HCI: Nontraditional Interfaces

HCI: What are Nontraditional Interfaces?

- So far we have focused on conventional or traditional GUI's in HCI
- Nontraditional interfaces (Haptic, Speech, Olfactory etc.) involve our senses (Hearing, Seeing, Smelling, Tasting, Touching)
- Still an area of research although some cutting-edge technologies have been moving into mainstream products
- Some Examples…
  - Motion Detection
  - Gestures
  - Voice Recognition and Synthesis
  - Augmented, Virtual and Mixed Reality, …

HCI: What are Nontraditional Interfaces?

(Role of Cutting-Edge Technologies in Military Warfare)

- Exploration of new operational concepts for utilising such technologies and retaining the best and brightest in human resources to achieve objective of eventual peace.
- Future Force Capability focuses on promising tech. areas such as robotics & system autonomy, miniaturisation, big data, and advanced manufacturing.
- Autonomous learning systems; human-machine collaborative decision-making; assisted human operations; advanced manned-unmanned systems operations, network-enabled autonomous weapons, and high-speed projectiles.
- Cause 'unprecedented effects and disruption' by impacting cognitive and perceptional domains through weapons, other means, soldiers, robots, and cyborgs.

Traditional Interfaces Evolving (Skeuomorphic vs. Flat Design)

- Skeuomorphic Design – It is a metaphor based design using the 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 – It is the minimalist, emphasizes 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 responsive
- Do users care or only designers?

Flat Design

- Initially, too “Flat”, less obvious affordances
- “Fatting Flat Design” - more depth, shadows and highlights

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?

What are Nontraditional Interfaces?

- Haptic Interfaces – Sense of Touch and Body Movement
- Gesture Interfaces – Hand and Face Movement
- Speech and Hearing

- Olfactory Interfaces – Sense of Smell
- Taste – Research Topic

- Other Research Areas – Brain Wave Interpretation, Holographic Interfaces (air as the medium), …

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

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
  - Cost
  - Portability
  - External environment
  - Backdriveability – move without interference
  - Latency
  - Stability

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 Now, Alexa
  - FYI – Google claims 90% accuracy for search
- And of course direct Person-to-Person Communications

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, Chs. 13 and 14
- Philip Kortum , *HCI Beyond the GUI: Design for Haptic, Speech, Olfactory and Other Nontraditional Interfaces,* Morgan Kaufmann, 2008

Gesture Interface Design

Hand Gestures

Introduction to Gestures

“A gesture is any physical movement that a system can sense and respond 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

- Word gesture touch screen keyboard
  - Trace from starting to end letter
  - Pattern is analyzed to find the most likely word
- Microsoft Kinect - motion sensing input device
  - Users interact using gestures and spoken commands
  - Software technology enables gesture, facial, and voice recognitio…
- “Air Writing”
  - Sensors attached to a glove capture hand movements
  - User writes letters in the air
  - System recognizes characters (<5% error rate)

Gesture Design Guidelines and Techniques

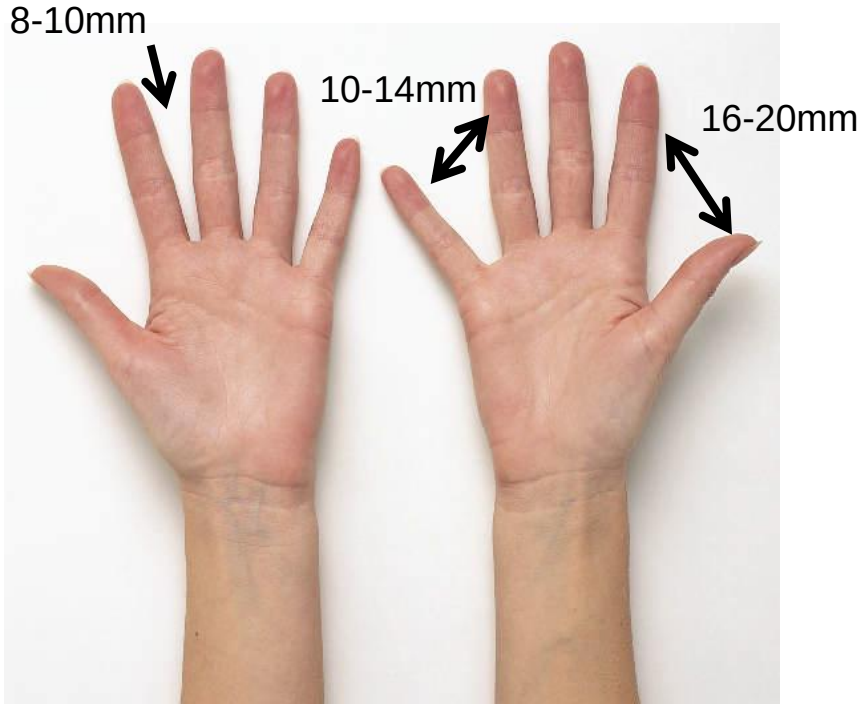
- Match gesture complexity to task complexity
  - Sequence gestures based on task analysis
- Design gestures appropriate to the available sensors and input devices
- Avoid putting essential information like a label below a touchable target – the hand may hide it
- Target size – apply Fitt's Law, target 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 (contd...)

- 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 (contd...)

- 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(contd...)

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

Learnability

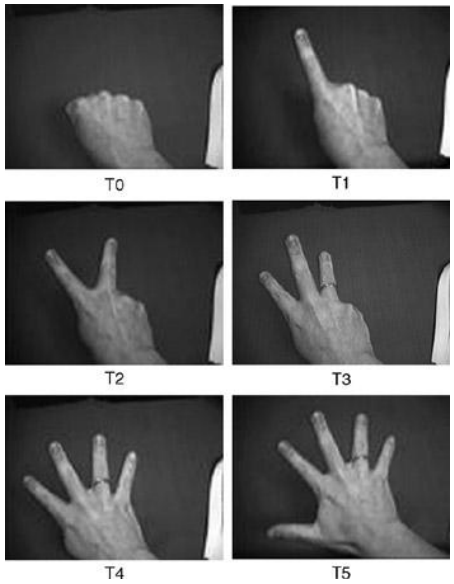
- The more complicated the gesture, the fewer people capable of doing it
- New users have a learning curve with a gesture interface
  - No visual clues in a simple interface
  - Non-intuitive vocabularies
  - Particularly true for new application specific gestures
- Document
  - Written instructions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

Personal Experience?

References

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