tactile and tangible interaction
&
augmented reality

Anastasia Bezerianos
&
Jean-Marc Vezien

touch interfaces

technology
frameworks
touch & muti-touch design
tables, walls,
mobile

Some systems
http://billbuxton.com/multitouchOverview.html

adapted from Arnout de Vries

touch screen interaction

- touch interaction
  - 1960: Touch
  - 1982: Multi-touch
  - 2006: Lucid touch
- touch interfaces controlled by
  - touch + widgets
  - touch + gestures
  - touch + speech
  - touch + objects

adapted from Arnout de Vries

single touch

Touch screen interfaces (since ‘60)

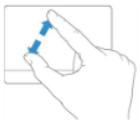
- interaction via
  - stylus, light pens, finger, hand, …

ergonomics:
× finger stress
× “gorilla arm”
hci:
× fingernail interaction
× finger/hand occlusion
× gestures to learn

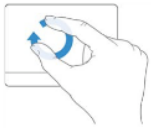
adapted from Arnout de Vries

multi-touch interaction

- in real life we do actions with 2 hands or more than one finger

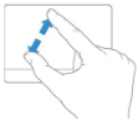


- multi-touch interaction allows parallel actions
- reduce task complexity of single input
- increases parallelism and reduces time

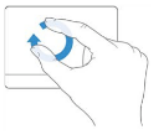


multi-touch interaction

- but still …
  - × finger stress
  - × “gorilla arm”



- as in any finger interaction …
  - × chubby fingers, fingernail interaction
  - × screen occluded by fingers
- and
  - × more gestures to learn
  - × ambiguity (think of examples)



ergonomics

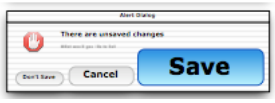
- what you can do …
  - provide designs with hand support
  - rest device on hand
  - design fast interaction



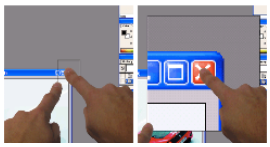
chubby fingers

avoiding fingernail interaction (small target acquisition)

- finger sized targets
- scale display [Orwal, 2003] (can be fast [Roudaut 2008])
- object pointing [Guiard 2004]
- scale motor space [Blanch, 2004]
- use interaction widgets [Albinsson 2003]
- multi-finger precision techniques [Benko 2006]
- use sliding targets [Moscovich 2009] or crossing



[Blanch et al 2004]


[Benko et al 2006]


[Moscovich 2009]

videos

[Roudaut 2008] http://youtu.be/3u9rVyC5x9E

[Benko 2006] http://youtu.be/XUy2bQpavc4

[Moscovich 2009] http://youtu.be/k-bbgS8vUto

occlusion

avoiding occlusion

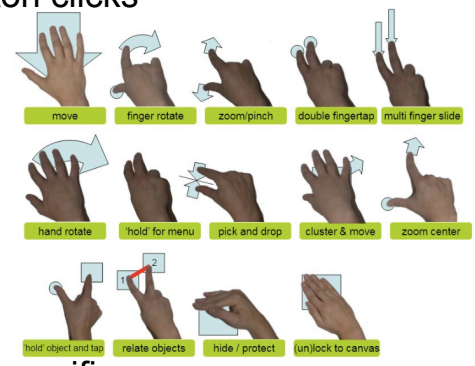
- sometimes using display scaling [Orwal, 2003] (can be done fast, e.g. taptap [Roudaut 2008])
- offset-cursor [Potter 1988]
- displace area under touch visually [Vogel 2007]
- object pointing techniques [Guiard 2004]

[Roudaut et al., 2008]

[Vogel et al., 2007]
http://youtu.be/kkoFlDArYks

(multi-touch) gestures

- alternative to buttons and widgets
- more expressive than button clicks



- no standards, but vendor specific
- hard to guess & perform correctly

videos

[Wu 2003]
http://www.dgp.toronto.edu/~ravin/videos/uist2003_tabletop.mpg

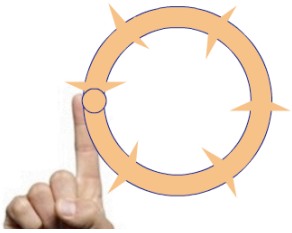
[Agarawala 2006]
Bumptop http://youtu.be/6jhoWsHwU7w

adapted from Arnout de Vries

multi-touch gestures

Solution: gesture previews

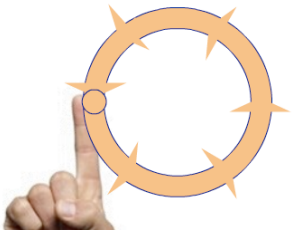
- overlay with visual feedback
- shows what gestures can be performed
- shows when others can join (collaborative gest.)
- indicates meaning of gestures
  - previews don't limit expert users
  - increases detection rate, reduces learning curve



gestures learning …

Solution: gesture previews

- progressive feedforward: OctoPocus [Bau 2008]
- complex tutorial guides: ShadowGuides [Freerman 2009
- metaphors: Gesture Play [Bragdon 2010]
- hand physiology and chords: Arpege [Ghomi 2013]



videos

OctoPocus [Bau 2008]
http://vimeo.com/2116172

ShadowGuides [Freerman 2009]
http://www.dustinfreeman.org/research/papers/tabletop2009_shadowguides.mpg

Gesture Play [Bragdon 2010]
http://youtu.be/-RF4NsLpEi8

Arpege [Ghomi 2013]
http://youtu.be/dGxeHjGp9kE

large multi-touch interfaces

why?

when?

how?

why multi-touch surfaces?

- digital equivalents to desks or walls
- direct interaction with environment
- multiple people
- desktop screens are often too small
- new contexts

Picture from (McGee, 2001)

multi-touch large display

- ≥ 30 inch diagonal
- surface as main interface
- several simultaneous inputs

[P. Isenberg, 2010] [T. Isenberg, 2008]

when table vs. wall?

Microsoft Surface

Perceptive Pixels

equal participation tasks vs. presentation

[Rogers, 2004]

how?

- Tabletop challenges
  - × all touch challenges +

× orientation (menus, text)
× reach
× privacy & sharing
× user identification and conflicts

how?

tabletop challenges

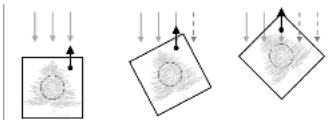
MS surface

dealing with orientation

- share orientation
- allow multiple copies (e.g. [Wu 2003])
- adjust (e.g. Occlusion aware menus [Brandl 2009])
- let the user decide (e.g. draw orientation [Leithinger 2007])
- make object rotation easy (e.g. RnT [Kruger 2005])

[Brandl 2009]

[Leithinger 2007]



[Kruger 2005]

videos

[Brandl 2009]
http://youtu.be/1ursnHWyPgs

long Pentable video [Leithinger 2007]
http://www.leithinger.net/files/pentable_video.wmv

how?

tabletop challenges

reach

- throw / flick (e.g. [Reetz, 2006])
- radar views (minimap, dollhouse, …)

http://youtu.be/f1Pceuot16I

- direct vs. indirect interaction (e.g. [Parker 2006])

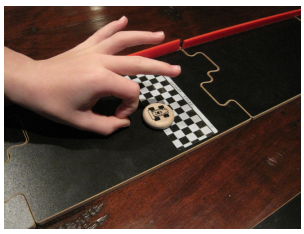


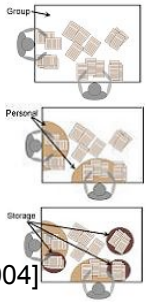
image: Parker et al., 2006

how?

tabletop challenges

privacy & sharing

- ease sharing (e.g. with flicking)
- respect and support territories
  - personal, group, storage [Scott 2004]
- allow privacy interactions (e.g. [Wu 2003])



[Scott 2004]

[Wu 2003]

how?

tabletop challenges

user ID and conflicts

- affects ownership and makes gestures ambiguous
- use technology (e.g. DiamondTouch)
- use heuristics (e.g. finger distance, temporal displacement)
- allow users to coordinate
  - using social protocols
  - enforce sharing protocols (e.g. [Morris 2004])
  - define collaborative gestures (e.g. [Morris 2006], needs ID)

how?

- wall challenges
  - × all touch challenges + most of tabletop ones

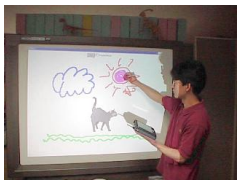
× gorilla arm
× reach (!!)
× change blindness
× perspective distortion

how?

wall challenges

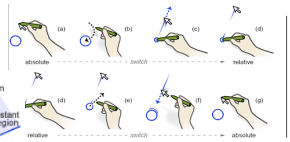
reach

- walking (e.g. pick-and-drop [Rekimoto 1997])
- mediators to reach
  - (e.g. drag-and-pop [Baudisch 2005], vacuum [Bezerianos 2005])
- radar views or other lenses
- absolute vs. relative pointing (Hybrid Pointing [Forlines 2006])



[Rekimoto 1997]

[Baudisch 2003]
[Bezerianos 2005]



[Forlines 2006]

videos

[Rekimoto 1997]
http://www.sonycsl.co.jp/person/rekimoto/pickdrop/pd1.mpg

[Baudisch 2005]
http://www.patrickbaudisch.com/projects/dragandpop/index.html

[Bezerianos 2005]
http://youtu.be/_o8H89fAHII

[Forlines 2006]
http://youtu.be/FZmOBIg5KjM

how?

wall challenges

change blindness

- do nothing
- use notifications close to the user
- store and replay (e.g. Mnemonic rendering [Bezerianos 2006])

http://youtu.be/POFV4fZYz_E

perspective distortion [Bezerianos 2012] and LCDs [Kim 2011]
http://www.youtube.com/watch?v=1Oszb7AhKGA#t=15

- walking, radar views, remote interaction [Nancel 2011]
http://www.lri.fr/~nancel/videos/CHI_11_CamReady_GoodRes_SD.mov

and overlapping/occlusion by other people …

how?

wall challenges

so why not just interact from a distance?

- miss resolution and detailed work
- miss implicit zooming to change perspective
- remote techniques (e.g. laser pointers) often inaccurate or require extra devices
  - much work on this, ask if interested in references

Best: support both!

recent trends in tables and walls

- Fundamental aspects
  - input (e.g. remote interaction [Nancel 2012]),
  - output (e.g. perception [Bezerianos 2012], multiple encodings [Isenberg 2013]),
  - collaboration (e.g. [Wallace 2011]), etc.
- Applications
  - Scientific analysis (e.g. [Isenberg 2010], [Sultanum 2011]),
  - public displays (e.g. engagement [Müller 2012]),
  - crisis management (e.g. [Doeweling 2013]), etc.
- Technology and novel large displays (e.g. floors [Augsten 2010])

http://www.youtube.com/watch?v=spiKgkW1UmI

- Modality combination
  - pen/touch/gesture input (e.g. [Frisch 2011]),
  - haptic and visual output (e.g. [Kim 2013]), etc.

recent trends in tables and walls

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related internships (in|situ)

- at least 5 on wall display related topics
- at least 3 on tabletop related topics

also in AVIZ

touch interfaces (and more)

technology
frameworks
touch & muti-touch design
tables, walls,
mobile

slides adapted from Jose Alves

mobile interface design

slides adapted from Jose Alves

2003 - The first mobile phone with a cursor - NEC FOMA N2051.

2007 - Apple introduce's the iphone.

2008 – HTC Dream, first Android phone

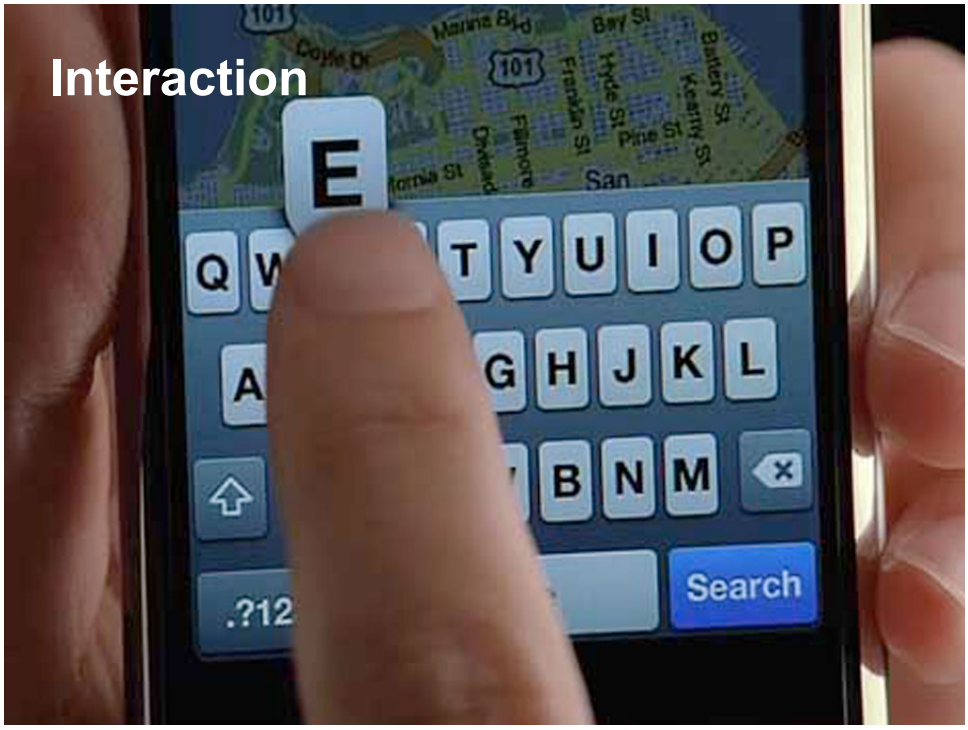
2010 – iPad and other tables …

slides adapted from Jose Alves

Staggering Numbers

- **1996** - GSM (Global system for mobile communications) phones in 103 countries
- **2000** - 10 million i-mode users (Japan)
- **2002** - 1 million mobile phones
- **2008** - 3.0 billion mobile phones
- **2010** - 5.0 billion mobile phones
- **2013** - 6.0 billion mobile phones (population ~7.0 billion)

number of mobiles will exceed world population by 2014



Mobile interaction techniques & elements

- Clickable scroll wheel
- Mini joysticks
- Click Wheel
- Voice Input
- Soft Keys
- Key Pad
- Stylus
- Touch Pad
- Touch Screens
- Multi-Touch Screens
- Gestures

slides adapted from Jose Alves

Interaction

- One handed interaction
  (most of the phones)
- Two handed interaction
  (e.g. larger smartphones, notes, tablets)

- Indirect interaction (wheel)
- Direct interaction (touch)

slides adapted from Jose Alves

Indirect Manipulation

- One item on the screen has focus
- Keys or joystick as an intermediate device to move focus to the item you want and click it

slides adapted from Jose Alves

Indirect Manipulation

Challenges

- Scrolling is tedious
- Navigating through options slow
- Navigate and select often different keys
- Moving focus of interaction can be slow

Direct Manipulation

- You just tap/click anything directly

slides adapted from Jose Alves

Direct Manipulation

Challenges

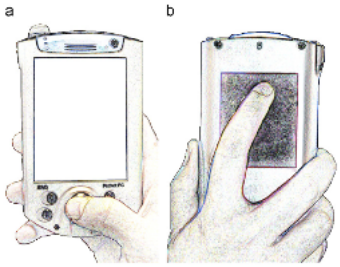
- Buttons need to be big for fingers or pen
- Fingers/pen can occlude content
- Easy to accidentally click on the wrong item
- Touch sensitivity (too much/little)
- Wearing gloves (chubby fingers & capacitors)
- No eyes-free interaction
- Still small screen

Direct Manipulation

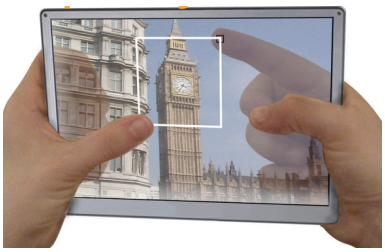
Some solutions

- Already seen some solutions in touch/multi-touch

- Occlusion
  - on the back interaction (e.g. [Wobbrock 2008])
  - lucid touch [Wigdor 2007]



[Wobbrock 2008]



[Wigdor 2007]
http://youtu.be/RsNFZAEssPQ

Direct Manipulation

Some solutions

- Not eyes-free interaction (use other channels)
  - **output**: audio
  - **output:** haptic feedback (vibration)
  - **input**: voice
  - **input**: gestures

    surface (e.g. Gesture Search [Li 2010])

    full phone gestures (e.g. Jerktilts [Baglioni 2011])

    also with visual feedback as shortcuts (e.g. GestureAvatar [Lu 2011])

http://www.youtu.be/umos1GZKbKw

Direct Manipulation

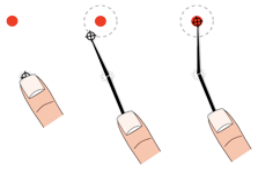
Some solutions

- Small screen
  - content adaptation (e.g. for web)
  - off-screen target visualization (e.g. Halo, Wedge)

[Baudisch 2003]

[Gustafson 2008]

http://www.patrickbaudisch.com/projects/halo/index.html
http://www.patrickbaudisch.com/projects/wedge/index.html



[Roudau 2008]

- Small, but too big for interaction (thumb reach)

  - object pointing (e.g. MagStick [Roudau 2008])

Phone vs. Tablet

- Tasks: single vs. multiple
  (e.g. task switching)
- Size: small vs. average
  (e.g. summaries vs. magazine layout)
- Goals: personal vs. entertainment
  (efficiency)

- Ergonomics
  - thumb vs. fingers
    (e.g. object size, location of targets)
  - single vs. two hand
    (e.g. different gestures)

some recent trends (1)

- Fundamental aspects
  e.g. Finger interaction modeling (e.g. [Bi 2013])
  Perception, change blindness (e.g. [Davies 2012])

- Text input (e.g. using hand posture to help [Goel 2013])

- As input devices (e.g. [Boring 2010], [Nancel 2013])

http://www.youtube.com/watch?v=lTMAKHzbl1E

some recent trends (2)

- Augmenting input/output

  e.g. pressure sensors (Gripsense [Goel 2012], SidePress [Spelmezan 2013]),
  tilt as input (JerkTilts [Baglioni 2011], Sensor synaesthesia [Hinckley 2011]),
  input vocabulary (MicroRolls [Roudaut 2009], ThumbRock [Bonnet 2013]),
  output using force feedback ([Kim 2013],[Roudaut 2013b]), etc.

- Foldable devices

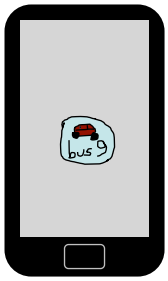
  input and interaction (e.g. [Steimle 2013]),
  http://www.youtube.com/watch?v=AZwUW7HqcQg
  output and self actuation (e.g. [Roudaut 2013a]), etc.
  http://www.youtube.com/watch?v=oaZHj9SEzLQ

- AR (e.g. [Liu 2012])

related internships (in|situ)

- view management and mobile devices

- allowing users to sketch their own interfaces on mobile devices



touch interfaces

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touch can be fun

SandCanvas [Kazi et al. 2010]
http://youtu.be/NQ9FERXWWsQ