[20210628] INFOMMOB - Mobile interaction - 4 - HOME

Cursus: BETA-INFOMMOB Mobile interaction (INFOMMOB)

Tijdsduur:	2 uur
Aantal vragen:	9
Gegenereerd op:	27 jun. 2021

Inhoud: Pagina's:

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EXAM CONTENT AND DURATION

The exam contains nine questions, each with several sub-questions. Be aware that some questions have lots of sub-questions, others have much less. You can go back and forth between the questions and are not needed to answer them sequentially.

You have 120 minutes and can get a maximum of 84 points. Notice that the points do not necessarily reflect the level of difficulty of the sub-question. Therefore, it might well be that a sub-question that gives you the similar number of credits than another one can take longer to answer.

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 during or after the exam.
- You will only use permitted tools and resources. In this case, since it is an open book exam, these are notes, books, printouts, and online resources.

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.

Good luck with the exam!

Aantal vragen: 9

In totaal zijn 84 punten voor deze toets te behalen, 42 punten zijn nodig om voor de toets te slagen.

1 General aspects of mobile interaction

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. Two of these trends are **divergence** and **convergence**.

Divergence means that you are using devices that are optimized for a particular purpose (e.g., an MP3 player for listening to music), whereas convergence means that you are using a multipurpose device that offers this functionality as well (e.g., listening to music on your smartphone).

0 pt. **a.** Give a good example for divergence, that is, an example for a non-multipurpose mobile device (i.e., not a smartphone) that some people still use these days for certain tasks.

Important: *This answer gives 0 points because it is just needed to answer the following three sub-questions. Make sure to read them all before answering!*

1 pt. **b.** [max. 1 pt] Give one performance-related reason related to your example why people are doing this, i.e., are not using their smartphone although they could technically do these tasks on a smartphone as well.

1 pt. **c.** [max. 1 pt] Give one ergonomics-related reason related to your example why people are doing this, i.e., are not using their smartphone although they could technically do these tasks on a smartphone as well.

1 pt. **d.** [max. 1 pt] Give one good reason why others might not use such a dedicated device but prefer to do these tasks on their smartphones despite the advantages that you listed above.

Another trend described by Kjeldskov is **connectivity**. Although he introduces these trends as “waves” (suggesting a sequential impact), there are also dependencies between them.

1 pt. **e.** [max. 1 pt] Give one example how connectivity impacted divergence and convergence. That is, give an example where people nowadays commonly decide either for divergence (i.e., use a dedicated device) or for convergence (i.e., use their smartphone for this) and connectivity is a major if not the sole reason for this.

A good example for divergence versus convergence is mobile MP3 or music players, such as the iPod. In the early 2000s, they were very popular. Yet, nowadays, most people do not use them anymore but playback music on their phones.

1 pt. **f.** [max. 1 pt] Give one convincing reason why many people still used these standalone devices to playback music until the mid-2000s despite also owning a mobile phone.

1 pt. **g.** [max. 1 pt] Give one convincing reason why even people who preferred to carry around two devices (mobile music player and mobile phone) in the mid-2000s have now mostly abandoned the first and solely use their smartphones for playing music when they are on the go.

The final wave described by Kjeldskov is **digital ecosystems** where we have an interplay of multiple digital entities that are connected to each other. Let’s have a look at this in relation to divergence and convergence using the two devices “smartwatch” and “smartphone.”

1 pt. **h.** [max. 1 pt] Give a convincing example for a task, app, or functionality where you would rather use a smartwatch and not a smartphone (i.e., an example for divergence).

1 pt. **i.** [max. 1 pt] Give a convincing example for something that you can do on a smartwatch, but the benefit for most people will not be high enough to motivate them to carry one, because they can do the same task reasonably well on their smartphone (i.e., an example for convergence).

1 pt. **j.** [max. 1 pt] Give a convincing example for a task, app, or functionality where people want to use both devices, that is, a smartphone and a smartwatch together (i.e., take advantage of the digital ecosystem that is created by wirelessly connecting your smartwatch with your mobile phone).

Kjeldskov also discusses the role of **context** in mobile interaction. In the lecture, we also had many situations where we stated that context can make the interaction design more difficult. But we also saw examples where context can be used in a beneficial way. Let's have a look at this in relation to maps (e.g., Google Maps on Android or Apple Maps on iOS).

1 pt. **k.** [max. 1 pt] Give a convincing example where context is used in a beneficial way in mobile interaction with maps. That is, give a concrete map-related task, and then shortly describe how context is used in a beneficial way here.

1 pt. **l.** [max. 1 pt] Give a convincing example where context can create problems in mobile interaction with maps. That is, state a concrete map-related task, shortly describe the context and why this context can cause problems or make the task more difficult.

2 Sensor technology for interaction

Modern smartphones contain many sensors that can be used for interaction. Two of them are **accelerometer** and **gyroscope**.

A short decription is sufficent for the following two sub-questions.

1 pt. **a.** [max. 1 pt] Give a mobile interaction example where the accelerometer and gyroscope are used for <u>active input</u> (i.e., the user actively makes changes to modify the input coming from these sensors). The information that you get from these two sensors should be the sole input. No other sensor should be needed to perform the input that you are describing.

1 pt. **b.** [max. 1 pt] Give an interaction example where the accelerometer and gyroscope are used for <u>passive input</u> (i.e., the phone passively senses the input coming from the environment). The information that you get from these two sensors should be the sole input. No other sensor should be needed to perform the input that you are describing.

Imagine you want to use **tiling** as method for <u>one-handed input</u> to make selections from a pie menu. To guarantee that users can have a stable grip of the phone while tilting you do not want to use any other kind of input, that is, you do not want to use, for example, touch but solely rely on the tilting actions.

2 pt. **c.** [max. 2 pts] What is the problem with this idea? Give a possible solution to it, that is, shortly describe how you would implement it.

Hint: We saw an example in the lecture. Yet, there are other ways to approach this problem, and every convincing answer will give full credits.

3 Mobile evaluation

User studies can be done in different ways. For example, in a controlled lab environment (**lab study**), by studying people's behavior during their daily life (**field study**), and, especially in mobile interaction research, by uploading an app to their phones, so they can do the study remotely by themselves (**remote study**). For each of these three study types, give an example from mobile interaction research and shortly state why you suggest that this is the best way to do this type of research.

Make sure that your answers address a mobile interaction problem and not a general HCI topic. Also, be specific. Generic answers, such as "I would use this study type to get a higher internal validity" will give no credits, but it must be clear why a high internal validity is important in this case. A short answer is sufficient if it is clear what you mean. You can also refer to examples from the lecture. No description of the research example is needed then if it is clear which one you mean. Make sure that it is a convincing example, that is, it must be clear why this type of study is the best for it.

2 pt. **a.** [max. 2 pts] Give a mobile interaction research example for which you would use a lab study and shortly explain why it is best to do this research in this way.

2 pt. **b.** [max. 2 pts] Give a mobile interaction research example for which you would use a field study and shortly explain why it is best to do this research in this way.

2 pt. **c.** [max. 2 pts] Give a mobile interaction research example for which you would use a remote study and shortly explain why it is best to do this research in this way.

4 Touch screens and touch interaction

In the lecture, we saw a video introducing "**TapBoard**", an approach that, according to the related paper's authors, makes "a touch screen keyboard more touchable".

1 pt. **a.** [max. 1 pt] Which common touch screen problem is this approach addressing and why is this a problem?

1 pt. **b.** [max. 1 pt] Give another context or example other than typing on a keyboard where this issue can affect interaction negatively, too, and shortly explain why.

Hint: I mentioned one in the lectures, but any convincing one will give full credits. Note that it is not necessary that the example can be resolved with the approach proposed by the authors. The question is solely about the problem. In fact, the example that I gave in the lectures suffers from the same problem, but the authors' approach would not resolve it.

We also discussed different **alternative touch technologies**. Can any of the following two resolve this problem as well? Answer with "yes" or "no" if it can be resolved with it or not, respectively, and shortly explain your answer.

1 pt. **c.** [max. 1 pt] Can optical touch screens (e.g., the ones used in the interactive tables by Microsoft or one back-of-device approach that we saw) resolve this problem? Why or why not?

1 pt. **d.** [max. 1 pt] Can electrostatic touch screens (e.g., the one that we saw from Disney Research) resolve this problem? Why or why not?

Another problem with common touch technology (i.e., capacitive touch screens that are used in most mobile phones and tablets) is that they do not provide a **hovering mode** (also known as the "Midas touch problem").

You might want to read the four following sub-questions before answering the first one, since the answers should all relate to the example that you will be giving in the first sub-question.

1 pt. **e.** [max. 1 pt] Give one example where this is a problem.

1 pt. **f.** [max. 1 pt] Is it possible to have a pure software-based solution for the example that you gave? Answer with "yes" or "no" and shortly explain why.

1 pt. **g.** [max. 1 pt] Is it possible to implement a solution for the example that you gave if you are using optical touch screen technology instead of a capacitive touch screen? Answer with "yes" or "no" and shortly explain why.

1 pt. **h.** [max. 1 pt] Is it possible to implement a solution for the example that you gave if you are using pressure sensitive touch screen technology instead of a regular capacitive touch screen? Answer with "yes" or "no" and shortly explain why.

5 Human aspects & UI design

In the lecture, we discussed human perception and how we can take advantage of human capabilities in interface design. One of them is the ability to still process information that is presented rather fast. For example, **speech recordings** can still be processed to some degree even if they are played faster, slower, or even backwards (if some related signal processing is done).

Let's look at this in the context of learning. In particular, imagine a scenario where a student wants to learn with speech recordings (e.g., to gather new knowledge, to prepare for an exam, etc.).

Short answers are sufficient below. You only need to provide one use case or situation. No detailed elaboration is needed, as long as your anwer reflects that you understood the matter at hand.

1 pt. **a.** [max. 1 pt] What advantage would it have to play speech at a 1.5 times faster playback rate in this context, that is, what are good use cases where this could be useful in relation to learning? Give one concrete example or use case.

1 pt. **b.** [max. 1 pt] What advantage would it have to play speech at a 2 times faster playback rate in this context, that is, what are good use cases where this could be useful in relation to learning? Give one concrete example or use case.

1 pt. **c.** [max. 1 pt] What advantage would it have to play speech at a 0.7 times slower playback rate in this context, that is, what are good use cases where this could be useful in relation to learning? Give one concrete example or use case.

1 pt. **d.** [max. 1 pt] What advantage would it have to play speech backwards in this context, that is, what are good use cases where this could be useful in relation to learning? Give one concrete example or use case.

If we are not dealing with speech recordings but with transcribed text, **RSVP (Rapid Serial Visual Presentation)** can be used for reading it faster. Again, let's look at an example from learning. Imagine the text is the transcript of a lecture or presentation.

Again, short answers are sufficient in the following. No detailed elaboration is needed if your answer makes it clear that you understood the matter at hand.

1 pt. **e.** [max. 1 pt] Give one good and convincing use case, situation, or scenario related to learning where using RSVP with such documents would be useful or may have a benefit.

1 pt. **f.** [max. 1 pt] Give one good and convincing use case, situation, or scenario related to learning where using RSVP with such documents would not be useful or may even have a negative effect.

Most phones contain some hardware that allows developers to provide output to the user in form of simple **vibrations**. While some higher-end smartphones have hardware that can create rather sophisticated vibration signals, most phones only offer the opportunity for rather simple vibration output.

Give three mobile interaction examples for which such rather simple haptic stimuli in the form of vibrations can be used for. First, state what it is used for, then give a convincing example that illustrates this with a concrete use case or context.

Questions are split in two parts to make it easier to answer and grade them. Complete the first *sentence and then provide an example for it. Short statements should be sufficient to get full credits.*

1 pt. **g.** [max. 1 pt] First answer (part 1):

Vibration feedback can be used to ...

1 pt. **h.** [max. 1 pt] First answer (part 2)

A good example for this would be:

1 pt. **i.** [max. 1 pt] Second answer (part 1):

Vibration feedback can be used to ...

1 pt. **j.** [max. 1 pt] Second answer (part 2)

A good example for this would be:

1 pt. **k.** [max. 1 pt] Third answer (part 1):

Vibration feedback can be used to ...

1 pt. **l.** [max. 1 pt] Third answer (part 2)

A good example for this would be:

Interaction is not just about perceiving but also about actively giving input to the system that we are interacting with. Limiting human factors that we must consider in interaction design include **ergonomics** and the human **motor system**.

1 pt. **m.** [max. 1 pt] Give one example for a limitation or characteristic of the <u>human motor system</u> that may pose a problem that designers of mobile phone apps should be aware of and consider in mobile interaction design.

1 pt. **n.** [max. 1 pt] Give one example for a limitation or characteristic related to <u>ergonomics</u> that designers of mobile phone apps should be aware of and consider in mobile interaction design.

6 Interaction design

Touch is a very powerful interaction method. But it also has some shortcomings and problems that researchers and designers aim to overcome with new hardware and clever solutions on the software side. One of these innovations is **back-of-device interaction**. (i.e., a hardware extension that also registers touch input on the back of the device, not just on the touch screen at its front).

1 pt. **a.** [max. 1 pt] Give one touch interaction problem that could be solved with back-of-device interaction. State the problem and shortly explain how or why back-of-device interaction would solve it.

1 pt. **b.** [max. 1 pt] Give one problem that is introduced with back-of-device interaction but does not exist with standard touch interaction or becomes more critical in this context.

The two papers "**HeadReach**: Using head tracking to increase reachability on mobile touch devices" by Voelker et al. and "**ForceRay**: Extending Thumb Reach via Force Input Stabilizes Device Grip for Mobile Touch Input" by Corsten et al. both address the same problem that we often have when using touch to interact with our mobile phones.

1 pt. **c.** [max. 1 pt] What problem is that? Shortly describe it.

Both use different hardware to create their solution. Shortly describe what they are doing.

A detailed description of the methods is <u>not</u> required. Just a short illustration of the techniques highlighting what hardware they use to create it and the <u>basic idea</u> behind their solutions is sufficient. For example, you do <u>not</u> have to explain the different implementations that they tested in the HeadReach paper.

1 pt. **d.** [max. 1 pt] How does the <u>ForceRay</u> approach work, that is, what is the basic idea here and what additional hardware support are they using (beyond regular touch input)?

1 pt. **e.** [max. 1 pt] How does the <u>HeadReach</u> approach work, that is, what is the basic idea here and what additional hardware support are they using (beyond regular touch input)?

Compare both approaches with respect to **ergonomics**. That is, for each of them, list one potential disadvantage that they might have compared to the other from an ergonomics perspective.

No detailed elaboration needed, but make sure that you list an aspect that is characteristic for the respective approach. You will not get credits for listing a general ergonomic issue that can potentially apply to both approaches.

1 pt. **f.** [max. 1 pt] One potential ergonomic problem with the <u>ForceRay</u> technique is:

1 pt. **g.** [max. 1 pt] One potential ergonomic problem with the <u>HeadReach</u> technique is:

In the lecture, we discussed that most touch gestures can be categorized into either being (a) gestures for direct manipulation, (b) abstract gestures that are done in context with the content they are manipulating, or (c) abstract gestures that are unrelated to any content.

We can also apply this categorization to **kinetic gestures**. Give one example for a kinetic gesture done with a smartphone for each of these three categories.

A short answer is sufficient. It should be clear what gesture you mean, but there is no need to describe it in detail.

1 pt. **h.** [max. 1 pt] A kinetic gesture that is representative for a direct manipulation gesture is:

1 pt. **i.** [max. 1 pt] A kinetic gesture that is representative for an abstract gesture done in context with the manipulated content is:

1 pt. **j.** [max. 1 pt] A kinetic gesture that is representative for an abstract gesture unrelated to any content is:

7 Mobile gaming

In game UI design, the so-called **Diegesis theory** is often used to describe individual interaction elements by categorizing them into four different groups. One of them is diegetic representations.

1 pt. **a.** [max. 1 pt] Shortly describe what it means if we say that an interaction element in a game uses a diegetic representation.

1 pt. **b.** [max. 1 pt] Give one concrete example for a diegetic representation in relation to video games.

There is no need to describe the game, but just a short description of the element is fine. Make sure that it is clear why this is a diegetic representation since there are many borderline cases. If you think that your example may not be obvious, you can add a short explanation.

1 pt. **c.** [max. 1 pt] Give one advantage of diegetic representations in relation to mobile gaming.

You can refer to the previous example, but you do not have to. A general advantage is fine, too.

1 pt. **d.** [max. 1 pt] Give one disadvantage of diegetic representations in relation to mobile gaming.

You can refer to the previous example, but do not have to. A general disadvantage is fine, too.

The **fat finger problem** is a common issue that we are faced with when interacting with touch screens. In the following, we want to address this in relation to mobile gaming, in particular **onscreen controllers**.

The fat finger problem occurs because our fingers are generally bigger than the area that we want to touch (which can be as small as a few pixels). That actually results in two potential issues. What are these?

Two short phrases are sufficient to answer this. You are welcome to explain these issues, but if your phrases are correct, an explanation is not needed.

1 pt. **e.** [max. 1 pt] First issue resulting from the fat finger problem:

1 pt. **f.** [max. 1 pt] Second issue resulting from the fat finger problem:

1 pt. **g.** [max. 1 pt] Now let's investigate the first issue that you listed above in relation to onscreen controllers. Does this part of the fat finger problem apply here? If not, why? If yes, is it more, less, or equally critical compared to regular touch interaction tasks, such as texting? Shortly explain your answer.

1 pt. **h.** [max. 1 pt] Now the same question for the second issue that you listed above. Does this part of the fat finger problem apply here? If not, why? If yes, is it more, less, or equally critical compared to regular touch interaction tasks, such as texting? Shortly explain your answer.

One problem with onscreen controllers for mobile games is "drifting".

2 pt. **i.** [max. 2 pts] Shortly explain in your own words what this means and why it happens for onscreen controllers but not with regular controllers when we play console games.

Now let's assume we decide to replace the onscreen controller with **tilting** as input.

1 pt. **j.** [max. 1 pt] Does the fat finger problem (both issues) still apply? If not, why? If yes, how?

1 pt. **k.** [max. 1 pt] Give one obvious potential disadvantage that tilting might have compared to an onscreen controller.

“Obvious” means that it should be a convincing example (there are several). A detailed explanation is not needed, but make sure that your answer is not just a general disadvantage of tilting for games but a clear disadvantage compared to onscreen controllers.

8 Mobile 3D interaction

High processing power allows us to create **3D environments** on smartphones. Yet, they still do not look like we perceive our real environment, even if they were almost photorealistic. Give two reasons why this is the case.

Hint: If you do not know it immediately, a peek at the next question may help.

1 pt. **a.** [max. 1 pt] First reason:

1 pt. **b.** [max. 1 pt] Second reason:

Fish tank VR and **Shoebox VR** are two 3D visualization techniques that we can use on mobiles and that aim to make 3D graphics appear more realistic.

1 pt. **c.** [max. 1 pt] What problem of standard 3D graphics are they addressing?

You can repeat your answer from above if you listed it there as one of the two reasons.

Fish tank VR and Shoebox VR are comparable, but they address this issue in a different way, also resulting in differences in the actual usage.

1 pt. **d.** [max. 1 pt] One difference between Fish tank VR and Shoebox VR is the hardware, i.e., the sensor technology that they use to achieve the 3D effect. For each of them, list what hardware that is.

1 pt. **e.** [max. 1 pt] Utilizing this different hardware also has consequences for the usage. Shortly describe the biggest difference when using Fish tank VR versus Shoebox VR.

1 pt. **f.** [max. 1 pt] Give one good use case or example where Fish tank VR or Shoebox VR would be an improvement or likely add to the experience when using this 3D app.

Another 3D interaction technique we addressed in the lectures is **Fixed world VR**. People often call this approach intuitive in situations where you are interacting with data or objects placed around you (like in several of the examples that you saw in the two papers about Body Centric Interaction) or where the data is "surrounding you" (like in the compass mode of Google Streetview).

1 pt. **g.** [max. 1 pt] Shortly explain why it is justified in such situations to call this approach "intuitive".

1 pt. **h.** [max. 1 pt] Shortly explain why this is not necessarily true when you are interacting in all three dimenstions, that is, not just left/right and up/down, like in the examples above, but also in depth, i.e., when you move your phone closer or further away from you.

Many 3D interaction techniques, including the ones discussed above plus several others that we talked about in the lectures, rely on modifying the 3D visualization based on how we move our device.

Make sure to read both sub-questions below before answering, since their answers must relate to each other.

1 pt. **i.** [max. 1 pt] Give one convincing example where you would move the 3D visualization to the left based on a certain motion of the device.

1 pt. **j.** [max. 1 pt] Give one convincing example where you would move the 3D visualization to the right based on the very same input, i.e., the very same motion of the device than in your example in the previous sub-question.

9 Mobile Augmented Reality (AR)

Mobile AR combines virtual elements with the real world surrounding us.

1 pt. **a.** [max. 1 pt] How is the "real" part of AR represented in mobile AR?

We can distinguish between different "incarnations" of mobile AR, depending on how well the virtual objects are integrated into the real environment.

3 pt. **b.** [max. 3 pts] Give a useful example for a mobile AR app, use case, or functionality, where it is totally sufficient, if not better, to just "superimpose" the virtual objects onto the representation of the real world. Shortly explain why this is sufficient (or better) in this context. Finally, describe all the sensors that are needed to create this type of mobile AR and what for.

A short answer should be sufficient, but make sure that it is convincing and do not forget any of the sensors and why they are needed.

3 pt. **c.** [max. 3 pts] Give a useful example for a mobile AR app, use case, or functionality, where it is important, if not essential, to "perfectly" integrate the virtaul objects into the representation of the real world (or, in technical terms, to achieve full 3D registration). Shortly explain why this is needed in this context. Finally, describe all the sensors that are needed to create this type of mobile AR and what for.

A short answer should be sufficient, but make sure that it is convincing and do not forget any of the sensors and why they are needed.

2 pt. **d.** [max. 2 pts] Shortly discuss your two examples with respect to Azuma's definition of AR. Do they fulfill all three criteria or not?

A short answer is sufficient.

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!