Fall 2019

CS6501: Topics in Human-Computer Interaction

http://seongkookheo.com/cs6501_fall2019

# Touch Interfaces

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# Milestones of Touch Interfaces

Based on “Multi-touch systems that I have known and loved” by Bill Buxton

http://www.billbuxton.com/multitouchOverview.html

# The first touchscreen (1960s)

- Invented by E.A. Johnson, Roayl Radar Establishment, UK.
- Used capacitive touch sensing, which is what we use for most mobile devices.
- Johnson, E. A. (1965). Touch display--a novel input/output device for computers. *Electronics Letters*, *1*(8), 219-220.

# The first touchscreen (1960s)

## Touch Displays: A Programmed Man-Machine Interface

By E. A. Johnson
Royal Radar Establishment, Malvern

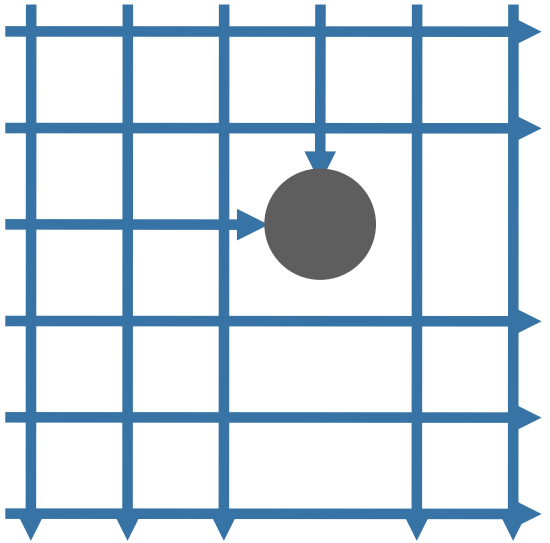
### 1. Introduction

A very large number of so-called automatic data-processing systems require the co-operation of human operators to achieve satisfactory operation. In many of these systems it is necessary to reduce operator reaction time to a minimum, which in turn demands an arrangement where the man-machine communications are optimized. This requires that the methods of presenting information to, and receiving instructions from, the operator should be rapid and easy.

Johnson, E. A. (1967). Touch displays: A programmed man-machine interface. *Ergonomics*, *10*(2), 271-277.

# PLATO IV Touch Screen Terminal (1972)

- PLATO IV computer assisted education system had a terminal with a touchscreen.
- Initial implementation had a 16 x 16 infrared light beams.



# Soft Machines (1983)

- The first paper providing a comprehensive discussion of the properties of touchscreen-based user interfaces– which they call “soft machines”, in comparison with hard machines

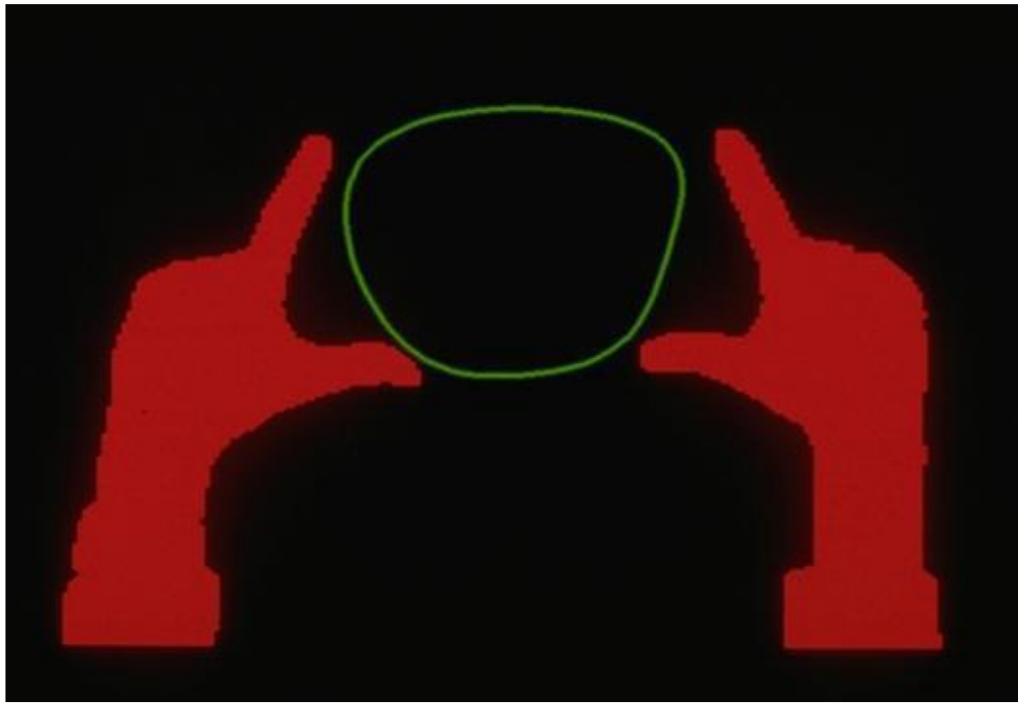
- Properties of hard machines and controls
  - Modularity
  - Form follows function
  - One-to-one mapping of controls and operations
  - Manual operation
  - Immediate feedback
  - Language of controls

- Soft machine = Properties of hard machines + Flexibility

Nakatani, L. H., & Rohrlich, J. A. (1983, December). Soft machines: A philosophy of user-computer interface design. In *Proceedings of the SIGCHI conference on Human Factors in Computing Systems* (pp. 19-23). ACM.

# Videoplace (1985)

- A vision-based system developed by Myron Krueger
- Suggests a rich set of gestures, including the pinch gesture to scale and translate objects



Krueger, M. W., Gionfriddo, T., & Hinrichsen, K. (1985, April).
VIDEOPLACE—an artificial reality. In *ACM SIGCHI Bulletin* (Vol. 16, No. 4, pp. 35-40). ACM.


SLIDES 1 2 3 4 5 6 7 8 9

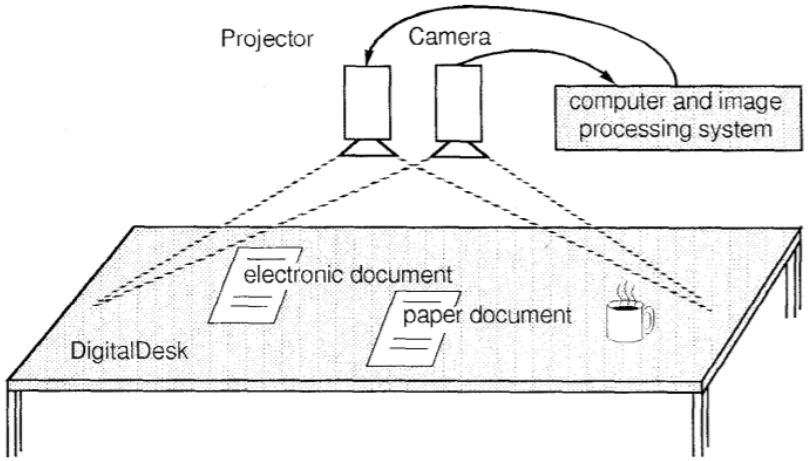
# Multi-touch Tablet (1985)

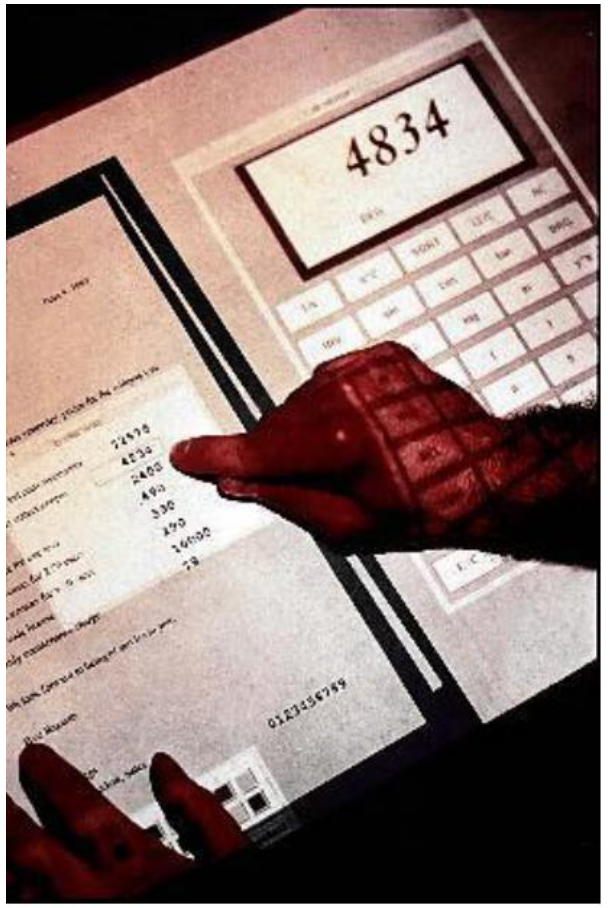
- A touch tablet capable of sensing multi-touch, developed by Lee, Buxton, and Smith.
- It could also detect pressure (degree of touch) for each finger
- Used capacitance sensing, so was thinner and simpler than vison-based methods

Lee, S., Buxton, W., and Smith, K.C.
A multi-touch three dimensional touch-sensitive tablet. CHI 85.

# DigitalDesk (1991)

- Classic example of Augmented Reality: Enabled interaction on physical objects
- Also demonstrated multitouch concepts, e.g., two-finger scaling and translation




Wellner, P. (1991). The Digital Desk Calculator: Tactile manipulation on a desktop display. *Proceedings of the Fourth Annual Symposium on User Interface Software and Technology (UIST '91)*, 27-33.

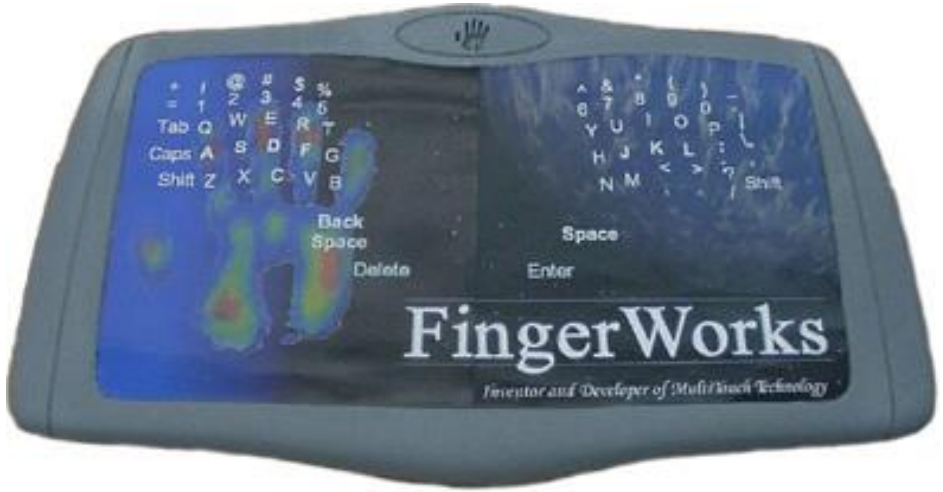
Wellner, P. (1991). The Digital Desk Calculator: Tactile manipulation on a desktop display. *Proceedings of the Fourth Annual Symposium on User Interface Software and Technology (UIST '91)*, 27-33.

# Simon (1994)

- First smart phone designed by IBM and manufactured by Mitsubishi Electric.
- Relied on “soft machine” user interfaces
- Could run many applications, including emails, address book, calendar, calculator, notepad, etc.

# iGesture Pad (1998)

- Gesture input + Keyboard
  - Capacitance between electrodes and grounded object
- Fingerworks, largely based on Westerman's thesis work




Westerman, W. 1999. PhD Dissertation
Hand tracking, finger identification, and chordic manipulation on a multi-touch surface.

# iGesture Pad (1998)

| *Channel Icon* | *Finger Combination* |
|---|---|
|  | Any 2 fingertips (excluding thumb). |
|  | Any 3 fingertips (excluding thumb). |
|  | All 4 fingertips (excluding thumb). |
|  | Thumb and any fingertip. |
|  | Thumb and any 2 fingertips. |
|  | Thumb and any 3 fingertips. |
|  | Thumb and all 4 fingertips. |

| *Motion Icon* | *Type of Chord Motion* |
|---|---|
|  | Brief tap on surface (one-shot). |
|  | Translation (slide) in any direction. |
|  | Reversible translation up or down. |
|  | Reversible translation left or right. |
|  | Reversible up or down translation, irreversible right translation. |
|  | Translation in a particular direction (one-shot). |
|  | Contractive hand scaling (one-shot). |
|  | Expansive hand scaling (one-shot). |
|  | Clockwise hand rotation (one-shot). |
|  | Counter-clockwise hand rotation (one-shot). |

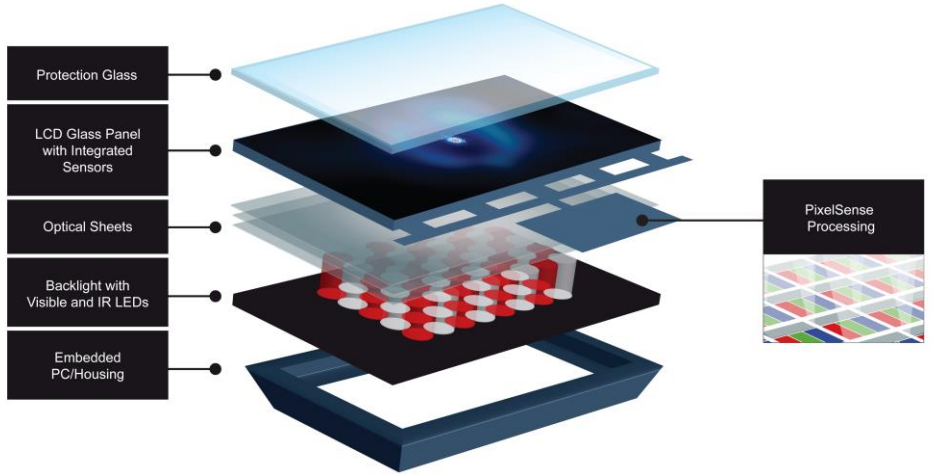
| *Right Hand Channel* | *Chord Motion* | *GUI Action* |
|---|---|---|
|  |  | Primary mouse button click. |
|  |  | Mouse cursor manipulation. |
|  |  | Primary mouse button *double*-click. |
|  |  | Dragging/Selection via primary mouse button. |
|  |  | No mapping to avoid accidents. |
|  |  | Continuous scrolling/panning of current window. |
|  |  | Key layout homing. |
|  |  | No mapping to tolerate shifts in resting hand posture. |

# Apple iPhone (2007)

- Not the first mobile phone with a touch-based interface
- Multi-touch capacitive touch display
- Well-designed and smooth interaction and visual feedback accommodated with a rich set of functions

# PixelSense (2011)

- Developed by Microsoft and Samsung
- Also known as Surface 2.0, now discontinued.
- Displays pixels have optical sensors



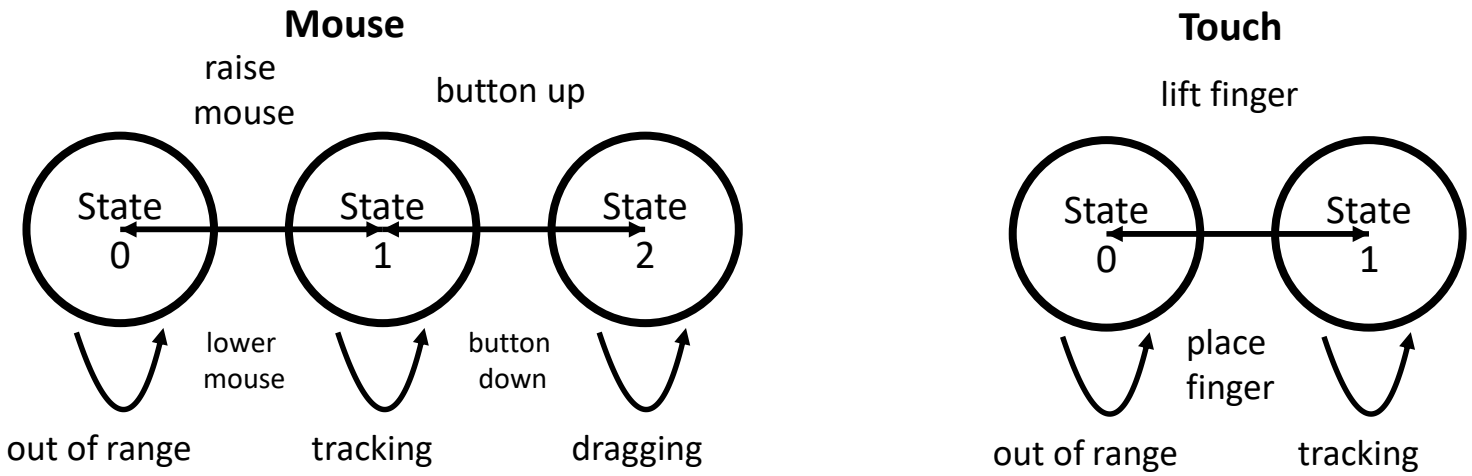
Microsoft®
# PixelSense™

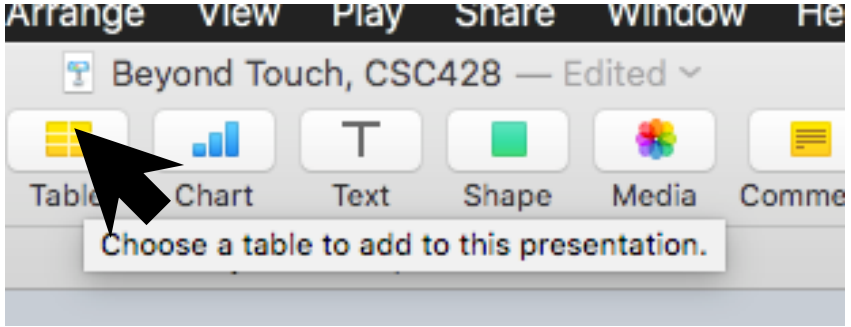
Microsoft

# Usability Issues of Touch Interfaces

# Limited Input Vocabulary

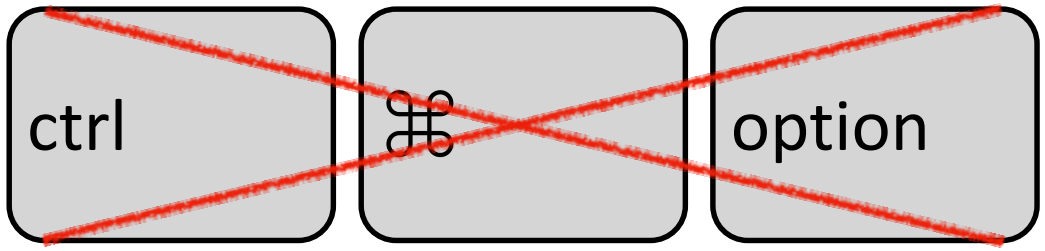
- Limited input states



# Limited Input Vocabulary

- Limited input modes
  - No modifier keys
  - No extra buttons
  - No scroll wheels



# Limited Input Vocabulary


**iPhone 6s – Force Touch**

Image by Bob Jouy
https://www.flickr.com/photos/bobjouy/21679830866


**Samsung Galaxy S4**

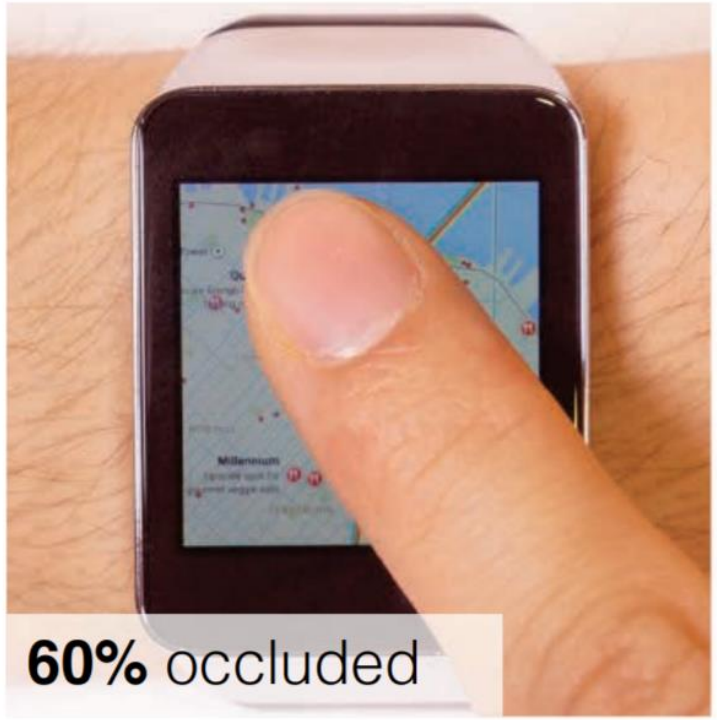
YouTube video
https://www.youtube.com/watch?v=U8STgCviLe0

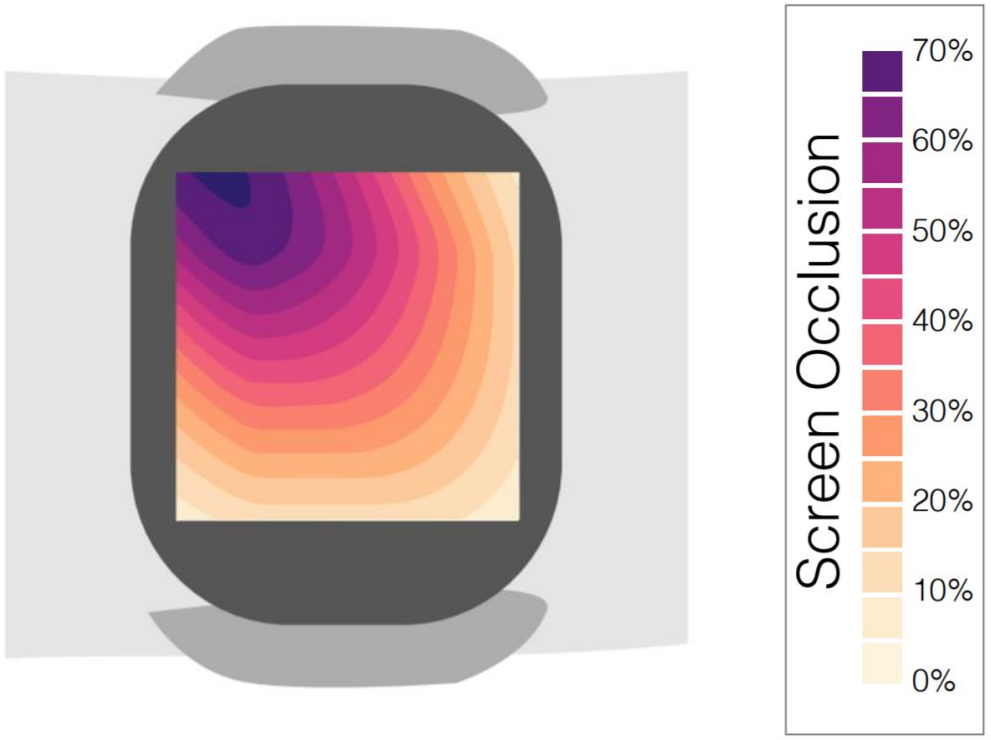
# Imprecise input

vs

# Imprecise input

- Finger occlusion

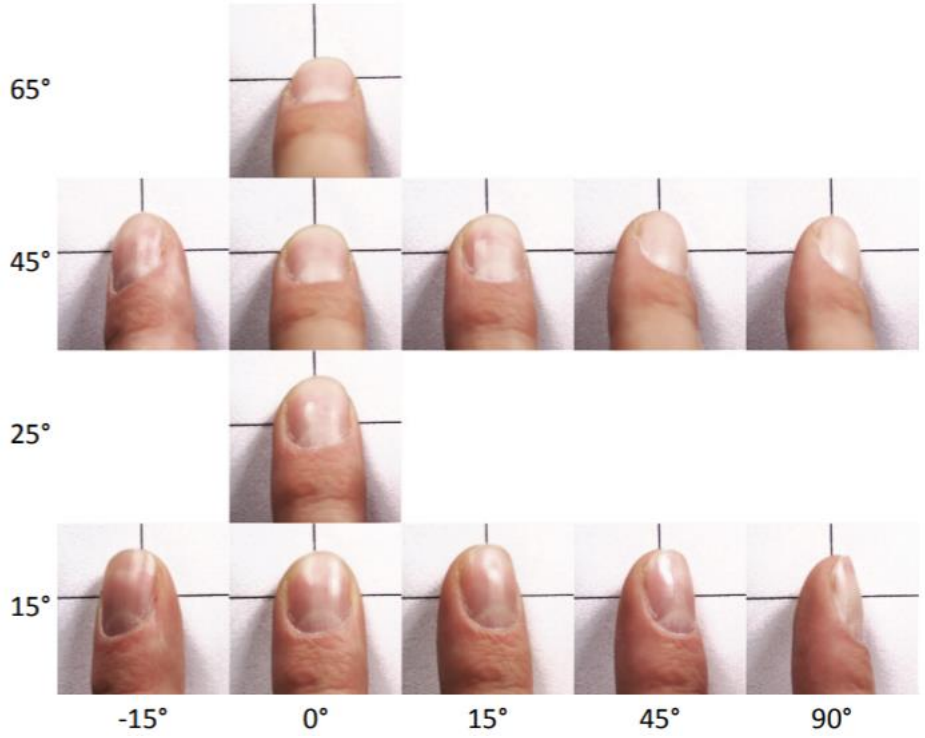


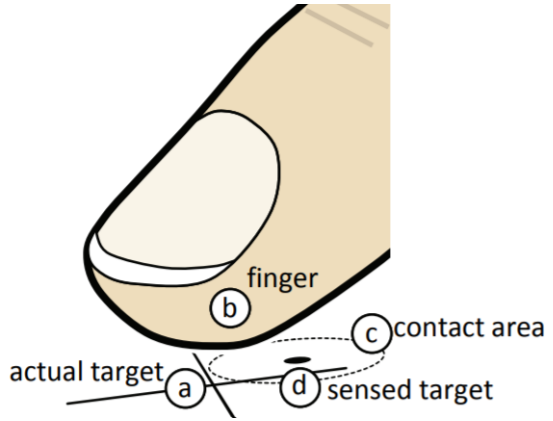



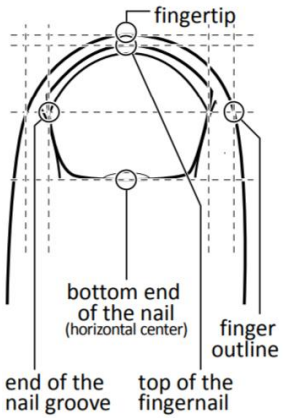

Xia, H., Grossman, T., & Fitzmaurice, G. NanoStylus: Enhancing input on ultra-small displays with a finger-mounted stylus. UIST 2015

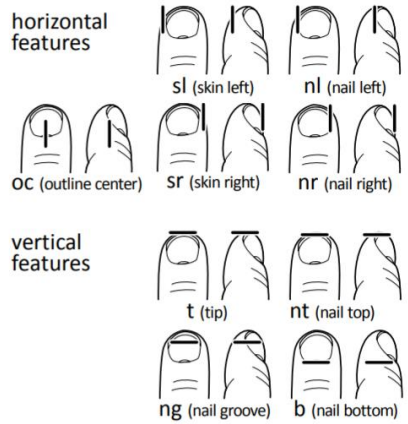
# Imprecise input

- Finger control



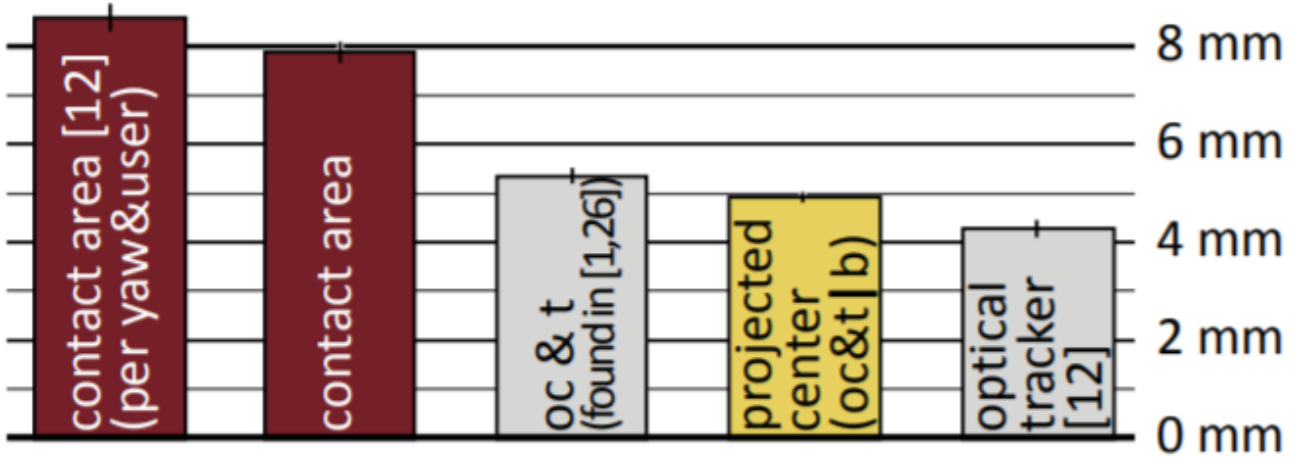



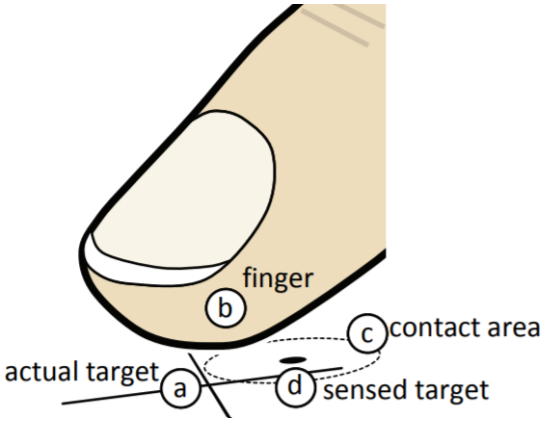



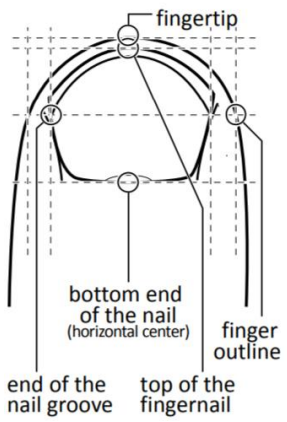

Holz, C., & Baudisch, P. Understanding touch. CHI 2011. ACM.

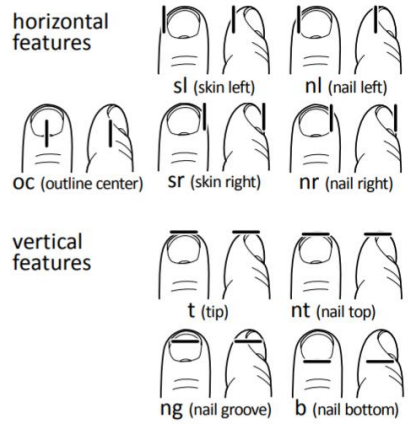
# Imprecise input

- Finger control



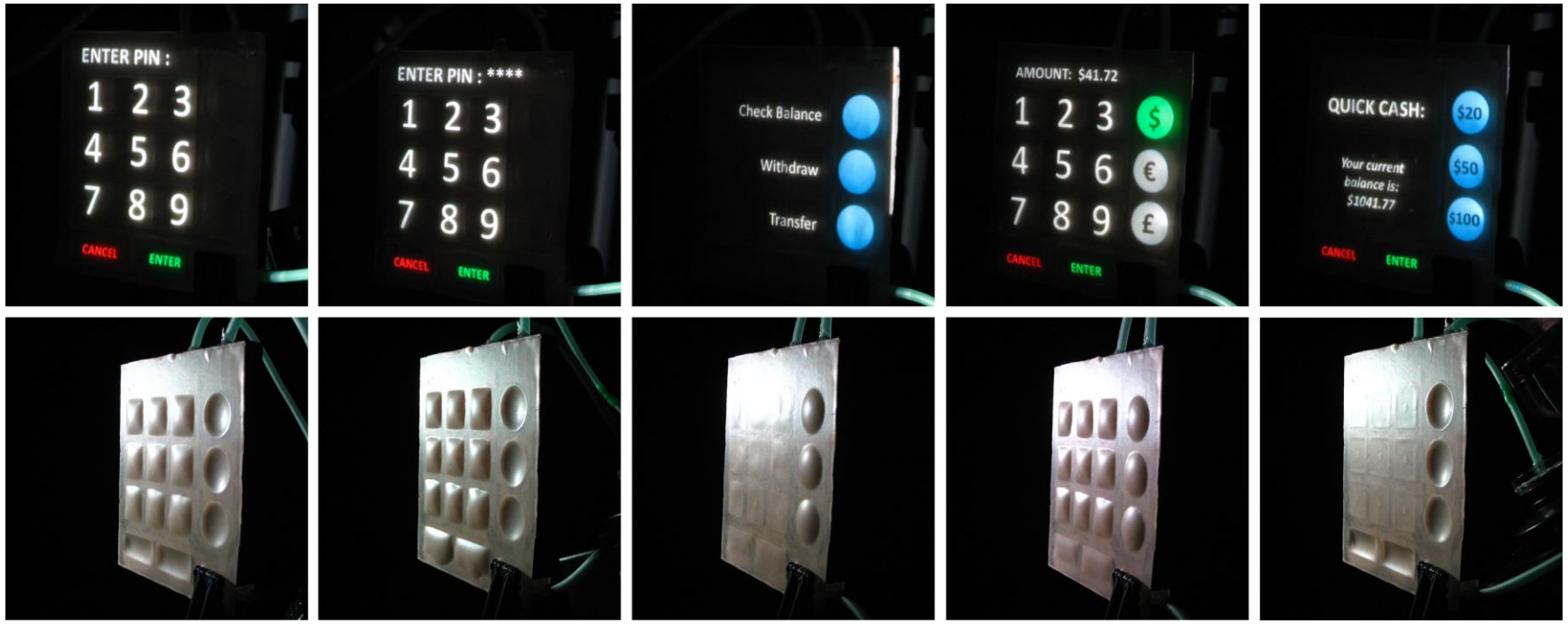




Holz, C., & Baudisch, P. Understanding touch. CHI 2011. ACM.

# Lack of Tactile Feedback

- No physical boundaries, no clicks




Harrison, C., & Hudson, S. E. Providing dynamically changeable physical buttons on a visual display. CHI 2009

# Lack of Tactile Feedback

- No physical boundaries, no clicks

Tactus Technology, transparent physical buttons for touchscreens

# Sanitary issues


Touchscreen Kiosk at San Antonio Military Medical Center

# Sanitary issues


Kandel, C. E., Simor, A. E., & Redelmeier, D. A. (2014). Elevator buttons as unrecognized sources of bacterial colonization in hospitals. *Open Medicine*, *8*(3), e81.

Infographic from https://sunnybrook.ca/media/item.asp?c=1&i=1150&f=elevator-button-bacteria

# Usability Issues of Touch Interfaces

Limited Input vocabulary

Imprecise input

Lack of tactile feedback

Sanitary issues

And many more…

Thank you!