Wearables

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Who am I?

• Maoming, Guangdong, China
• BSc (Huazhong University of Science & Technology, 2008), PhD (National University of Singapore, 2013)

• Research: interactive handicraft, ubiquitous/pervasive computing (http://zhukening.me)

• Teaching: SM3702: Pervasive Media, SM2705: Physical Computing, SM3713: Special Topics in Art and Science

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• Office: M6026, CMC
What are we gonna do in this class?

Not just LED!!!
Class Schedule

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<th>Week</th>
<th>Date</th>
<th>Topic</th>
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<td>Wearable Technology 101</td>
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<td>Workshop 1: Soft Circuit</td>
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<td>Design Methodology for Wearables</td>
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<td>Making, Hacking and Upcycling</td>
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# Class Assessment

## Assessment Tasks/Activities

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<td>Project Proposal</td>
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<tr>
<td>Final Project and Presentation</td>
<td>40%</td>
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Final Project

• In a group of 3

• An interactive prototype of artwork with wearable technologies
Important Dates

• Form your group – Start from today!!!

• Think of your project – Start from today!!!

• Project Proposal Submission and Presentation – Week 7 Oct 13th!!

• Final Presentation – Week 12 Nov 17th!!
Plan your final project properly

• Form your group now
  • Roles: designing, prototyping

• Have group meeting frequently (once a week?)
  • I can provide time slot for group discussion in class (last 30 min?)

• Start thinking about ideas as early as possible
• Hopefully you would have an idea on what to do after week 6
And...

• Feel free to talk to me/miu
  • for comments and ideas
  • or if you are interested in doing research in pervasive media/handicraft

• I can speak Cantonese, Mandarin, English.

• But…only English in class please~
What is “Wearable”?
“Wearable technologies are clothing and accessories incorporating computer and advanced electronic technologies. The designs often incorporate practical functions and features, but may also have a purely critical or aesthetic agenda.”

Wikipedia
Wearable Aesthetics
“I have always been interested in conducting research that yielded new methods by which to make cloth, and in developing new materials that combine craftsmanship and new technology. But the most important thing for me is to show that, ultimately, technology is not the most important tool; it is our brains, our thoughts, our hands, our bodies, which express the most essential things.”

- Issey Miyake
Hussein Chalayan
creators project
Skin Probe Dress (2006)

by Philips Design
SHOWstudio Presents
Lady Gaga introduces VOLANTIS, the World’s First Flying Dress
http://www.youtube.com/watch?v=RjrhxNsxq60
Wearable Database

• http://vandrico.com/database
Wearable Technology
Outline

• History behind wearable technology
  • Humanoid vs. Mechanoid
  • Exoskeleton
  • Virtual reality
  • Data glove

• Contemporary wearable technology
Where is wearable technology from?

• It all comes from a dream…
Brief history

• It all starts from robotics.
Humanoid

- An humanoid is a robot with human-like looks and actions.
- It aims at assisting routine works currently handled by human beings.

Hiroshi Ishiguro from Osaka University

ASIMO Humanoid by Honda

http://en.wikipedia.org/wiki/ASIMO
Mechanoid

- Comparing to humanoid, mechanoid can be designed with diverse shape.
- Function is the central focus of the design principle.
The technical challenges

- Technical challenges are faced when designing a robot.
  - Integration of electrical and mechanical component
  - Sensing and perceiving the environment
    - Vision
    - Touch
  - Kinetic motion: Kinematics
    - Manipulation
    - Grip
    - Locomotion
    - Flying
    - ...
  - Artificial Intelligence
Wearable technology

- In addition to the application of a complete robot, can we WEAR some of the technology for a seamless integration with the human activities?
About Vision: Virtual reality

HIS POWER LEVEL
IT'S OVER NINE THOUSAAAAAAAND!
About Vision: Virtual reality

• Head mounted display (HMD)
  • A headset (helmet, visor, or eye-glasses) with one or two display to create virtual reality to the user
  • Monocular HMD: one eye
  • Binocular HMD: both eyes

• It has been widely used for pilots, military, police, firefighters to view tactical information such as map, or thermal image
Virtual reality

- Head mounted display lacks the traction of users’ body motion.
- Virtusphere is a hollow sphere which can rotate freely in any direction according to the users steps. Therefore, it transmit the user’s motion to the virtual environment with the aid of a wireless head mounted display.

http://www.virtusphere.com/
Virtual reality

- It often adopt the stereoscopic imagery, which presents two different images for each eye for reconstructing virtual 3D images.
- Going beyond the stereoscopic imagery, the ability to incorporate the observer’s head and eye directions increase the realization of the depth information. This enriches the real 3D experience.
3D format technology

- **Dual video input**
  - Use separated video sources for each eye.
  - The full resolution

- **Time-based multiplexing**
  - Fast alternating the images for left and right vision.
  - Full resolution
  - Time frame rate is reduced

- **Side-by-side multiplexing**
  - Half of the pixel for either left or right vision
  - Halved resolution
Virtual reality

- Thus, to create the real 3D experience, more sophisticated features are required
  - Head tracking
    - To detect head’s orientation and change the display accordingly
  - Eye tracking
    - To sense the location that the user is looking
  - Hand tracking
    - To perceive the hand’s movement and convert it to a natural interaction
Head tracking

- Current sensing mechanism: ultrasound, inertial, optical, or electromagnetic

Head tracking is widely used for pilot for precise weapons delivery and carrier and land-based operations
Ultrasound sensing

- Ultrasound is a very common sensing mechanism. Bats send out a sound wave and listen to the echo bounced back from an object. The echo sound is then used to determine the location of the object and its shape. Using ultrasound sensing, bats can detect objects as thin as a human hair in complete darkness.

http://askabiologist.asu.edu/
Eye tracking

- Available technology
  - Measuring the reflection of light from the eye. Infra-red light is used to minimize distraction and interference from the visible wavelength.
  - Measuring the electric potential in the skin around the eyes.
  - Measuring the movement of a special contact lens attached to the eye.

Oculus Rift
About Body: Exoskeleton suit

- One of the important application for robotics is to provide a powered device to support elderly or disabled populations.

- The example is exoskeleton suit, a mobile machine consisting a powered framework wearable by human. Electrical or hydraulic energy is used to carry out the motion such as walking or lifting heavy items.

- Applications:
  - Enhance the soldier’s durability
  - Increase the muscle strength for workers in medical care or rescue service
  - Increase the strength and safety for the firefighters
Exoskeleton

• Cyberdyne HAL robot suit
Exoskeleton

• Advantages of the exoskeleton:
  • Integrated with human: a synergy of mechanoid and humanoid
  • Accessible in many human working conditions
  • Human is still the decision maker, so it avoids the need of artificial intelligence

• Disadvantages?
What do you see from Exoskeleton?

- The exoskeleton inspires the researchers to think about wearable technology
- The robotic suit consists of
  - sensors
  - actuators
  - control circuit
  - computational units
  - power source
  - => it is a fully integrated, wearable system for receiving the information and take action accordingly!
- For simpler application, can we make it smaller?
About Hand: data glove

- A input device to convey the gesture information into computer.
- Magnetic or inertial sensors are used to capture the position and orientation of the figure.
Data gloves

- The gesture information can be translated into text for further communications
Sensor involved in data gloves

- Finger bending:
  - Optical flex sensor: an IR light source and infrared diode are positioned at either end of a piece of clear aquarium tubing. When the tube is flexed, the amount of light transmitted to the diode is reduced, causing a change that can be measured by a microcontroller.
- Gyroscope
- Accelerometer

http://hackaday.com/
Flex sensor

- As the flex sensor is bent, the resistance is changed, which indicates the level of bending.

Array of resistors for sensing the bending

Flat (nominal resistance)  
45° Bend (increased resistance)  
90° Bend (resistance increased further)

We will learn how to DIY it in Week 5!!
Wearable technology

- So far, we have been talking about three wearable technology that can enhance the vision, body strength, and interpret the hand gesture.
Current wearable technology

- **Smart Accessory**
  - Google glass
  - Smart watch
  - iRing

- **Outfit**
  - Apollo dress shirt
  - Catalytic clothing

- **Body Contact**
  - Electronic skin
  - Contact lenses

- **SixthSense**
Google glass

• Google glass can be considered as a wearable computer developed by Google. It displays information using connections with smartphone-like hands-free and voice control, and can exchange data through the Internet

• Available functions
  • Picture taking
  • Video recording
  • Navigation
  • Message
  • Phone calls
  • Google+ handout
  • Google

http://www.androidheadlines.com/
Google glass
Technology involved

- It works like a mini-projection that transmit image signals from a small projector and mixed with the reality signal: holographic display.
Prism

- Can you look at the projector and get the image displayed?
- The projected image should not go to the retina directly. Instead, it should focus on a “screen”, and we can visualize it via the reflection

http://www.dvice.com/
How it looks like
Controversy

- Privacy concern
  - Taking photograph without consent or knowledge such as using Winky, a program that allows a Google Glass user to take a photo with a wink of an eye
  - Casinos in Las Vegas has banned the Google Glass

- Safety concern
  - Vehicle driving
  - In the US, West Virginia state amended the state’s law against texting while driving to include the use of wearable computer with head mounted display.
  - A driver wearing Google glass in California was pulled over and ticketed due to speeding. The first report.
Smart Watch

- With the increased multi-function of mobile phone, up to date, there are two types of wearable watches that can serve as the new way of communication
  - Pebble E-paper Watch
  - Samsung Galaxy gear

- The basic idea of the watch is an screen extension when you cell phone is not convenient accessible.
- It allow quick check of
  - Emails
  - Notifications
  - Answering incoming calls
  - Messages

Smart Watch

- Samsung Galaxy Gear
Google glass & Smart watch

• These products are the current available consumer products
• The main function relies on the mobile phone as the central computational units
• In additional to the big screen on the phone, the glass and watch provide an addition vision and convenience.
• Central idea is more or less like the blue tooth earphone
• Similar item: Nike+ Fuel Band and Ring presenter

http://4.bp.blogspot.com/
http://deals.htxt.co.za/
iRing

- iRing is an accessory that works similar with data gloves, but in much smaller scale.
- The iRing incorporate a camera that picks up the gesture and translate them for controlling music such as design or mix tunes.
RingU

- Made by my friend in at Sogang University, Seoul, Korea :D
- I hope I can invite him to give a talk :D

http://yongsoon.me/ringu
Current wearable technology

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- SixthSense
Apollo Dress Shirt

- A kickstarter project that strive to make shirt that can work like a heat battery:
  - Absorb heat energy when you go outdoor
  - Release the heat energy back to you when you are back indoor
  - odor control, moisture management, wrinkle free

- Phase-change materials (PCM) is used. Working on the principle that when solids turn to liquids, they absorb a lot of heat, and vice versa
Apollo Dress Shirt
Phase changing material

- A polymer that can change between solid and liquid is encapsulated as microcapsule
Apollo dress shirt

Ministry of Supply, USA
Catalytic Clothing

- Can we use our everyday clothing to purify our air surrounding us?
- Concept: implement photocatalyst to fabric that is then turned into fashionable garments. A photocatalyst is the chemical uptake energy from light and breaks down pollutants in the air.
Catalytic Clothing

- Taking the advantage of surface to volume ratio, nanomaterial is used here to capture the molecule and conduct the necessary reaction
Catalytic Clothing

• What do you think?

• The idea is novel: in addition to cosmetic and protection purposes, our cloth may provide a new solutions for air purification.
Color-changing Clothes

• From another one of my friends :D

We will learn how to make later in the semester :D
TWare

- Hugging Jacket for Autistic Children
- From my 師兄 :D
Current wearable technology

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- **SixthSense**
Electronic Skin

- Ultrathin membrane with a variety of sensors (LED, Temperature sensor, strain gauge, etc) and wireless power coil.

Dae-Hyeong Kim, Science, 2011
Electronic Skin
Electronic skin

- The sticky patch uses van der Waals force to attach the skin
- It can be used to monitor patient health by measuring the brain activities, or transmit heat energy for helping the wound healing.
- Any idea arising?
Interactive Skin

• A sheet of thin plastic embraces a pressure sensor and organic LED to achieve interactive lighting in response to “touch”
Electronic Skin

- The intimate interfacing the physiological epidermis with the functional circuit.
- Enabling the transmission of biological signals, such as EMG, pressure, temperature, and stretch into digital stimuli for further operation.

- Advantages:
  - Thin, lightweight
  - Multifunctional
  - Integratable with electronic devices and robotics

- Disadvantages:
  - Fragile
  - Power source, current using wireless power
Bionic Contact Lenses

- Contact lenses with integrated circuit, antenna, optoelectronic units, sensors using semitransparent materials.
- It can be applied for displaying words, charts, photos which keeping the vision to the real-world, and monitoring the medical conditions such as glucose level in tears for diabetes.

A R Lingley, JMM, 2011
Microtechnology

- The construction of the LED follows the stacking of multiple layers.
  - 2 μm thick n-doped GaN layer
  - A multiple quantum well (MQW) stack consisting of five pairs of 3 nm thick InGaN (QWs) and 20 nm thick GaN barriers to sufficient indium incorporation in the wells
  - A 50 nm GaN capping layer was grown on top of the QW to prevent desorption of indium from the QWs

A R Lingley, JMM, 2011
Google contact lenses for glucose monitor

- Measure the body fluid, tear, a contact lens can be used as the non-invasive monitor for glucose level
- Comparing to regular glucose meter that sample blood from figure tip, this device enables real time monitor with comfort
- A mobile phone is required to process the data

http://www.extremetech.com/
Augmented Reality

- Combining google glass and contact lenses. It may also enable another level of augmented reality.
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- SixthSense
SixthSense

• SixthSense is a wearable interface that seamlessly connect our physical world to the digital world using the nature gesture.

• The system comprises a pocket projector, mirror, and camera worn in a pendant-like mobile device. A computation unit is also needed.

• Computer-vision technique is used to process the video-stream data in real time.

• Several functions have been enabled, such as taking picture, dialing, post-processing for photos, etc
Technology involved

- Vision based systems heavily relies on an application-specific algorithm development, programming, and machine learning.
- Skin color, shape, and appearance is usually used for image segmentation. Shortcomings stem from confusion with similar-colored objects in the background

SixthSense

- How do you think?