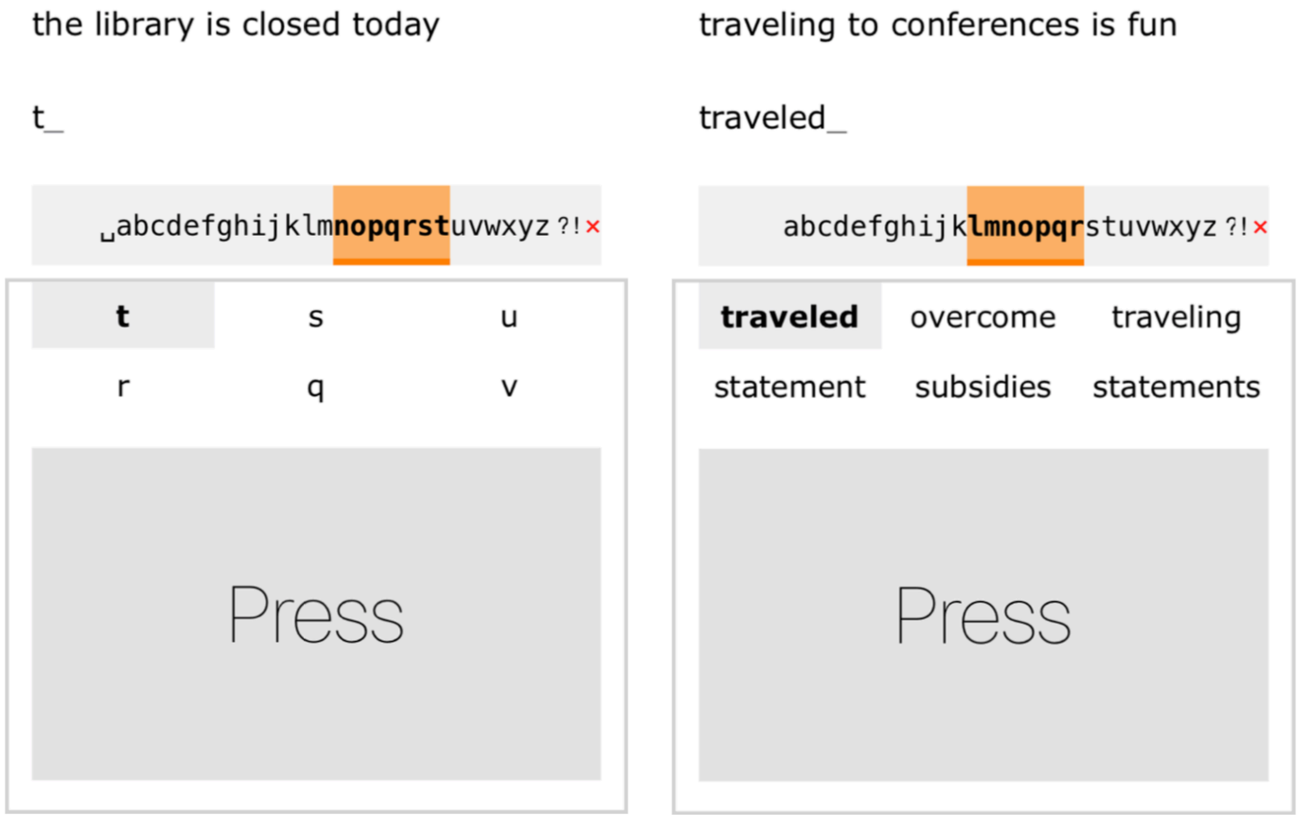
ForceBoard:
Subtle Text Entry Leveraging Pressure

Mingyuan Zhong, Chun Yu, Qian Wang, Xuhai Xu, Yuanchun Shi
Department of Computer Science and Technology
Key Laboratory of Pervasive Computing, Ministry of Education
Global Innovation eXchange Institute
Tsinghua University, Beijing, China

Forceboard

Zhong et al., CHI ‘18

- 1D keyboard with sliding cursor controlled by force + tap
- Cursor width: 7 characters
- Quick Release to select,
  tap to select from available choices
- 11 WMP after 10 minutes of training



Benefits of Force Input

- Reduces gesture footprint & occlusion problems (e.g., with on-screen menus)
- Brings natural mappings for manipulation in the z-dimension
  - Pressure-sensitive back of device?
- Lets idle fingers (used for holding the device in place) partake in the interaction
  - Fingers can stay at a fixed location
  - Reachability benefit

Wrap-Up

- Pressure input extends touch input by adding a z-dimension
- Embedded in desktop and mobile devices
- Benefits: Bounce-back, natural inverse, input from idle fingers, could address occlusion and reachability issues on mobile devices
- A lot of factors influence human performance: Levels, transfer function, control mechanism, feedback, selection mechanism, …
- Usual DV’s: Task completion time, error rate, number of crossings