Introduction to Mobile HCI

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Welcome!

This course aims to introduce the challenges of developing interactive systems for mobile computing devices, e.g., mobile phones and wearable computers.

You will learn about challenging aspects of mobile interaction contexts, e.g., device movement, situational impairments, social acceptability.

Timetable

Every week:

- Labs: Monday 10-11am / 11-12pm / 12-1pm
- Lectures: Monday 3-5pm
- Unassessed activities: In your own time

Assessment

Coursework (40%):

- Design, develop, and evaluate an interactive prototype;
- Written report + demonstration;

Exam (60%):

- See past exam papers on Moodle;

Feedback

Formative feedback

- There will be three lab weeks dedicated to coursework
- Happy to discuss your ideas and progress

Summative feedback

- Will provide whole-class written feedback

Give me feedback too!

- Use the EvaSys surveys to tell me what you liked and disliked

Changes to the Course

Refreshed course content

- Small updates to include recent examples

Added course content

- Created new lecture on location-based interactions

No guest lectures

Will add material on evaluation

- Not part of the course but people wanted advice for coursework

Intended Learning Outcomes

ILO1: “Explain problems associated with human-computer interaction in mobile and ubiquitous usage contexts.”

Key point:

- What are the challenges of mobile interaction?

Intended Learning Outcomes

ILO2: “Critically analyse a proposed mobile interactive system considering its intended usage context”

Key point:

- How appropriate is a design given its intended use?

Intended Learning Outcomes

ILO3: “Design usable mobile interactive systems for a given problem or application area”

Key point:

- What are viable solutions to an interaction design problem?

Intended Learning Outcomes

ILO4: “Develop and evaluate prototypes of mobile interactive systems using a variety of prototyping methods and evaluation techniques”

Key point:

- How do you develop and evaluate your solution?

Intended Learning Outcomes

ILO5: “Discuss cutting edge developments in mobile human-computer interaction, such as context-aware systems, sensor-based interaction, location-based interaction, and mixed reality”

Key point:

- What is the future of mobile human-computer interaction?

Motorola DynaTAC 8000x

Released in 1983

First ‘mobile’ phone

- 30 minutes battery life (after 10 hours charging!)
- Started the ‘Brick’ era
  - Named for size and lack of reliability…

IBM Simon

Released in 1994

First smartphone?

- Had ‘apps’ for email, calendar, notes, etc.
- Touchscreen input (with stylus)

Nokia Communicator 9000

Released in 1996

First smartphone?

- First to render web graphics
  - IBM Simon didn't have a web browser
- Had two screens!
  - When closed, it worked like a normal phone

Nokia 3210

Released in 1999

First ‘fun’ phone, not a ‘business’ phone

- Mobile games, including Snake
- Compose your own ringtones
- Had a precursor to emojis
- Colourful replaceable plastic covers

Motorola Razr V3

Released in 2004

First ‘stylish’ phone:

- Emphasised sleek design and slim profile
- Started the trend of slimmer, lighter phones

Apple iPhone

Released in 2007

First ‘touch’ phone:

- Not really (LG had touchscreens first)
- But Apple made better use of touch, creating a new interaction language based on swiping, scrolling and tapping with multiple fingers

HTC Dream/G1

Released in 2008

First Android phone:

- An ‘open’ attempt to take on Apple’s closed platform
- Form factor mostly unrecognisable now
  - Integrated wheel for 2D pointing
  - Several physical buttons
  - Slide-out keyboard

Then it all got a bit boring…

Over the past 15 years, most new phones were just ‘better’ versions of the same thing…

Mainly hardware improvements:

- Many-core processors, dedicated GPUs
- Co-processors (e.g., activity tracking, machine learning)
- Multi-lens cameras, better image sensors
- Higher resolution screens, higher refresh rates
- Improved battery life and charging protocols

But fundamental interactions have barely changed!

… but new sensors arrived?

New sensors

- Soli radar in Google Pixel 4 (video)
- Grip pressure in Google Pixel 3
- 3D Touch in Apple iPhone 6

New sensors can enable new interaction techniques

- More than just tapping or swiping
- Introduces new design challenges: how do users discover, learn and efficiently use new interaction styles?

Why do new sensors come and go?

Need to balance interaction benefits with integration challenges

- Extra sensors take up space and consume battery

Gesture and pressure sensors not yet widely adopted

- e.g., Apple, Google, Huawei, Samsung released devices with these
- But most have removed them – the benefit doesn't outweigh the cost yet

Speech recognition is now an expected feature

- Sensing hardware already there
- Speech recognition processing is now on-chip, e.g., Google Tensor

… and form factors changed?

New form factors

- Samsung Galaxy Z Fold (top)
- Motorola Razr (right)
- Google Pixel Fold (bottom)

New form factors can support new ways of interacting with content;

- Introduces new design challenges: how do you design apps for screens with several configurations?

… and AI took over?

New AI capabilities

- Everything ‘with AI’

More ‘intelligent’ devices can enhance functionality and reduce need for interaction

- e.g., improved photography
- e.g., taking actions on users’ behalf

These devices don’t really do anything new…

- But now it’s ‘done by AI’

Apple Intelligence

Gemini

But do people care?

Growing weariness around AI

- Everyone is rushing out features
  - At the expense of quality
  - BBC: Apple urged to withdraw ‘out of control’ AI news alerts. 6 Jan 2025.
- Hallucinations and “bullshit”
  - ChatGPT is bullshit. Hicks, Humphries and Slater. In *Ethics and Information Technology (26)* 2024.

‘AI’ better when it’s out of sight?

- e.g., photo improvements
- e.g., digital assistants

What about other devices?

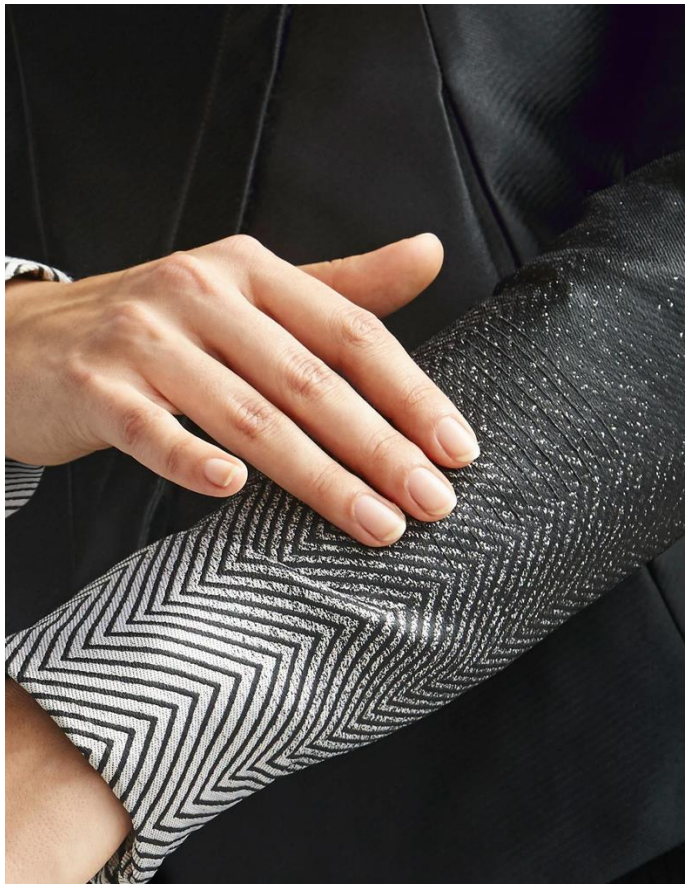
Mobile computing devices are becoming more diverse:

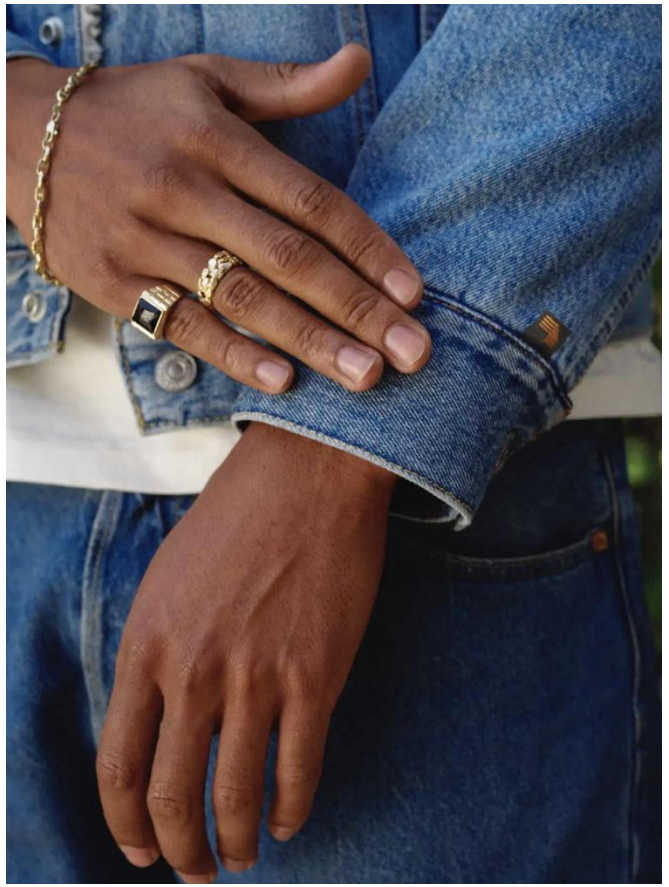
- Held in your hand: phones, tablets, etc
- Worn on the body: watches, rings, glasses, headsets, clothes, etc
- Inside your body?: implants, ‘smart tattoos’, etc
- Vehicles?: cars, bicycles, etc

Example: Interactive Clothing

New sensing methods are changing what ‘computing devices’ look like…

E.g., Project Jacquard from Google sees interaction literally woven into clothing;





Google Project Jacquard: https://atap.google.com/jacquard/

Example: New Sensors for Wearables

Google Project Soli, full video: https://www.youtube.com/watch?v=0QNiZfSsPc0

Example: Augmented Reality

Is it all good?

Is better mobile technology always a good thing?

- New capabilities can enrich our lives, but what are the other impacts?

Computing is now always-on and always with us:

- Difficult to disconnect – impacts on mental health?
- A continuous distraction – impacts on social interaction?
- “There’s an app for that” – relying on tech too much?
- Increased sensing – privacy implications?

“I Forgot My Phone” by Miles Crawford: https://vimeo.com/73085316

Windows Phone advert (2010): https://www.youtube.com/watch?v=4mhrKWVQ0sk

Socially Acceptable?

Source: http://www.metrocf.or.jp/manners/poster.html

Is technology getting in the way?

Suggested (not required) reading:

- There’s Not An App For That by Robinson, Marsden and Jones
- Available via library: https://go.exlibris.link/GQ5W6D0f

Why is mobile interaction challenging?

Interaction is affected by the environment:

- Poor connectivity in rural areas, difficult to type when walking, cannot see the screen when cycling, hard to hear when on the subway, etc.

Users divide their attention with surroundings and other tasks:

- Leading to “fragmented” interaction in “micro-bursts”

Hardware constraints:

- Small screen sizes, limited tactile feedback, lack of device stability, etc.

Mobile HCI Research

ACM Mobile HCI started in Glasgow in 1998;

“MobileHCI seeks contributions in the form of innovations, insights, and analyses related to human-computer interaction and experiences with mobility and beyond. The conference series has shaped research, development, and practice in mobile devices and services for over 20 years. Our interpretation of mobility is inclusive and broadly construed.”

Source: https://mobilehci.acm.org/2019/call-for-papers/

Mobile HCI Research

Form factor and capabilities have changed, but many of the basic interaction challenges have not…

From "User Needs for Mobile Communication Devices" by Väänänen-Vainio-Mattila et al. (Mobile HCI 1998)

Ubiquitous Computing Research

ACM UbiComp started in Seattle in 1998;

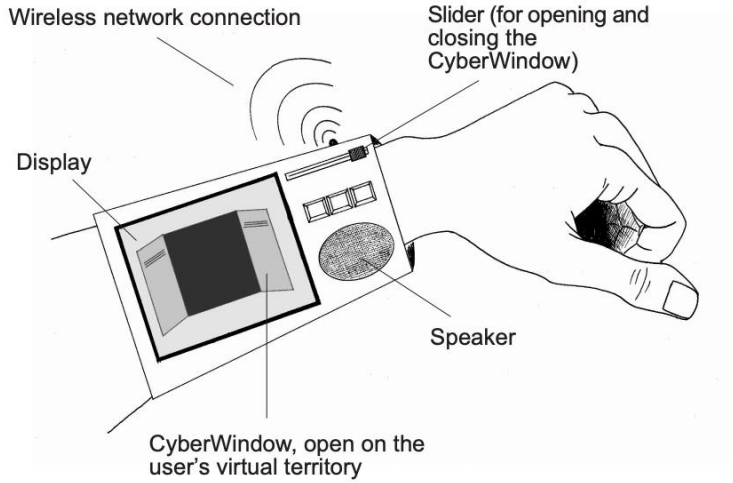


Figure 1. Tentative sketch of a wearable CyberWindow

From "Supporting Social Awareness on the World Wide Web" by Liechti et al. (Handheld CSCW 1998)

See: http://www.teco.edu/hcscw/

Wearable Computing

Lecture Summary

Exciting new features and hardware designs.

- How do we take advantage of these new capabilities?
  - And what are the challenges?

Mobile devices come in all shapes and sizes:

- More than just smartphones…
- What are the new opportunities for interaction?
  - And what are the challenges?

Mobile devices used in different contexts for different purposes:

- How can mobile devices enrich our lives and bring new benefits?
  - And what are the challenges?

Lab Exercise Review

Today's lab was an introduction to mixed-reality prototyping:

- Glitch is a web app deployment platform
- A-Frame is a mixed reality framework for web apps

You should now be able to:

- Position primitive 3D objects relative to the user's perspective
- Change the appearance of primitive 3D objects
- (Optional) Add primitive 3D objects to a fixed 'heads-up display'

Any questions about Lab 1?

Lab Exercise Preview

Next week's lab adds interactivity

Using device orientation (or 'gaze direction') as input

- i.e., activate/select objects by 'looking at' them

AR VR

Lab Exercise Preview

Has a ‘cursor’ in middle of screen to represent gaze direction:

- Defined relative to the camera, not the scene
- Objects inherit properties from their parent
  - When the camera moves, their child objects also move
- Buttons activated using ‘dwell’ – look at them for 600ms

```
<a-entity camera look-controls position="0 1.6 0">
    <a-entity
        ...
        position="0 0 -1"
        geometry="primitive: ring; radiusInner: 0.02; radiusOuter: 0.035"></a-entity>
</a-entity>
```

Lab Exercise Preview

A-Frame provides an event-driven callback interface:

- Mouseenter: cursor overlaps the target for the first time
- Mouseleave: cursor leaves the target
- Click: occurs after the 600ms countdown completes

Do stuff in here

```
AFRAME.registerComponent('button', {
    init: function () {
        element.addEventListener('mouseenter', function () { ... });
        element.addEventListener('mouseleave', function () { ... });
        element.addEventListener('click',      function () { ... });
    }
});
```

Lab Exercise Preview

We use A-Frame components and mixins to reduce duplicate code:

- Objects can be instances of a component
  - Inheriting their behaviours, etc
- Use a schema to initialise component instance values (similar to constructors)

```
AFRAME.registerComponent('button', {
    schema: { item_id: {default: ‘0} }
});

<a-plane ... button="item_id: 1;"></a-plane>
```

Lab Exercise Preview

By the end of next week's lab you should be able to:

- Create basic interaction techniques using event-driven programming
- Use components to provide shared functionality
- Modify scene objects based on user behaviour