(INFOMMOB) Mobile Interaction - 24 june 2020

Course: BETA-INFOMMOB Mobile interaction (INFOMMOB)

Duration:	2 hours
Number of questions:	9

(INFOMMOB) Mobile Interaction - 24 june 2020

Course: Mobile interaction (INFOMMOB)

The exam contains questions from nine areas related to mobile interaction. ***Important***: Each area contains multiple sub-questions; some contain more, others less. Some questions can be answered rather quickly, others might need longer. Thus, make sure to manage your time carefully.

Good luck!

By partaking in the exam you agree to the following CODE OF CONDUCT

This test takes place under special circumstances in which we, even more than usual, rely on your professionalism and integrity. By partaking in this digital exam, you agree to the following code of conduct:

- You are logged in with your own account and take this exam in your own name.
- You will take this exam yourself, without contact or help from others.
- You will not copy, “screen dump”, or otherwise record or distribute questions or answers.
- You will only use permitted tools and resources. In this case, since it is an open book exam, this includes notes, books, printouts, and online resources. You are not allowed to contact and ask other people for help.

By partaking, you also confirm that you are aware of the following things:

- Violation of the aforementioned agreements is regarded as Fraud (see OER art 5.14).
- Answers can be checked for plagiarism.
- The results of this exam are conditional: if deemed necessary, the examiners can invite you for an additional oral exam at a later stage.

Number of questions: 9

1 General aspects of mobile interaction

Note: in the following, short answers are sufficient. In some cases, you don't even have to write full sentences, but some phrases or words could be enough to get full credits.

In the chapter "***Mobile Computing***" of *The Encyclopedia of Human-Computer Interaction*, J. Kjeldskov describes the history of mobile computing by discussing seven waves or trends. One of these trends is **divergence**. Common advantages of this trend include better form factors / ergonomics, better performance, and better interaction.

Digital cameras are a good example for this wave. While you can integrate them into other devices (e.g., smartphones), some people are still using stand-alone cameras instead of smartphones to take pictures. Shortly discuss why with respect to the three potential advantages listed below. That is, explain why these are advantages in this concrete context. *(Be concrete. E.g., for "performance" something generic such as "because they offer better performance than smartphones" is not sufficient, but state what concretely is better or, e.g., bring a concrete example why this higher performance is needed.)*

1 pt. **a.** [max. 1 pt] Form factor / ergonomics:

1 pt. **b.** [max. 1 pt] Performance:

1 pt. **c.** [max. 1 pt] Interaction:

The trend of **convergence** can be seen as the opposite of divergence. ***Mobile music players*** are a good example for this wave. Despite the three advantages of stand-alone devices listed above, nowadays most people use their mobile phones to listen to music. Shortly discuss this, i.e., state why these three advantages are not that relevant in this context.

1 pt. **d.** [max. 1 pt] Form factor / ergonomics:

1 pt. **e.** [max. 1 pt] Performance:

1 pt. **f.** [max. 1 pt] Interaction:

1 pt. **g.** [max. 1 pt] Give one additional convincing reason why stand-alone music players mostly disappeared from the market.

Smartwatches are another successful example for the wave of **divergence**, although many of the features that they offer could easily be provided with a smartphone as well.

1 pt. **h.** [max. 1 pt] Give one feature or functionality that is *offered by both devices*, but it is easier or more convenient to use on a smartwatch rather than a smartphone (other than looking at the time) and thus contributed to the establishment of this new device category.

1 pt. **i.** [max. 1 pt] Give one feature or functionality that is offered by a smartwatch that is *not offered by a smartphone* (or only *in a limited, reduced way*) and thus contributed to the establishment of this new device category.

Because of these advantages, smartwatches have been established as a new device category. Yet, their market share is much lower than the one of mobile phones (meaning there are more smartphones sold than a smartwatches).

1 pt. **j.** [max. 1 pts] Give a convincing reason why this is the case and why it will very likely not change in the future.

Another wave described by J. Kjeldskov is **apps**.

1 pt. **k.** [max. 1 pt] Give one convincing benefit for <u>developers</u> resulting from the wave of apps.

1 pt. **l.** [max. 1 pt] Give one convincing benefit for <u>consumers</u> resulting from the wave of apps.

1 pt. **m.** [max. 1 pt] Give one convincing benefit for <u>scientists</u> resulting from the wave of apps.

2 Sensor Technolog for interaction

Note: Short answers are sufficient. Each of the questions below could be answered correctly with one simple sentence or phrase. Longer answers, if correct, will not give you a deduction, but they are not needed.

Common smartphones usually contain an **accelerometer** and a **magnetometer**. Both sensors can be used for interaction design.

1 pt. **a.** [max. 1 pt] Give an example for an app or a task that uses the accelerometer as sole input (i.e., the input for this task is solely based on the data that you get from this sensor).

1 pt. **b.** [max. 1 pt] Give one common problem with accelerometers.

1 pt. **c.** [max. 1 pt] Give an example for an app or task that uses the accelerometer and the magnetometer as sole input (i.e., the input for this task is solely based on the data that you get from these two sensors and cannot be achieved by using only one of them).

1 pt. **d.** [max. 1 pt] Give one common problem with magnetometers.

Now let's look at a concrete use case, **digital photography**, and how sensors can be used to make it better.

First, let's look at accelerometers. Name two usages of this sensor to improve photography or to make photo taking on your smartphone easier or to allow you to do things that would otherwise be harder if not impossible to do.

1 pt. **e.** [max. 1 pt] First possible usage of accelerometer in digital photography:

1 pt. **f.** [max. 1 pt] Second possible usage of accelerometer in digital photography:

1 pt. **g.** [max. 1 pt] Name one other sensor that is commonly found in today's smartphones and that can be used for digital photography. Name the sensor and shortly explain how or what it is used for. *(Hint: we didn't discuss this in the lecture, but there is actually a very simple answer to this.)*

Some newer smartphones also contain **sensors that measure force** (i.e., higher pressure when, e.g., touching the screen or other parts of the device). In the lecture, we saw several examples on how such sensor information can be used to address various ***problems*** that we sometimes have ***with touch interaction***.

For each of the examples below, shortly state what problem it solves (no need to explain how it is solved; it's sufficient to just state the problem).

1 pt. **h.** [max. 1 pt] The **ForceRay** is an approach that uses force input to select objects during one-handed input. Pressure is used here to solve the following problem:

1 pt. **i.** [max. 1 pt] The **ForcePicker** is an approach that uses force input to pick values from, e.g., long ordered lists. Pressure is used here to solve the following problem:

1 pt. **j.** [max. 1pt] **NanoTouch** is an approach that uses force input to register a click on the back of a (very small) device as input. Pressure is used here to solve the following problem:

3 Mobile evaluation

In this part, we want to look into the evaluation done by Browne and Anand in their paper "**An empirical evaluation of user interfaces for a mobile video game**", which you read in relation to the Mobile Gaming lecture.

To refresh your memory: In their evaluation, they had 36 participants (students and general public, recruited via advertisement, e.g., by mail or Facebook messaging) and ran a controlled lab study where they compared three input methods (simulated button, touch gesture, accelerometer) for a scroll shooter game with quantitative and qualitative measures (questionnaire and user observation).

2 pt. **a.** [max. 2 pts] How would you rate the internal validity of their approach (rather high, okay, rather low)? Give **two** concrete reasons that justify your rating (there might be more, so make sure to pick two convincing ones).

Assume you were one of the authors of this paper and planned the experiment. But a week before it starts, a pandemic breaks out. Now you cannot do the experiment in person anymore but have to run it remotely. You decide to create an app that can be sent to people so they can install it on their phone, run the experiment themselves, and send the gathered data back to you.

3 pt. **b.** [max. 3 pts] Give one useful or necessary change that you would make in the experiment design (other than sending the app to the participants) and shortly state what kind of impact it would have on internal and external validity.

In the simulated button interface, the authors placed the buttons at the bottom portion of the screen. For the accelerometer interface and the touch gestures, this part was left empty.

1 pt. **c.** [max. 1 pt] Why did the authors decide to do this instead of using this empty space to display actual game content?

1 pt. **d.** [max. 1 pt] Give one reason that might speak against their decision, i.e., why one might have done it otherwise and extended the visualization of the game content across the whole screen for the accelerometer interface and touch gestures.

4 Touch screens

In the lecture, we saw different touch screen technologies dealing with the lack of **haptic feedback** that we commonly experience with regular touch screens. These included ***pneumatic displays*** (we saw a reseach prototype of that), ***electrostatic touch screens*** (we saw a video from Disney Research about these), and one that create a more ***sophisticated, richer vibration feedback*** (I mentioned the iPhone's Taptic Engine as an example).

Each of these technologies aim at creating a richer haptic experience, but address different haptic characteristics. For each of them, give one convincing example where you would use this technology.

1 pt. **a.** [max. 1 pt] Example where I would use pneumatic displays:

1 pt. **b.** [max. 1 pt] Example where I would use electrostatic touch screens:

1 pt. **c.** [max. 1 pt] Example where I would use screens that provide a sophisticated, richer vibration feedback:

We also discussed different systems that realized **back-of-device interaction** (i.e., interaction where people could create an input when touching the back of a device). Some use ***optical touch screen technology*** for that, others use ***pressure-sensitive input***.

1 pt. **d.** [max. 1 pt] Shortly explain why these systems cannot use standard touch screens for back-of-device interaction.

1 pt. **e.** [max. 1 pt] Give one **advantage** of using **pressure-sensitive input** compared to optical touch screen technology in the context of back-of-device interaction.

5 Human aspects & UI design

Often, mobile interaction design takes advantage of knowledge about **human perception**. One example is knowledge about how humans perceive ***audio signals***, in particular speech recordings.

If you look at some audio players, such as the iOS player for podcasts, you often find options for faster or slower playback, similar to the fast forward and slow motion feature that we know from video players. For example, the iOS podcast player offers the following options: normal speed, half speed, 1.25x, 1.5x, 2x. (We saw a screenshot of the interface in the lecture slides.)

3 pt. **a.** [max. 3 pts] Shortly explain why they are using these options and not others (e.g., faster playback and more options for slower playback). *(Hint: as the above text suggests, it has to do with human perception.)*

We also talked about playing speech backwards. For example, research has shown that people can still classify the content of a speech recording if small snippets of the signal are played in reverse order. Doing this allows you to implement some sort of "fast backward" playback similar to the fast backward feature for videos.

Yet, if we look at common audio players, we ususally never find this implemented. Instead, they commonly only feature a button that allows for discrete backwards jumps. For example, the aforementioned iOS podcast player has two buttons; one that jumps back during playback for 15 seconds, and one that jumps ahead for 15 seconds.

2 pt. **b.** [max. 2 pts] Shortly explain why this might be the case, i.e., why did the designers decide not to offer users a "fast backward" playback but only discrete backward jumps. *(This part requires some speculation, so different answers may be correct. Just make sure that your reasoning is clear and convincing.)*

RSVP (Rapid Serial Visual Presentation) is an example related to the perception of ***visual signals***. Assume a scenario where RSVP is used to read a larger text (e.g., a long email) on a small display, such as a smartwatch. Give two common problems that RSVP has in such contexts.

1 pt. **c.** [max. 1 pt] First problem:

1 pt. **d.** [max. 1 pt] Second problem:

Mobile phones have rather small displays, which is why researchers have evaluated different options for **data visualization** in the past (e.g., Overview+detail or Focus+Context). Yet, if you look, for example, at the visualization of maps on mobiles, we hardly ever see these visualizations in today's interface designs anymore.

2 pt. **e.** [max. 2 pts] What is the reason why today's map visualizations hardly ever use these visualization techniques?

Another human aspect that needs to be considered in mobile interaction design is **ergonomics.**

1 pt. **f.** [max. 1 pt] Give one example of a human aspect related to ergonomics that mobile interaction designers have to deal with.

6 Interaction design

In the lecture, we looked at four different approaches that all address the same problem that we are often faced with in mobile interaction: **SWiM (Shape Writing in Motion)**, the **ForceRay**, the **ExtendedThumb** approach, and **HeadReach**.

1 pt. **a.** [max. 1 pt] What mobile interaction problem are all these four approaches addressing?

One variation of HeadReach that worked particularly well in the tests is **Head Area + Touch (HA) Selection**. The authors did not compare it with the other three approaches, but there are intuitive reasons to assume that it will have a higher accuracy than any of those.

1 pt. **b.** [max. 1pt] Give one intuitive reason why Head Area + Touch (HA) Selection might have a better accuracy than ***SWiM***.

1 pt. **c.** [max. 1pt] Give one intuitive reason why Head Area + Touch (HA) Selection might have a better accuracy than ***ForceRay***.

1 pt. **d.** [max. 1pt] Give one intuitive reason why Head Area + Touch (HA) Selection might have a better accuracy than ***ExtendedThumb***. *(Note: The BezelCursor used for comparison in the HeadReach paper is very similar to the ExtendedThumb approach. Yet, you do not need to address the concrete results or numbers here. If you remember how the ExtendedThumb approach was implemented, there is an obvious reason why it might be less accurate in a test.)*

Now let's compare these four techniques in relation to ***ergonomics***. For each of the following approaches, name one ergonomics-related problem.

1 pt. **e.** [max. 1pt] Potential ergonomic problem for ***SWiM***:

1 pt. **f.** [max. 1pt] Potential ergonomic problem for ***ForceRay***:

1 pt. **g.** [max. 1pt] Potential ergonomic problem for ***ExtendedThumb***:

Name one non-ergonomic-related ***disadvantage*** that the ***HeadReach*** approach could have compared to one of the other approaches. *(Just pick whichever one of the three you want and give an obvious potential disadvantage that HeadReach might have compared to it; it should be non-ergonomic-related, because otherwise you could possibly just copy-paste from above).*

1 pt. **h.** [max. 1 pt] Approach and related ***disadvantage of HeadReach*** compared to it:

7 Mobile gaming

Give one common touch screen and touch interaction problem that is particularly critical for mobile gaming (i.e., a general problem that is even worse for mobile gaming). Shortly explain why this can cause even more issues in context of mobile gaming. *(I mentioned one in the lecture, but there are plenty more.)*

1 pt. **a.** [max. 1pt] Problem and reason why it might be more critical in a mobile gaming context:

Two approaches for interaction in mobile games are **on-screen buttons** and **touch gestures**.

1 pt. **b.** [max. 1pt] Give one ***advantage of touch gestures*** compared to on-screen buttons:

1 pt. **c.** [max. 1pt] Give on ***advantage of on-screen buttons*** compared to touch gestures:

1 pt. **d.** [max. 1pt] Give one example where **interaction based on tilting** your mobile phone is obviously the best interaction mode and shortly explain why. *("Obviously the best" is debatable, so make sure that your explanation is convincing, unless it is really super-obvious.)*

Diegesis theory is an interface design theory that is often used in video games. It distinguishes between ***non-diegetic representations, spatial representations, meta representations,*** *and* ***diegetic representations.***

1 pt. **e.** [max. 1 pt] Assume you are implementing a soccer game for a mobile phone. A designer suggests to display the score of the game and the remaining game time on a digital billboard that is placed inside the stadium, similar to how you would see it in the real world. Which of the four types defined by diegesis theory does this approach correspond to? Name it and shortly explain why.

1 pt. **f.** [max. 1 pt] Give one possible advantage of this option.

1 pt. **g.** [max. 1 pt] Now assume another designer proposes to have the game score and remaining time permanently displayed at a fixed location on top of the screen, independent of the rest of the game visualization. Which of the four types defined by diegesis theory does this approach correspond to? Name it and shortly explain why.

1 pt. **h.** [max. 1 pt] Give one possible advantage of this second option.

1 pt. **i.** [max. 1 pt] In most mobile soccer games, the second option is chosen. Shortly explain why.

8 Mobile 3D interaction

In the lecture, we discussed how you can use your smartphone together with a dedicated case such as Google Cardboard to create a virtual reality (VR) head-mounted display. We discussed why it is possible to create a perfect VR experience when you are looking around. Yet, we also stated that you cannot update the graphics in VR correctly when you start walking.

1 pt. **a.** [max. 1pt] Give a short explanation why this is the case.

Fishtank VR is an approach for 3D visualizations on mobiles that creates a better, more realistic 3D effect.

1 pt. **b.** [max. 1] Shortly explain why it is justified to say that it is “more realistic” than standard 3D graphics.

1 pt. **c.** [max. 1] Give one example of an app with a 3D visualization where using Fishtank VR makes sense and would likely be an improvement. Shortly explain why.

1 pt. **d.** [max. 1] Give one example of an app with a 3D visualization where using Fishtank VR does not make sense and would likely not be an improvement. Shortly explain why.

In his research proposal “**Body-centric interaction with Mobile Devices**,” Xiang ‘Anthony’ Chen introduces a design space for Body-Centric Interactions (BCI). One dimension of this design space is ***input measure***, which can be either discrete or continuous.

1 pt. **e.** [max. 1pt] Give a useful example (e.g., an app or task) for BCI implemented on a mobile phone where one would obviously use a discrete input measure. *(Shortly explain why because the term “obviously” can be subjective.)*

1 pt. **f.** [max. 1pt] Give a useful example (e.g., an app or task) for BCI implemented on a mobile phone where one would obviously use a continuous input measure. *(Shortly explain why because the term “obviously” can be subjective.)*

In the accompanying video about BCI, Xiang ‘Anthony’ Chen also demonstrates different examples for BCI with mobile devices. Some of those could be implemented on a state-of-the-art smartphone, while others would need additional hardware.

1 pt. **g.** [max. 1pt] Give one example that can not be implemented on a state-of-the-art smartphone and shortly explain why.

1 pt. **h.** [max. 1 pt] Give one potential advantage that BCI on a mobile phone could have compared to swiping or scrolling.

9 Mobile AR

Augmented Reality (AR) can be created in different ways. For example, with head-mounted displays (HMDs) or with smartphones (**mobile AR**).

1 pt. **a.** [max. 1 pt] Give one potential *advantage* of mobile AR compared to AR with HMDs.

1 pt. **b.** [max. 1 pt] Give one potential *disadvantage* of mobile AR compared to AR with HMDs.

According to the definition of R. Azuma, AR "combines real and virtual".

1 pt. **c.** [max. 1 pt] How is the real part of our environment represented in mobile AR?

For the virtual part, Azuma also states that it needs to be "registered in 3D". For Mobile AR, we can distinguish different implementations or levels of sophistication depending on how well this registration in 3D is supported or not.

2 pt. **d.** [max. 2 pts] Give one example of a useful implementation that would commonly be considered as mobile AR, but technically does not fulfill the "registered in 3D" criteria. Explain what sensors you need (in addition to the camera) to create your mobile AR example (use the minimum amount of sensors needed).

3 pt. **e.** [max. 3 pts] Give an example of a mobile AR app that would clearly qualify as AR according to the definition of Azuma. Shortly describe your example, then list all three criteria from Azuma's definition and explain why they are fulfilled. Also list the sensors that are needed to do this and shortly state what they are used for.

Probably the most common way to do **interaction** in mobile AR is via ***ray casting*** or ray picking.

1 pt. **f.** [max. 1 pt] Explain in your own words how selection of an object works when using ray casting.

There are many approaches on how to manipulate 3D objects (e.g., rotate them, translate them, scale them) via ***touch screen gestures***. Yet, they are hardly used to manipulate 3D objects in mobile AR.

1 pt. **g.** [max. 1 pt] Shortly explain why.

Two techniques that are used to manipulate 3D objects in mobile AR are ***3DTouch*** and ***HOMER-S***. (They both have been introduced by the same researchers; we saw a video in the lecture comparing them).

2 pt. **h.** [max. 2 pt] Shortly explain the essential difference between these two approaches.

Interaction in mobile AR can also be done by ***tracking your fingers*** and using them to, for example, select and manipulate virtual 3D objects directly in the AR world.

1 pt. **i.** [max. 1 pt] Give one potential *advantage* of this interaction approach for mobile AR.

1 pt. **j.** [max. 1 pt] Give one potential *disadvantage* of this interaction approach for mobile AR.

Thank you for participating in the course.
I hope you enjoyed it.
Now have a nice summer vacation & stay safe!

PS: If you haven't done so already, please fill out the Caracal evaluation to help me improve the course. Thanks!