MOBILE COMPUTING
CSE 40814/60814
Spring 2017

The Past – The Present

Steve Mann
- 1970s, pre-laptop, early computer era.
- Building computers he could wear.
- Inventor of wearable computing.
Steve Mann

- 1991: Started the "Wearable Computing Project" at MIT.
- 1995: World's first covert wearable computer — camera and display concealed in ordinary eyeglasses.
- 1997: PhD from MIT in the field he himself had invented.
- Today: Works at University of Toronto.

What is Wearable Computing?

- Mann
  - constant and always ready,
  - unrestrictive, not monopolizing of user attention,
  - observable and controllable by the user,
  - attentive to the environment,
  - useful as a communication tool, and personal.

  "A wearable computer is a computer that is subsumed into the personal space of the user, controlled by the user, and has both operational and interactional constancy, i.e. is always on and always accessible. Most notably, it is a device that is always with the user, and into which the user can always enter commands and execute a set of such entered commands, and in which the user can do so while walking around or doing other activities"
What is Wearable Computing?

Seven attributes of wearable computing [Steve Mann, 1998]:

1. **Unmonopolizing** of the user’s attention. User can attend to other events.
2. **Unrestrictive** to the user. Allows interaction while user carries out normal functions.
3. **Observable** by the user. As the system is being worn, there is no reason why the wearer cannot be aware of it continuously... but this contrasts with 1!
   - Better phrasing: User can identify computational and non-computational components of their clothing.
4. **Controllable** by the user. User can take control at any time.
5. **Attentive** to the environment. Can enhance the user’s environment and situational awareness.
6. **Communicative** to others. Can be used as a communications medium.
7. **Shares the same physical and situational context as the user.**

Wearable Computing

Wearable computers will help provide a consistent interface to computationally augmented objects in the physical world.
- Example: Gesture Pendant
- One gesture could provide an intuitive command for many devices
Purpose: Aid Communication
- The wearable can also assist in human-to-human communication.
- Wearable computers can also help manage interruption in the user’s daily life.

Purpose: Provide Context-Sensitive Reminders
- Instead of simply acting as a virtual secretary, the wearable could be proactive and intimate, listening to the wearer’s conversations and providing reminders as appropriate.

Purpose: Augmented Reality
- Augmented reality overlays information-rich virtual realities onto the physical world.
- In a sense, augmented reality is a combination of the application domains described previously.
- https://www.youtube.com/watch?v=vDnzTasuYEw
Components of a Wearable Device

Head-Mounted Display (HMD)
- Small screen, typically covering one of your eyes.
- Works like an ordinary monitor, providing an image floating in the air in front of you.
- Transparent vs opaque.

Camera (& Sensors)
- Suitable placement
  - Head, follows user’s gaze.
  - Shoulder, more stable.
Input Device
- Keyboard
  - Canesta’s IR keyboard.
  - Arm-strapped keyboard.
- FrogPad
- Twiddler chording keyboard
- Mouse
  - Twiddler, again.
  - BrainGate

Input Device
- Gestures
  - Gesture Pendant (controlling smart homes)
- Voice recognition
  - Siri
- Multi-modal interfaces
  - Something new?

Output device
- Sight – Visual output
  - HMD, wristwatch...
- Hearing – Audio/sound/speech/music
  - Speakers, earplug/headset...
- Touch – Tactile feedback
- Taste and smell
The Computer Itself

- Anything small, but powerful enough
  - Smartphones
  - Smartwatches
  - Embedded computers

Network Connection

- Benefits of having a network
  - Access to the Internet
  - Communication
  - Localization
- Wireless network connection
  - WLAN
  - 3G, 4G, LTE
  - Bluetooth, ZigBee
  - InfraRed

Other Challenges

- Connecting all pieces
  - Wires (embedded into clothing?), wireless (security?), body as conduit
- Power supply
  - Batteries (rechargeable; solar power)
  - Human powered devices
    - Body heat, 0.6 – 4.8W (wetsuit clothes)
    - Breath, 0.4 – 2.5W (pressure mask)
    - Blood pressure, 0.2W
    - Limb motion, 0.3 – 1.5W
    - Finger motion, 0.019W (keyboard typing)
  - Walking, 5 – 8W (shoe generator)
- Heat dissipation
Examples

- Technicians
  - Blueprints, etc.
- Field workers
  - Access to information given by remote experts.
- Military personnel
  - Soldiers, monitoring health, equipment, etc.
  - Maps and terrain.
  - Infrastructure (sewers, roads) in urban areas.
- Researchers

Examples

- Wearables for sports training
  - Karate trainees are instrumented with acceleration sensors.
  - Sensor data is translated directly into sound output.
  - Trainees can now ‘hear’, as well as see instructor’s movements.
  - Trainees can also hear themselves: attempt to match own sound to sound of instructor.
  - Martial arts training is about reproducing patterns over time, not just matching static poses; therefore, sound is a useful sensory stimuli to introduce to training.
  - Result: Trainees with system tended to learn faster than trainees without system.

Examples

- Wearables for the military: Future Force Warrior (FFW)
  - Onboard physiological/medical sensor suite to accelerate casualty care
  - Netted communications to maximize robustness and integration of small teams
  - Embedded training (similar to martial arts example?)
  - Enhanced situational awareness (heads-up display?)
  - Synchronized firing of weapons from team.
  - Bone conduction technology: “talking and speaking without sound or hearing”
Examples: Smartphone Extensions & Fitness Trackers

Examples: Fitness & Health
- http://www.sensoriainc.com/

Examples: Fitness & Health
- Hexoskin Clothing
Applications

- **Mediated Reality**
  - Experiencing the world through the computer
  - Allows computer to process the sensory cues before reaching the user
  - E.g. block commercial billboards

- **Augmented Reality**
  - Overlaying virtual information on the real world
  - E.g. allow architects to build virtual houses
  - E.g. the AR Quake or AR Pacman game
  - Both realities can enhance your senses

Applications – Augmented Memory

- Trivial example, finding your way
  - "Where did I park my car?"
- Camera on your body records the way
- Replay helps you find your way back
  - Only key events need to be recorded
  - Example: Intersections at a car park

Applications – Augmented Memory

- Elderly or people with poor memory
  - Remember name and face of people
  - Image processing can recognize a face and map it to the person’s name and affiliation
  - How should it be presented?
Applications - Entertainment

PrioVR gaming

Applications – Aiding the Visually Disabled

• Some forms of low vision can not be alleviated by use of ordinary glasses
  • User wears non-transparent glasses with integrated displays, experiences the world through a camera
  • Computer processed video stream
    • Enhance contrast
    • Adjust colors
    • Night vision
    • Enlarged view

Applications – Aiding the Visually Disabled

• Fisheye lense for reading text.

• Remapping around blind spots.
Applications – Additional Vision Tricks

- "Edgertonian" eyes
  - Freeze-frame effect, fast shutter
  - Reading text on a tire of a speeding car
  - Clearly seeing the rotor blades of a helicopter
  - Counting the number of bolts holding an airplane rotor together in mid-air
  - Plus lots of other interesting effects

  https://www.youtube.com/watch?v=yr3ngmRuGUc

Applications – Additional Vision Tricks

- Giant's eyes
  - Enhances depth perception of distant objects

Applications – First Response
Applications – Social software

Usually designed for urban settings. Interface to groups or individuals.
- Safety net
  - Heart rate, perspiration, breath rate
  - Alert friends in case of abnormal values
- Friend finder

Google’s Vision for Glass

- Create a closer relationship with technology.
- Move away from technology that competes with real life
- Let Google Glass augment your experience.
- Share content with others.
- There when you want it, gone when you don’t:
  - Ex: Glass is not in front of you when you don’t.
  - Ex: Glass is not in front of you when you remain connected to what you doing.
- By bringing technology closer, we can get it more out of the way.

Development

https://www.youtube.com/watch?v=neo29M8Yk3Q
How it works

Glass
• Location: Sits above the line of sight
• Control: Look up to activate/ Look down to activate sleep mode

Wi-Fi/Bluetooth
• Location: Inside the right arm of Glass
• Control: Links to Wi-Fi or devices with Bluetooth

How it works

Touchpad
• Location: Right arm of Glass
• Control: By swiping and tapping touchpad

Speaker
• Location: Right arm of Glass just behind the ear
• Control: Automatic voice commands

Voice Commands

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<th>Glass Feature</th>
<th>Voice Command</th>
<th>Explanation</th>
</tr>
</thead>
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<tr>
<td>Take Picture</td>
<td>“Ok Glass” take a picture</td>
<td>Hands free and quick</td>
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<tr>
<td>Take Videos</td>
<td>“Ok Glass” take a video</td>
<td>In the moment recording</td>
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<tr>
<td>Video Chat</td>
<td>“Ok Glass” video chat [Person]</td>
<td>Lets others see what you’re seeing</td>
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<tr>
<td>Send Texts</td>
<td>“Ok Glass” send a text [Person]</td>
<td>Hand free texting like Siri</td>
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<td>Translate</td>
<td>“Ok Glass” translates [Word/Phrase]</td>
<td>Translates and recites back with proper pronunciation</td>
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<tr>
<td>Directions</td>
<td>“Ok Glass” give direction to [Place]</td>
<td>Turn by turn directions</td>
</tr>
<tr>
<td>Weather</td>
<td>“Ok Glass” what is the weather</td>
<td>Temperature, Chance of Rain and if it is currently sunny or cloudy</td>
</tr>
<tr>
<td>Google Hangout</td>
<td>“Ok Glass” hangout [Group Name]</td>
<td>Group interactions with selected friends</td>
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Medical Wearables

• Wearable Belts
• Sensor Insoles
• Smart Clothing
• Headsets
• Patches
• Respiratory Biofeedback and Body Sensor Networks
• Sensors in Sheets

Smart Watches

- Sony SmartWatch, Apple iWatch, Galaxy Gear …
- Uses NFC, Bluetooth, and RF technology for communication
- Pros & Cons
  - Pro: More integration, gateway to Internet of Things (IoT)
  - Con: Distraction on the road, battery life, smaller screens

Challenges

- Privacy
- Price
- Health risks
- Accidents
Wearable Computing & the Market

- Growth in wearable Computing
  - 35% growth by 2019
- Smartwatch will be leading product
  - Will rise by 41%
- Apple Watch market share
  - Account for 40% market share in 2015
- Fitness bands, smart eyewear, etc.
  - 36% percent market share this year