Nontraditional Interfaces

An Introduction into Nontraditional Interfaces

What are Nontraditional Interfaces?

- So far we have **focused** on **conventional or traditional GUI's**
- **Nontraditional interfaces** integrate **more** of our **senses**
- Still leading edge **research** although **many technologies** have been moving into **mainstream products**
- Some examples…
  - Motion and facial expression detection
  - Voice recognition and synthesis
  - Augmented and virtual reality
  - Artificial intelligence and adaptable interfaces, …

Traditional Interfaces Evolving

Skeuomorphic vs. Flat Design

- **Skeuomorphic design** – **metaphor based** design using graphical representation of real world objects
  - **Familiar** and understandable affordances
  - Aesthetically pleasing but can **become dated**
  - (Vs “realism” - a design style that mimics physical items for aesthetic reasons)
- **Flat design** – minimalist, emphasize simple usability
  - **More abstract –** object meaning and relationships expressed via color, shape, proximity
  - **3D illusion** (drop shadows, gradients or textures)
  - **Need** associated **typography** to understand
  - More screen size **responsive**
- Do users care or only designers?

https://www.nngroup.com/articles/flat-design/

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Flat Design

- Initially, too “flat”, less obvious affordances
- “Fatting flat design” - more depth, shadows and highlights

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Anthropomorphic Design

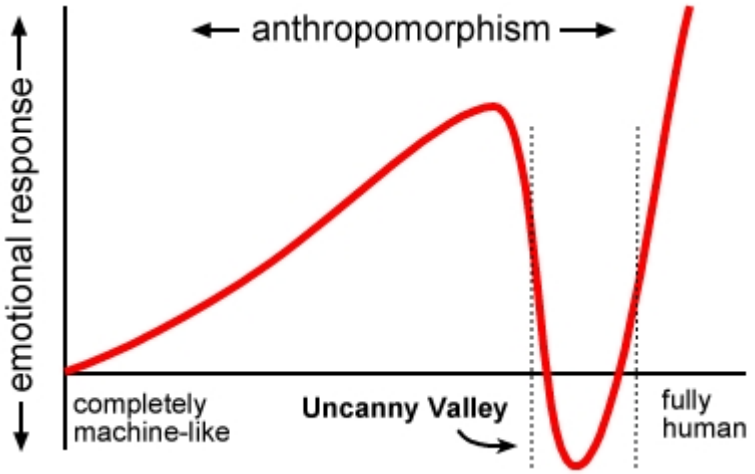
- Designing the **HCI** to **possess human like qualities**
  - E.g., error messages written as human to human dialog (“We’re sorry, but that page cannot be found.”), human forms on icons, or human voice based feedback
- **Social theories** of why there is value…
  - **Familiarity**
  - **Comfort** – things like us
  - **Elicit human responses** when interacting with inanimate objects; e.g., emotion
- **Controversial** – anthropomorphic interfaces need to be **believable and predictable**; **otherwise** they become **annoying and reduce usability**; e.g., Microsoft’s “Clippy”

Should computers say they are sorry?

http://www.nextnature.net/2011/12/11-golden-rules-of-anthropomorphism-and-design-introduction

Uncanny Valley

- Human replicas that appear too human may elicit negative feelings or revulsion
  - –Robots
  - –Chatbots
  - –Virtual and augmented reality
- Design guideline – retain an element of artificialness; e.g., synthetic voice



What are Nontraditional Interfaces?

- **Haptic** interfaces – sense of touch and body movement
- **Gesture** interfaces – hand and face movement
- **Speech and hearing** accommodation

- **Olfactory** interfaces – sense of smell
- **Taste** – research topic

- Other research areas – brain signal sensing, holographic interfaces (air as the medium), …

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General Observations

- The **UX life cycle** still applies
- **Affordances** and **design guidelines** still apply
- Still need to achieve **learnability, memorability, understandability, effectiveness, satisfaction**
- **Greater need** to account for user's **physical** skills and capabilities
- **Localization still necessary**
- **Different interface techniques collaborate** to support UX just as our natural senses do

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Haptic Interfaces

- Based on two **integrated** human touch related senses …
- **Tactile** (cutaneous) **feedback** based on the **sense of touch**
  - **Skin based** to feel heat, pain, and texture
    - **Texture most important** for haptic interfaces
      - Sensation of pressure, vibration, motion, shape
- **Movement** (kinesthetic) – sensing the **location**, **direction** and **speed** of 3D movement of the **body and its appendages**
- **Bidirectional** – **sense** environment, **exert force** on the environment

TED Talk- Haptography: Digitizing our sense of touch - Katherine Kuchenbecker

How Do We Perceive Our Environment?

- We **move our bodies and appendages** for **physical space perception**
- **Space perception** does **not** always **correspond** accurately with **physical space**
- **Haptic feedback** should augment **visual feedback**
- **Tactile and kinetic perceptions** should be **integrated**

Some Examples of Haptic Interfaces

- **“Teleoperation” of robotic devices** particularly in hazardous or hard to reach environments (e.g., radioactive material, minimally invasive surgery)
  - Operation at a distance
- **Disability assistance**
  - Environmental sensors detect objects that re-route a blind person via tactile feedback
  - Lechal – sneaker that vibrates to indicate turns
  - Enactive Torch – infrared sensors detect narrow passages and vibrate wrist bans for visually impaired
  - Tactile Braille readers (e.g., Anagraphs)
  - Exoskeleton devices for motor disabilities
- **Scientific visualization** that integrates **tactile feedback** with the visual information
- **Gaming**
  - Controller devices, environment immersion effects based on tactile feedback (Immersion Studio® SDK)
- ZeroUI – **Ziro** – hand controlled robotic kit; http://ziro.io/

Technology

- Various **sensors and actuators**, and **manipulation devices** such as gloves and arms
- Issues:
  - Perceptual threshold
  - Size/weight
  - User fatigue
  - Pain
  - Annoyance
  - Stability
  - Cost
  - Portability
  - External environment
  - Backdriveability – move without interference
  - Latency

Speech and Hearing

- **Hearing** – the sense by which we perceive **sound** (note, not necessarily listening)
  - We **respond more quickly to audio** input than visual stimuli
  - Fundamental connection to our environment
- **Speech** - significant part of our interaction with the world
  - Advantages – **natural** form of **communication**, easier to speak than write
  - Disadvantages – **requires** knowledge of a **language**, more efficient to read than listen

Using Sound in Interactive Design

- **Redundant Coding**
  - Use sound to **augment and reinforce basic interaction**
  - E.g., selection, alerts, actions
  - Aids memory and efficiency
- **Psychology of sound - positive/negative feedback**
  - **Success** confirmation is **welcome and effective**
  - **Alarms** and **error notification** may be **necessary but unwelcome**
- **Speech** and **non-speech** applications
- Significant **internationalization implications**

Speech Applications

- **Speech to text** conversion
  - –Document composition, annotation, editing
  - –Conversation transcription
- **Speech recognition** to initiate commands
  - –Virtual assistants - Siri, Cortana, Google Assistant, Alexa
  - –FYI – Google claims 90% accuracy for search
- **Speech synthesis** to produce speech output
- And of course direct person-to-person communications

Cornell University researchers investigating the wider ramifications of content discovery with smart speaker products found people who read choices online digested information nine times faster and explored at least three times as much as those who heard them listed by a Siri, Alexa, or similar product.

Non-Speech Sound

- Second nature, monitor the environment **unconsciously**
- Advantages – direct feedback, **faster** processing **than speech**, no language
- **Disadvantages** when used in interfaces:
  - It can be **ambiguous**
  - It must be **learned**
  - It must be **familiar**
  - It may not have **high discrimination**
  - It is **transitory**
  - It can become **annoying**

Nonspeech Applications

- Nonspeech sounds are either …
  - **Concrete** – those that exist in **nature** OR …
  - **Abstract** – those **created by humans** (e.g., music)
- **Auditory icons** – concrete, "ecological listening"
  - **Everyday sounds** designed to convey **information about events** by **analogy to everyday sound-producing events**
  - E.g., delete a file with sound of paper being crunched into waste basket
  - Examples: http://sonification.de/handbook/index.php/chapters/chapter13/

Auditory Icon Design Guidelines

- **Cohesion** – each auditory icon should be **identifiably unique**
- **Conceptual mapping** – sound must **map** to the user interface **context**
- **Balance physical sound parameters** – length, quality, frequency range for good usability
- **User experience** response; e.g., not too harsh, too cute

Example: Plug in or remove USB device on Windows

Earcons

- Short recognizable **musical snippets** that **represent** system **objects or processes**
  - –E.g., Windows startup and shutdown
- **Distinguish musical properties** such as pitch and timbre for **usability differentiation**
- Design **challenge** is to **ensure memorability and discrimination** (avoid mute due to user annoyance)
- Examples: http://sonification.de/handbook/index.php/chapters/chapter14/

References

- Steven Heim, *The Resonant* Interface, Pearson, 2008, Chapter 13 and 14
- Philip Kortum , *HCI Beyond the GUI: Design for Haptic, Speech, Olfactory and Other Nontraditional Interfaces,* Morgan Kaufmann Publishers, 2008

Gesture Interface Design

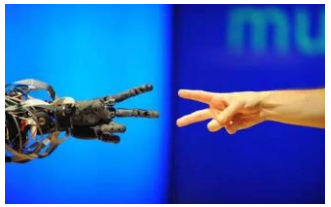
Intro to Gestures

"A gesture is any physical movement that a digital system can sense and respond to without the aid of a traditional pointing device such as a mouse. A **wave**, a head **nod**, a **touch**, a **toe tap**, a facial **expression** can be a gesture."

- **Touchscreen** – the user touches the screen to directly manipulate objects
- **Free-form** – the user's motion is sensed remotely
- Examples of everyday products?
  - Clapper – auditory sensor
  - Lights in this classroom
  - Water faucet
  - Touch screen kiosks, smartphones, tablets, …

More Sophisticated Examples

- Gesture controlled robots – free form or with glove based devices such as an accelerometer



- Microsoft Kinect - motion sensing input device
  - Users interact using **gestures and spoken commands**
  - Software technology enables **gesture, facial, and voice recognition**

- "Air Writing"
  - Sensors attached to a glove capture hand movements
  - User writes letters in the air
  - System recognizes characters (<5% error rate)

Karlsruhe Institute of Technology (KIT) research project

Gesture Design Guidelines and Techniques

- Match **gesture complexity** to **task complexity**
  - **Sequence** gestures based on **task analysis**
- Design gestures within **constraints** of **sensors and input devices**
- **Avoid** putting **essential information** like a label **below** a touchable target – the hand may hide it
- **Target size** – apply Fitt's Law, target size ≥ 1 cm (finger pad size)
  - **Iceberg targets** – touch target is larger than the visible icon representing it
  - **Adaptive targets** – algorithmically predict the user's next target and increase its size

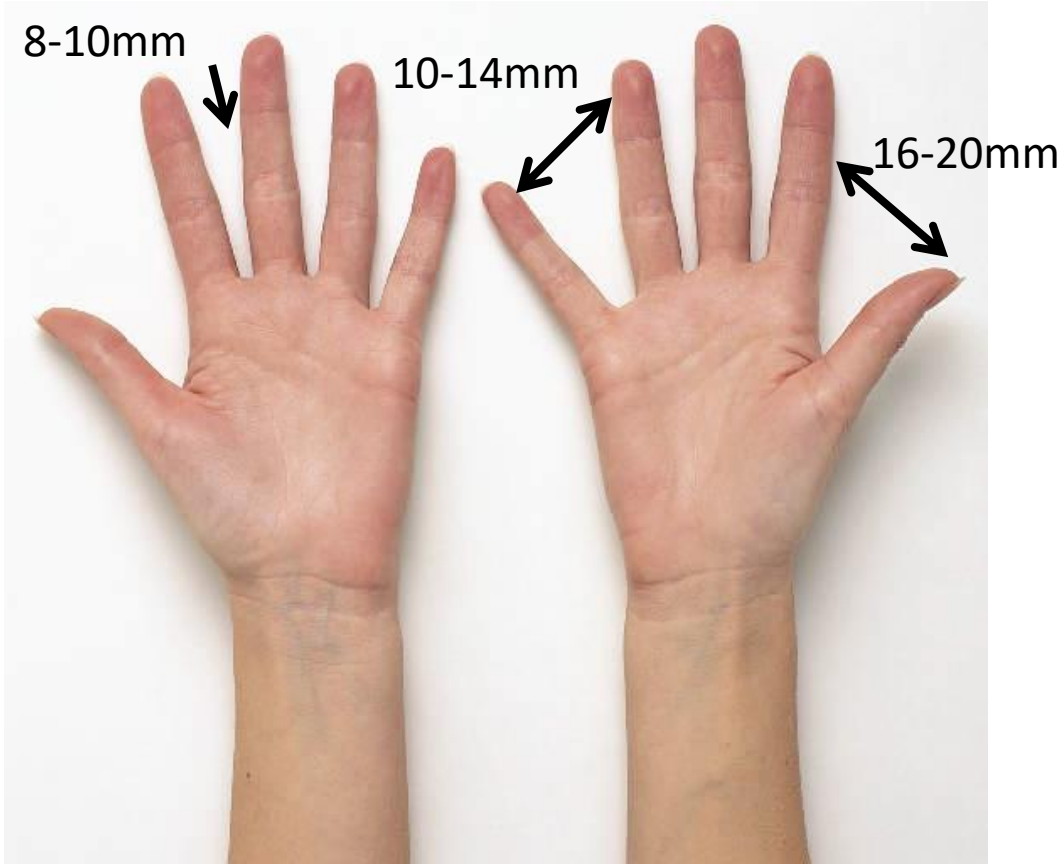
Gesture Design Guidelines and Techniques

(cont)

- **Natural behavior –** match the gesture to intuitive **real world** user **actions**; e.g., push a button
- Consider the **ergonomic impact** of **gesture motion** as constrained by the **physiology** of the human body
  - Avoid **hyperextension** or extreme stretches
  - Avoid **repetition**
  - Utilize **relaxed**, neutral **positions**
  - Avoid **staying** in a **static position**
  - Avoid internal or external **force on joints**

Human Anatomy Considerations

- Physical dimensions and range of motion



Human Anatomy Considerations (cont)

- Fingernails (fake fingernails are an issue)
- Finger oil
- Fingerprints
- (Left) Handedness
- Accessibility issues
- Wrist support
- Gloves
- Inaccurate (when compared to a cursor)
- Screen Coverage

Gesture Design Guidelines and Techniques
(cont)

- **Distinguish** the **beginning and end** of a **discrete gesture**
- Account for **cultura**l differences
- Provide appropriate **feedback**
  - Integrate with other interface modalities
- **Learnable** gesture vocabularies

Learnability

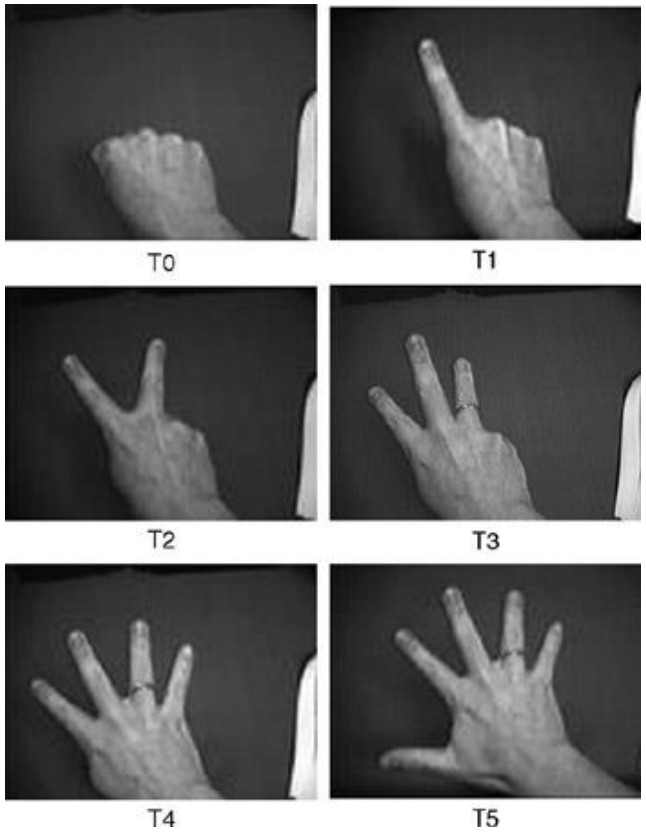
- The **more complicated** the gesture, the **fewer people capable** of doing it
- **New users** have a **learning curve** with a gesture interface
  - No **visual clues** in a simple interface
  - **Non-intuitive** vocabularies
  - Particularly true for new application specific gestures
- **Document**
  - Written instructions
  - Graphical illustrations
  - Video demonstration
  - Iconic symbols

Gesture “Vocabulary” Design

- **Gesture taxonomies** – a kind of **vocabulary**
  - **Semantic** – the gesture **meaning** (non-verbal)
    - E.g., a ring formed by the thumb and index finger; in Western culture this means "Okay,“ in Japan it means "Money.“
  - **Functional** - intended usage in an application
    - E.g., pointing, propositional (“this big”)
  - **Descriptive** - refer to the manner in which the **gestures are performed** in space and time
    - E.g., sign language

Gesture “Vocabulary” Design
(cont)

- **Limit the vocabulary**



- Context dependent vocabulary
  - E.g., edit commands - select, copy, cut, paste, release
- What about usability? Intuitive?

Gestures vs. Traditional Interface Conventions

- Many **traditional conventions still work well** with gestures; selecting, drag and drop, scrolling, …
- Others are not as useful or necessary
  - Cursors – you know where your finger is
  - Hovers and mouse-over events are awkward
  - Double click timing
  - Right click
- Typically **gesture** based **interfaces** are **stateless**
  - There is only **one task goal** for the system to accomplish **at any one time**
  - KISS principle

Gesture Patterns

- **Gesture patterns** have emerged as **best practice**
  E.g., "Touch Gesture REFERENCE GUIDE"
  - Defacto "standards"
- A sampling of "core gestures"
  - **Tap** to open/activate/select an object
  - **Drag** to move an object
  - **Slide** to scroll or pan
  - **Two fingers** to scroll
  - **Spin to scroll** – rapid scroll with limited screen space
  - **Flick** to **nudge**
  - **Fling** to scroll rapidly
  - **Pinch** to shrink, **spread** to enlarge

http://gesturecons.com/

References

- Saffer, Dan, *Designing Gestural Interfaces*, O Reilly Media Inc., 2009
- By Craig Villamor, Dan Willis, and Luke Wroblewski, *Touch Gesture REFERENCE GUIDE,* 2010