Natural User Interfaces

Xiaojun Bi

Xiaojun@cs.stonybrook.edu

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Review

- A tangible user interface is a user interface in which a person interacts with digital information through the physical environment.

- *Multimodal* generally refers to an interface that can accept input from two or more combined modes

What is NUI?

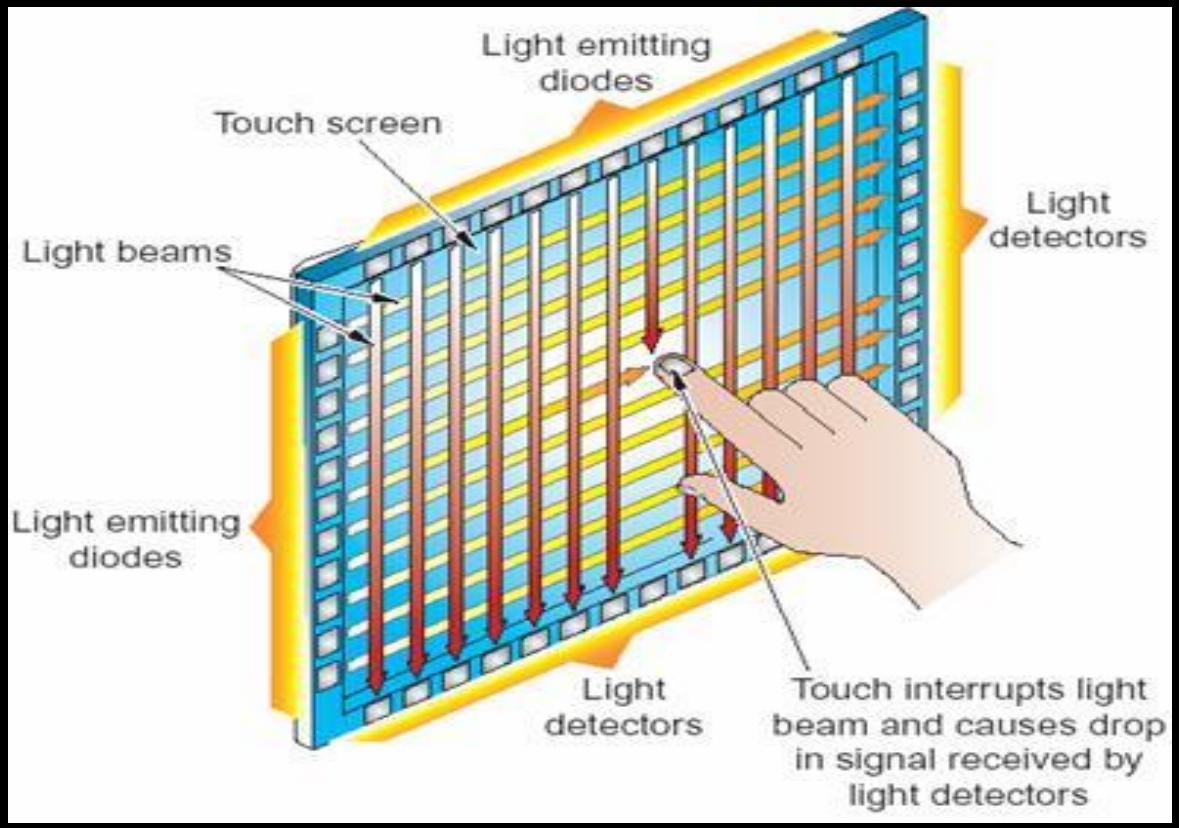
Natural user interface, or **NUI**, is the common parlance used by designers and developers of computer interfaces to refer to a user interface that is effectively invisible, or becomes invisible with successive learned interactions, to its users. The word natural is used because most computer interfaces use artificial control devices whose operation has to be learned.

NUI – Common Interactions

- Multi-touch
  - Mobile Devices, Table-top interactions
- Gestural Interfaces
- Speech Interfaces
- Physiological Interfaces
  - EEG, PPG, EMG, Sound

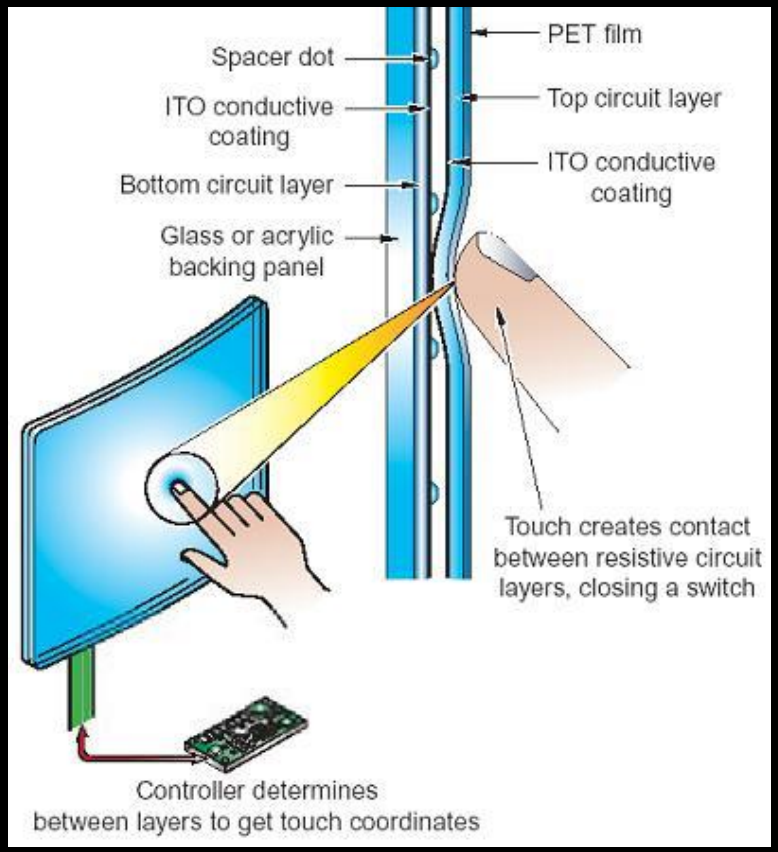
Touch Sensing - 1

Infrared *Think laser pointer(s)*



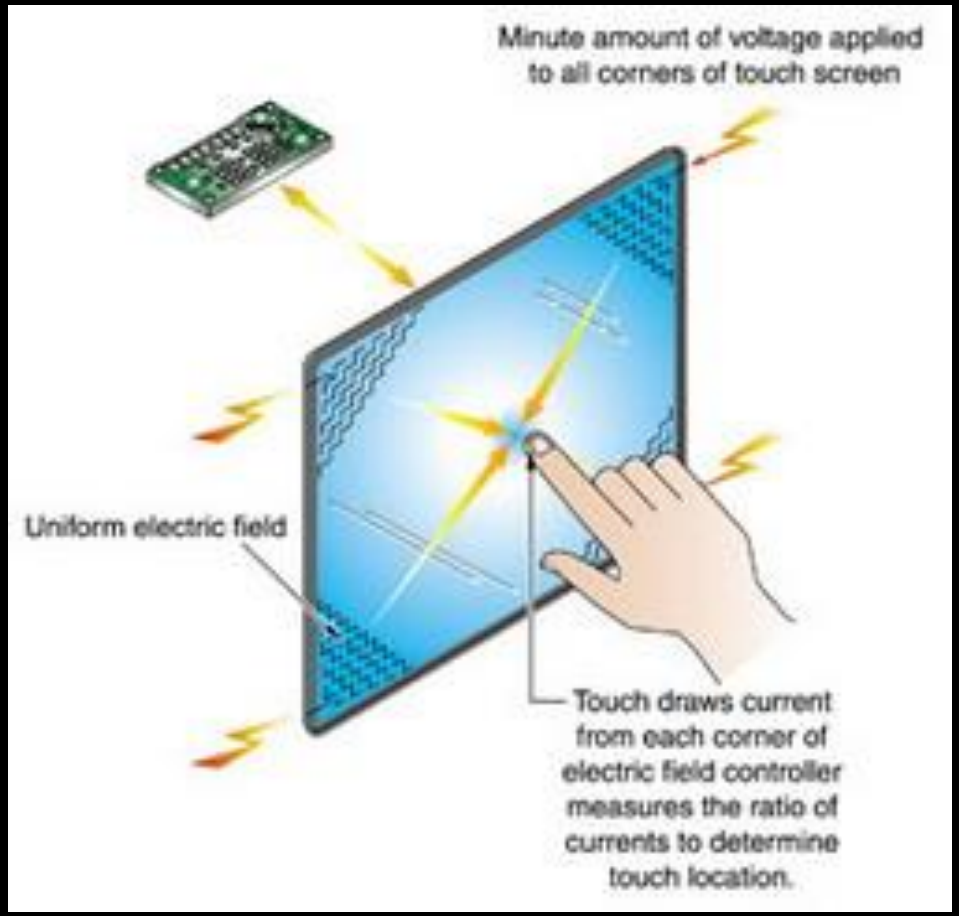
Touch Sensing - 2

Resistive *Think Push Down and drag*



Touch Sensing - 3

Capacitive *Think Electric Impulse*

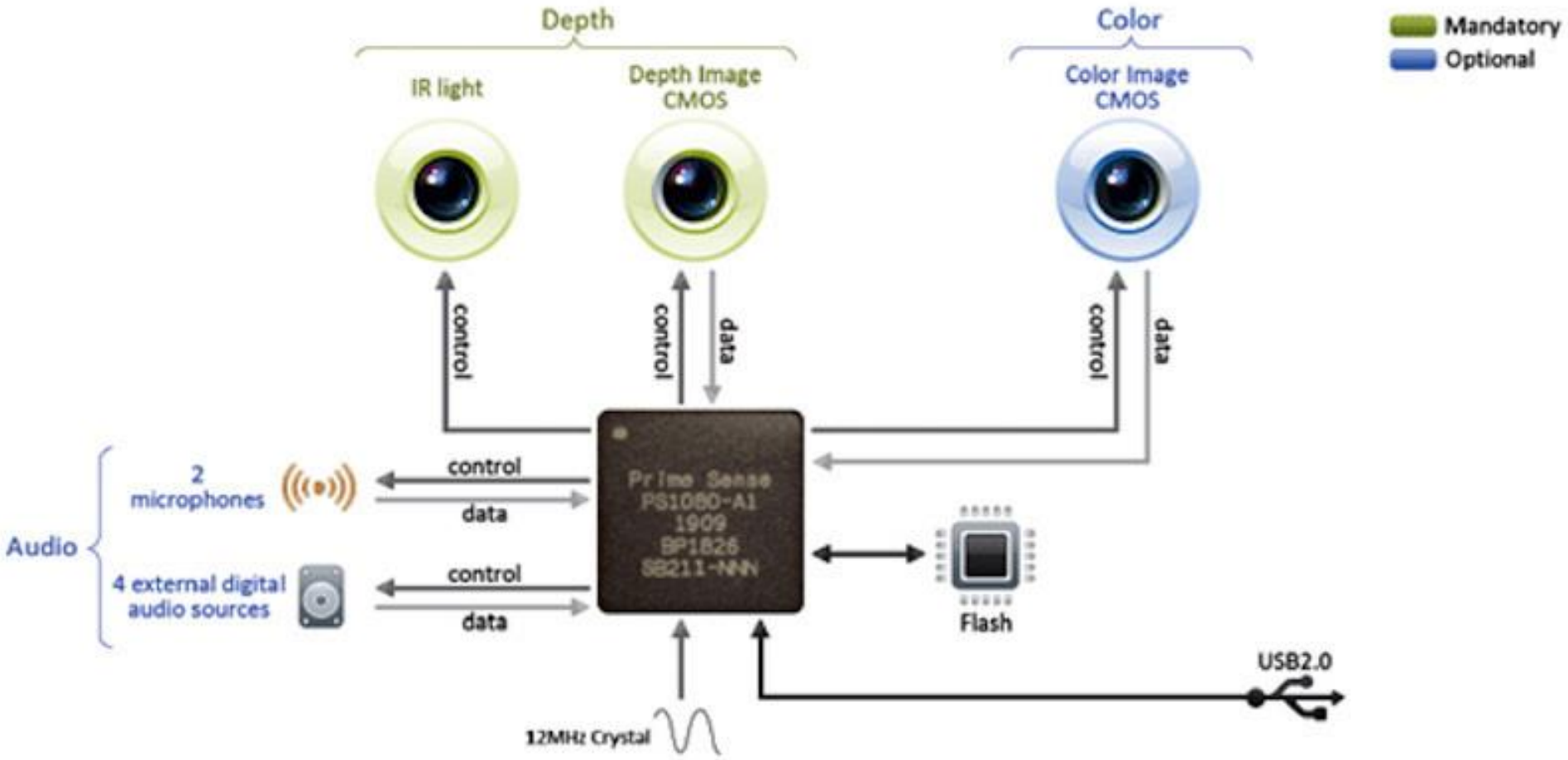


Gesture Interface - Kinect

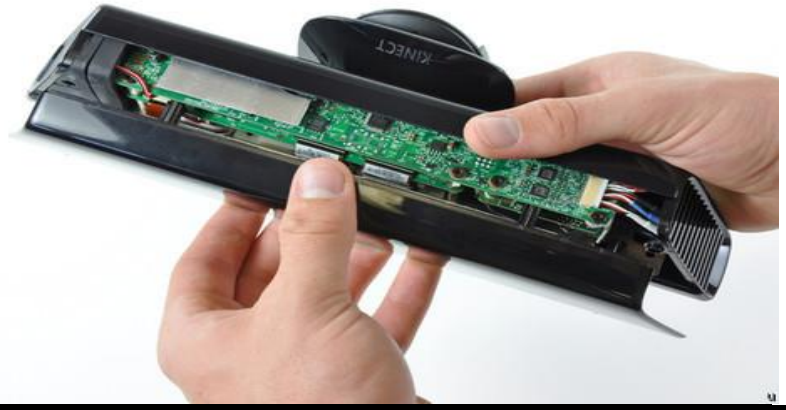
- Kinect (code name *Project Natal*) is a “controller-free gaming and entertainment experience” by Microsoft for the Xbox 360 platform
- Launched on 11/4/2010 in North America at USD $150 MSRP.
- Sold 10M+ units world wide.
- Open source drivers for Linux, Mac, PC appeared a few days after the launch date

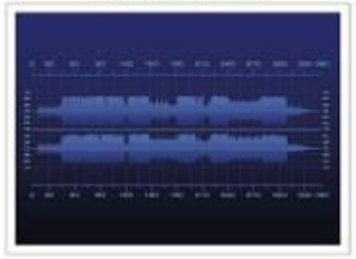
How Does It Work?

- The Kinect hardware is a combination of
  - An RGB camera,
  - A depth sensor
  - A multi-array microphone


Depth
Color
Mandatory
Optional
IR light
Depth Image CMOS
Color Image CMOS
control
control
data
control
data
Audio
2 microphones
4 external digital audio sources
control
data
control
data
Prime Sense
PS1080-A1
1909
BP1826
SB211-NNN
Flash
USB2.0
12MHz Crystal

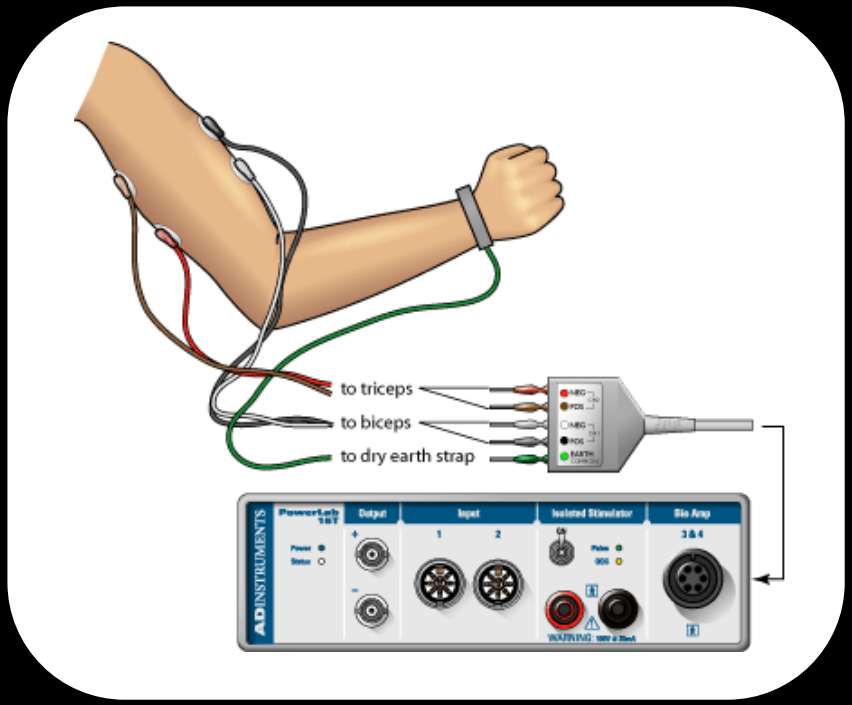
Kinect and PrimeSense



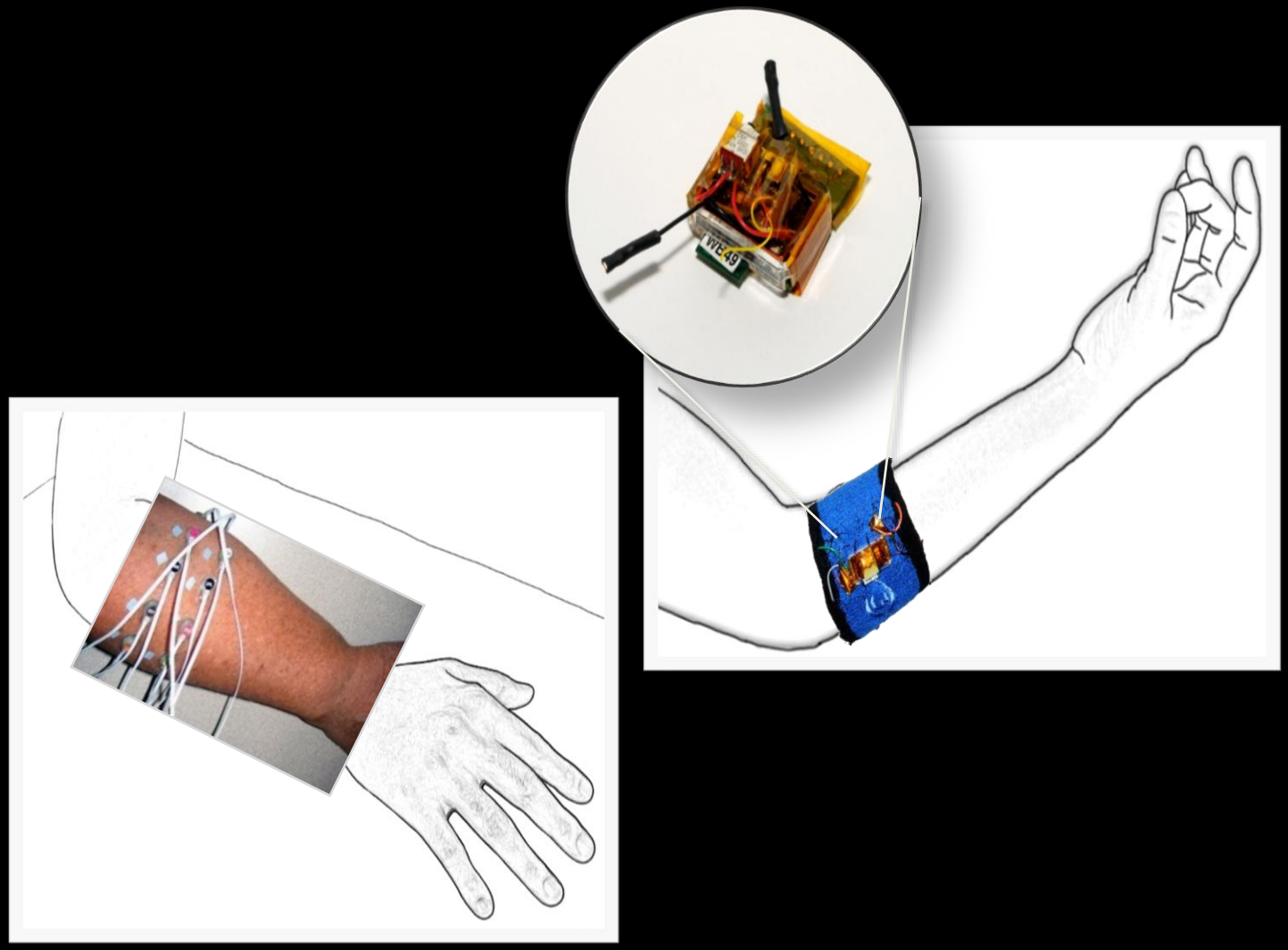


Physiological Interfaces

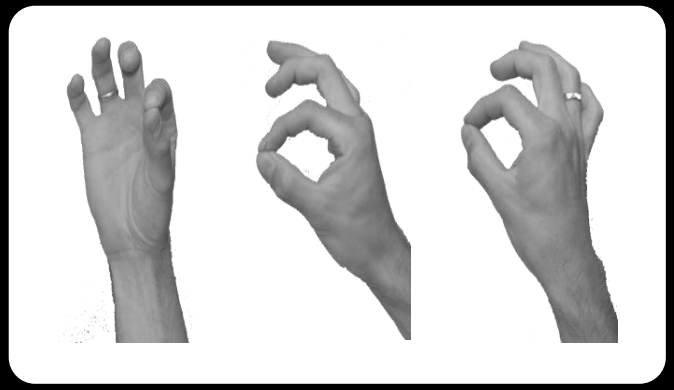
- Electroencephalogram (EEG)
- Sound (ScratchInput, Skinput)



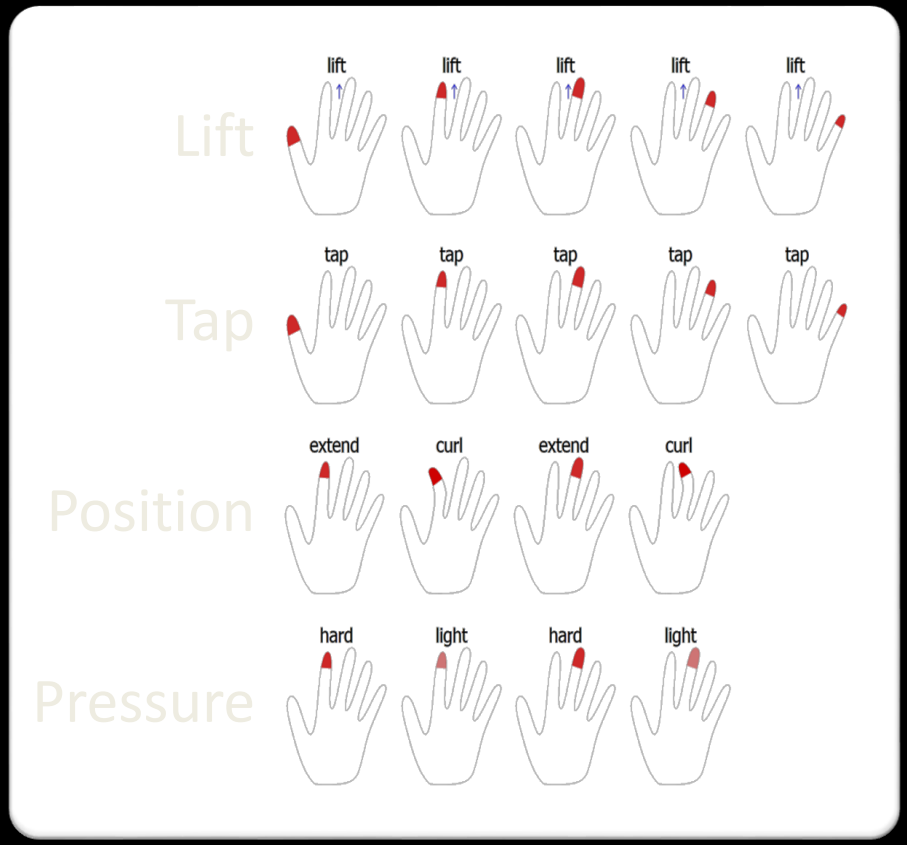
Muscle Sensing for Finger Gestures



Gestures in Free Space

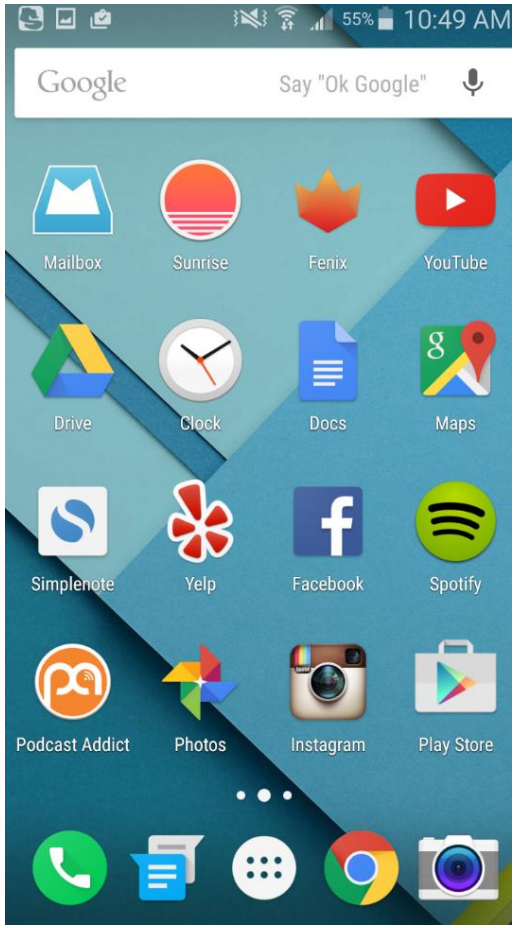


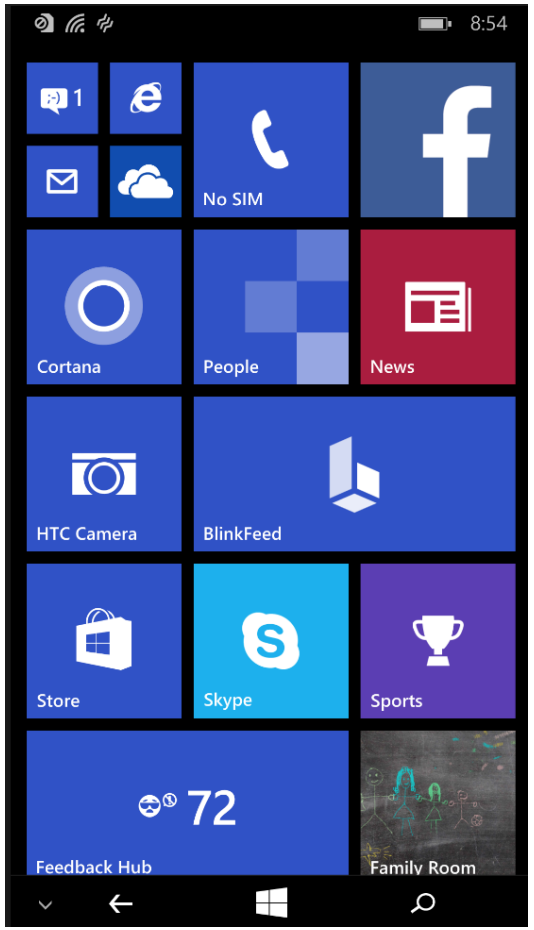
Gestures on Surfaces (e.g. table)



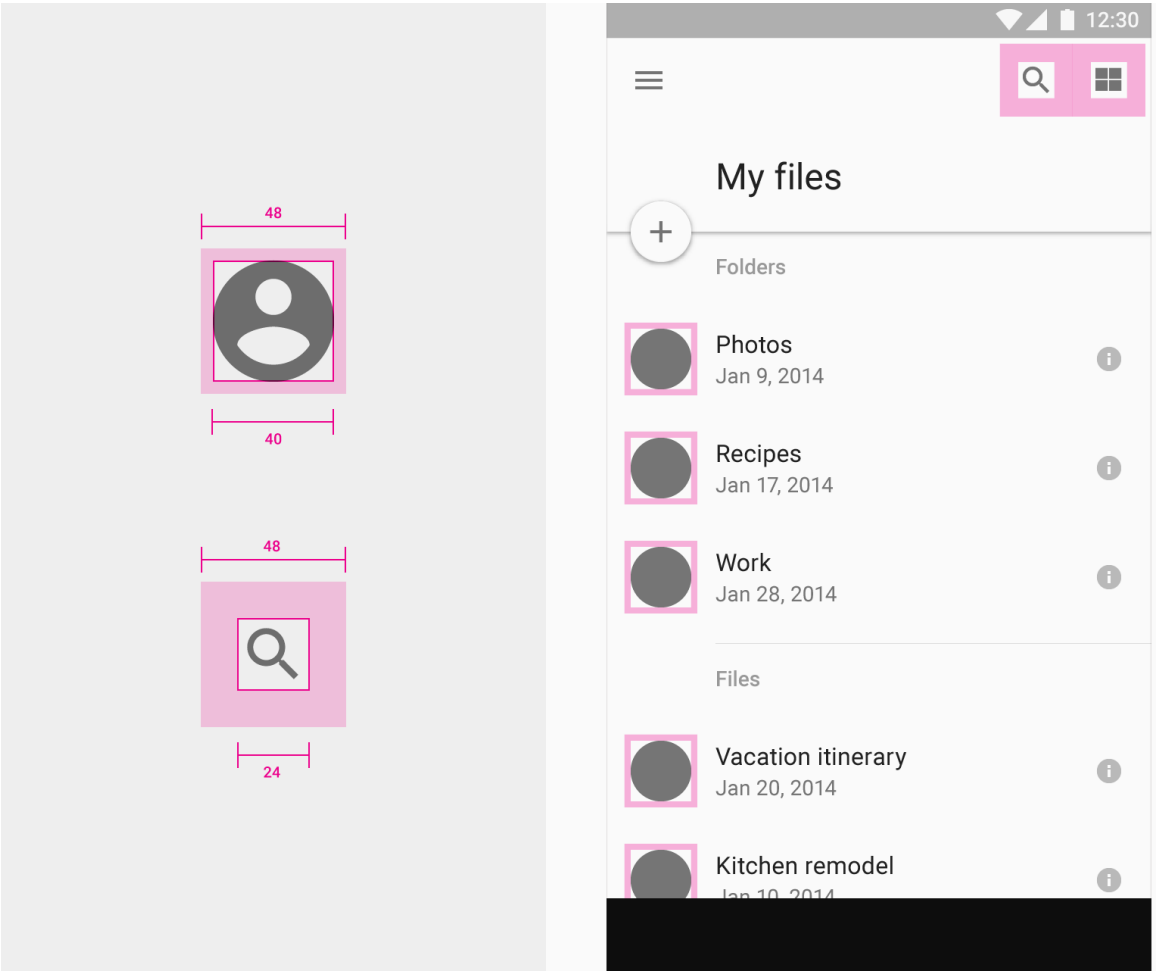
Touch Interaction

What is the Appropriate Target Size?

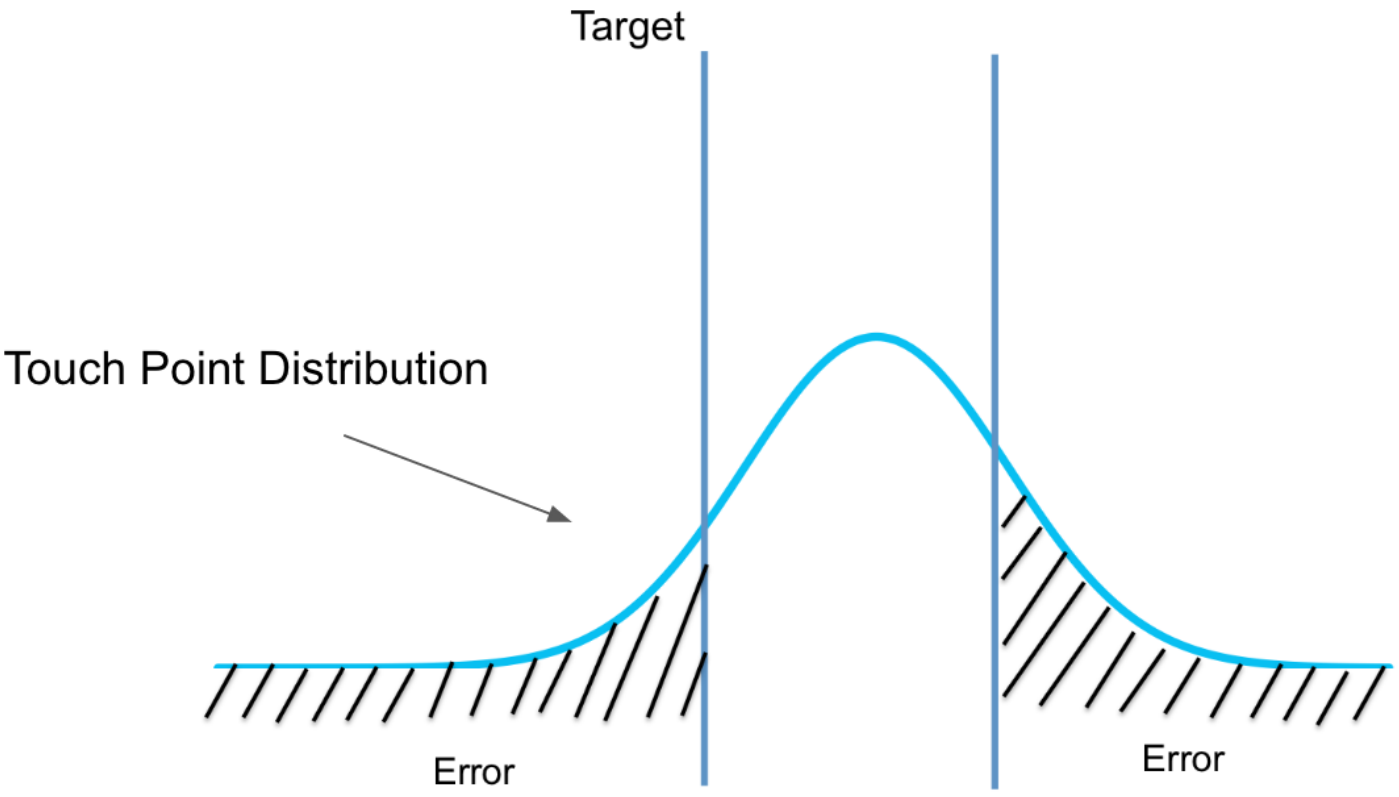


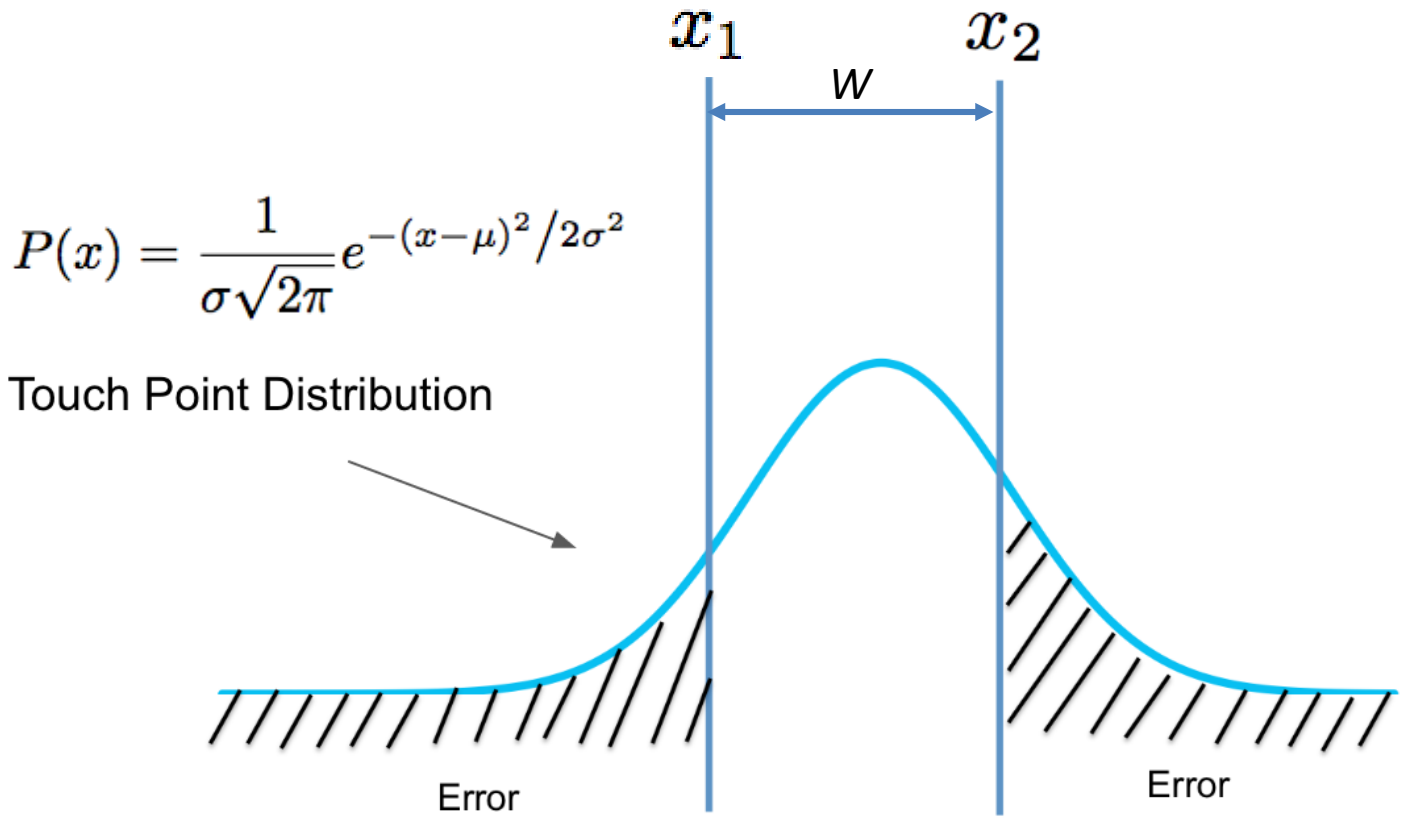


Target Size Suggested by Android



Target Acquisition

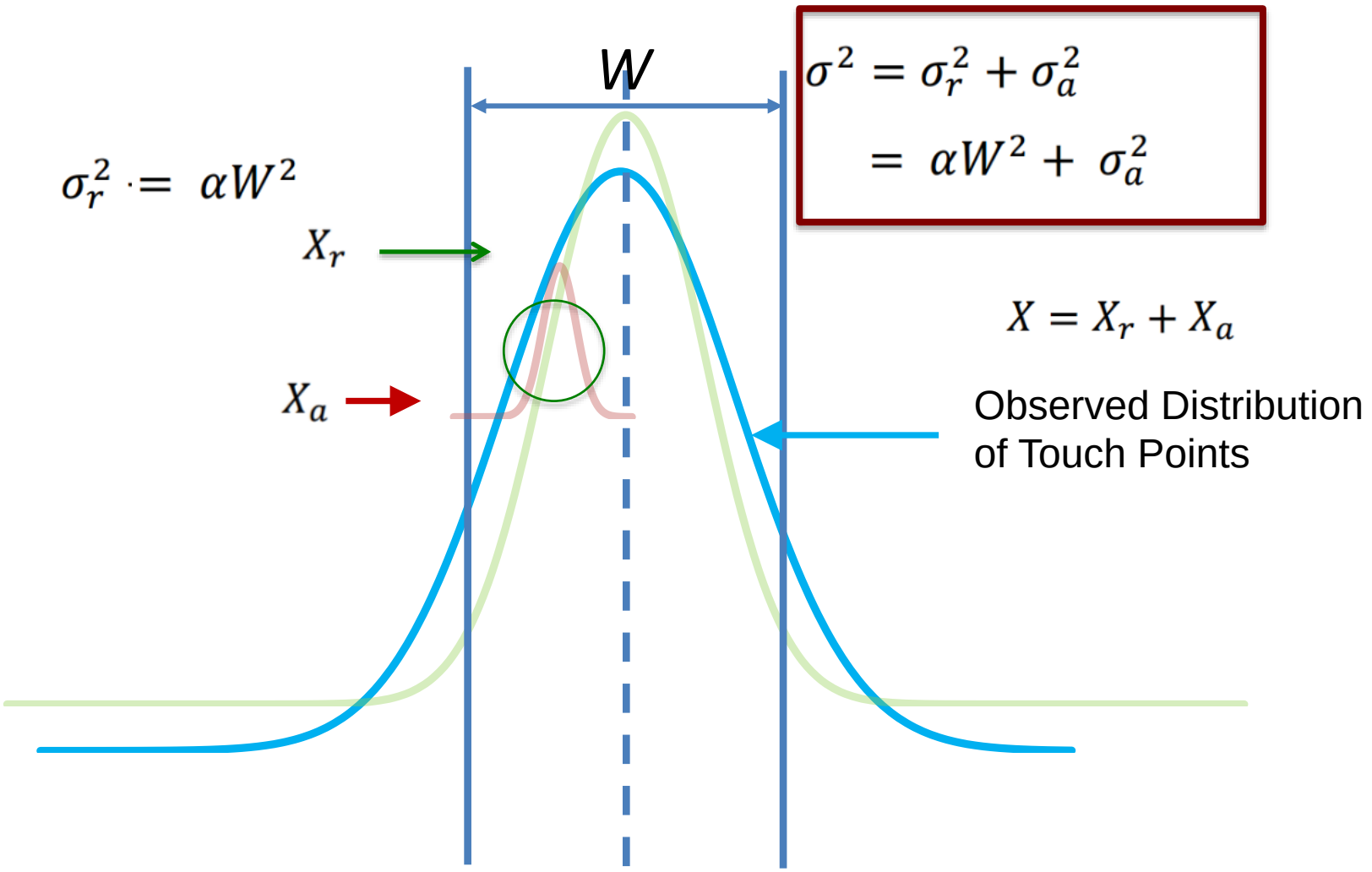




$$P(x_1 \leqslant X \leqslant x_2) = \int_{x_1}^{x_2} P(x)dx = \frac{1}{2}\left[\operatorname{erf}\left(\frac{x_2-\mu}{\sigma\sqrt{2}}\right) - \operatorname{erf}\left(\frac{x_1-\mu}{\sigma\sqrt{2}}\right)\right]$$

$$= \operatorname{erf}\left(\frac{W}{2\sqrt{2}\sigma}\right)$$

Dual Gaussian Distribution Model

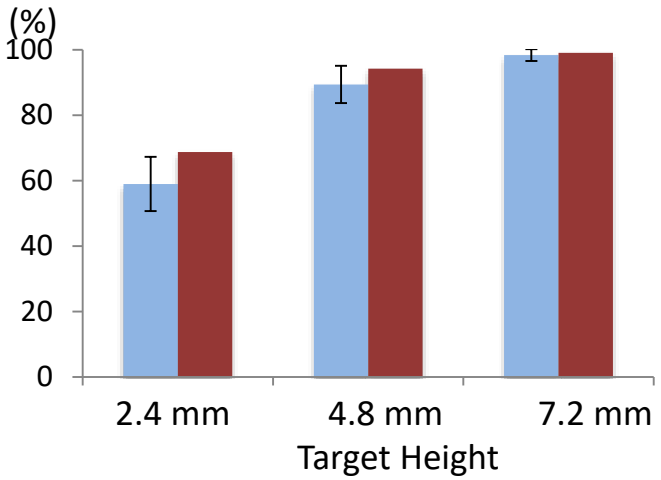


[**Bi,** Li, Zhai. *FFitts Law: Modeling Finger Touch with Fitts' Law.* CHI2013]

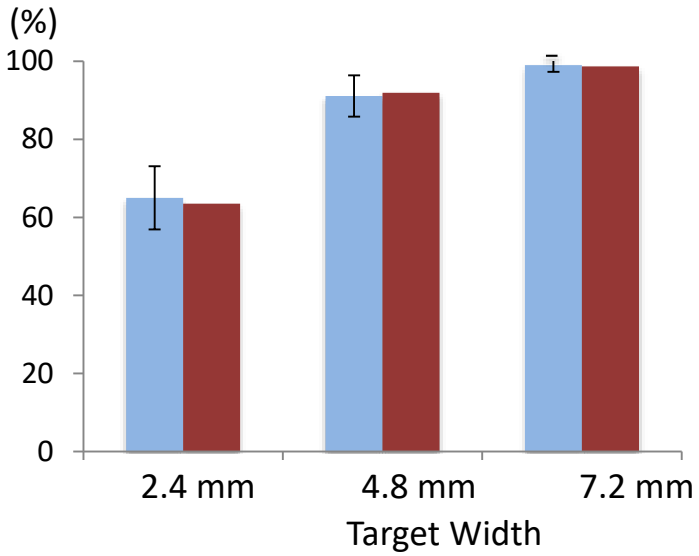
[**Bi,** Zhai. *Bayesian Touch.* UIST2013]

Evaluation Predicted vs. Observed Success Rates

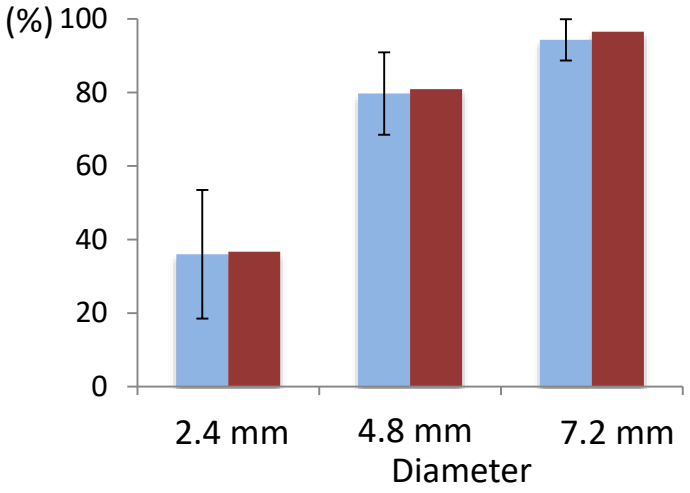
Horizontal Target



Vertical Target

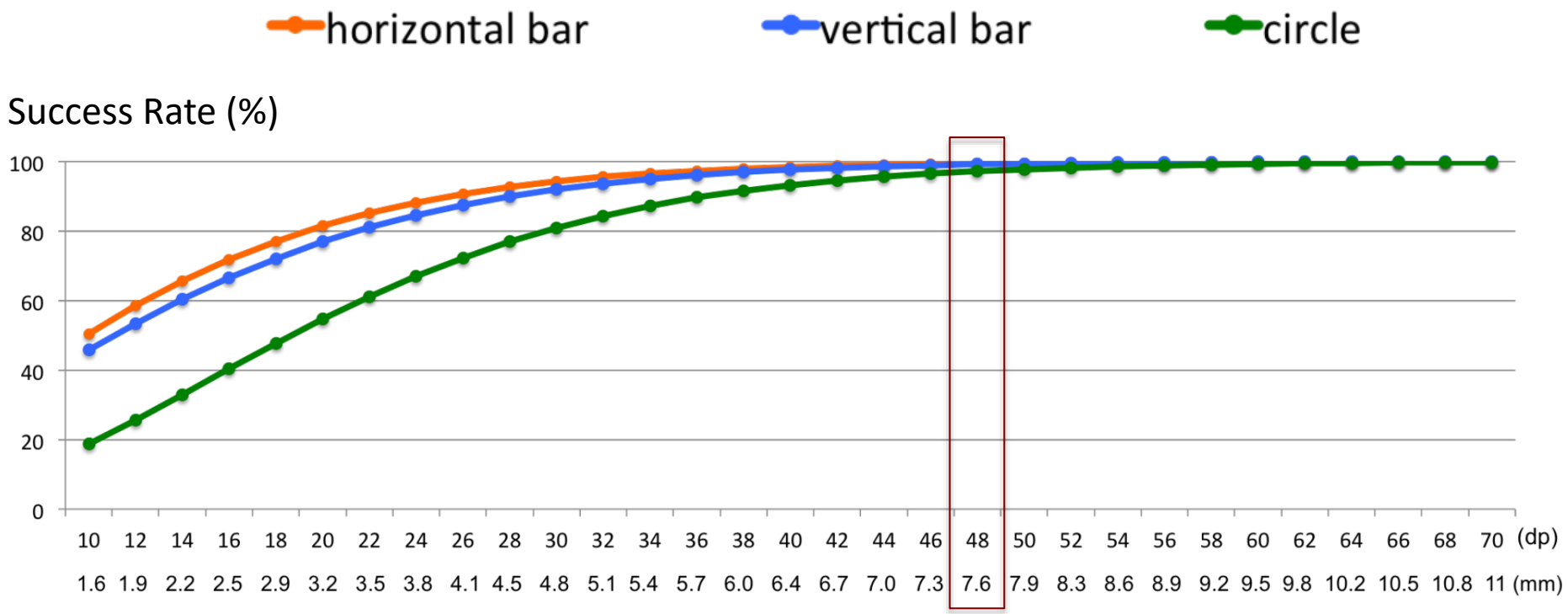


Circular Target



Application 1

Predicted Success Rate per Target Size



Target Width/Height/Diameter

[**Bi,** Zhai. *Predicting Finger-Touch Accuracy Based on the Dual Gaussian Distribution Model.* UIST2016]