[20210628] INFOMMOB - Mobile interaction - 4 - HOME

Cursus: BETA-INFOMMOB Mobile interaction (INFOMMOB)

Exam questions including some comments on the solutions
(not proofread, thus no guarantee for correctness)

Tijdsduur: 2 uur

Aantal vragen: 9

Gegenereerd op: 27 jun. 2021

Inhoud: Pagina's:

[20210628] INFOMMOB - Mobile interaction - 4 - HOME

Cursus: Mobile interaction (INFOMMOB)

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.

Obviously, there are different ways to answer the above questions correctly. One could be:

a. Camera for picture taking

b. Optics / better zoom, exchangeable lenses
(*A smartphone’s form factor does not allow for integration of such hardware which has an impact on performance / picture quality*)

c. Better grip
(*A smartphone’s form factor is not optimized for a stable hold when taking pictures, esp. when you take a photo with just one hand*)

d. You don’t have to carry around a second device.
(*That’s an obvious, “easy”, and generic answer. More sophisticated answers that are directly related to this example include:*
Despite these disadvantages, smartphones also offer advantages that regular cameras cannot provide (e.g., online connectivity for photo sharing, picture taking support (see examples from lecture). For some people, these advantages outweigh the ones speaking in favor of a stand-alone camera.)

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.

Again, multiple correct answers exist. Maybe the most obvious one is:

Music players pretty much disappeared from the market also due to flat rates and services such as Spotify.

Another one could be:

The decrease in sales for consumer cameras was impacted by the fact that many people want to instantly share photos on social media when taking them, which motivates them to use a smartphone.

A few people brought examples in the other direction (i.e., how connectivity fostered divergence), which was nice (but not required; one example was sufficient to get full credits). A good example for that direction is that due to local area networks (e.g., Bluetooth connections), you can also access the internet on other devices (watches, smart speakers, fitness trackers) which would have limited functionality without such online access and thus likely not being used but done with your phone instead.

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.
Several correct answers exist. Larger storage could be one of them.

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.
Today, most people listen to music via services such as Spotify, resulting in a need for connectivity (which is usually not provided by stand-alone music players) and no need for large storage spaces anymore.

General comment: you could have used the same answer for e. above and f/g. here. Nothing wrong with that, since it shows that you can apply the knowledge in different contexts (here, different ways to express a question). But of course, nothing wrong with giving two different examples either.

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).

Various examples exist here. Important for a correct answer is that for the first two parts, it is obvious and convincing that the respective device is the better one for this task. For the last, it is important that the interplay of both devices offers a clear benefit over just using one of them. Most people brought examples from fitness tracking for the first and the last, which is indeed a good case (if the example was explained correctly).

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.
Possible answers include considering location and personal preferences when displaying information (e.g., about restaurants).

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.
An obvious answer would be the physical context that a person is in (traffic, etc.) that could make it dangerous to interact with your device (distraction, etc.).

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 active input (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.

Many correct answers exist. Here an example:

Car racing game: The user actively tilts the phone, and these tilt motions are mapped to steering actions of the car in the game.

*Some people said "*Switching from portrait to landscape mode*" which is probably the simplest example and absolutely correct. Most people did indeed bring the car racing example. It was sufficient btw. to just state, for example, "a car racing game" to get full credits.*

1 pt. **b.** [max. 1 pt] Give an interaction example where the accelerometer and gyroscope are used for passive input (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.

Again, many correct answers exist. This question was basically related to the "phone sensing" paper from lecture 2, where several examples are discussed. Here one possible answer:

Step counter: The phone passively measures changes from the accelerometer in the user's pocket while walking and makes an estimate of the number of steps done.

Unfortunately, several people did not make the connection to the paper and thus gave no or wrong answers. It was sufficient btw. to just state, for example, "a step counter" to get full credits.

Imagine you want to use **tilting** as method for one-handed input 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.

The problem here is that there is no hovering mode, which makes it difficult how to decide when a selection is made or not. We saw one solution in the lecture when looking at the "tilting as input for a smartwatch" example (they used two "zones"). Other solutions exist, too.

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.

There are many ways to answer these questions correctly. The comments below just illustrate one possible approach. Several people used very different examples and explanations and got full credits.

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.

Anything where you need to eliminate external influences as much as possible (i.e., reach high internal validity). The experiments related to the "perception of visual information depending on a particular parameter" that we discussed in the lecture come to mind. (E.g., How well can people recognize images at very small sizes? How well can people read text at different sizes while walking? How well can people solve tasks with screens with different PPI? It is important here to have comparable conditions, e.g., same distance from screen in the last two cases, same phone resolution and PPI in the first one.)

Some mentioned experiments that need additional equipment, e.g., for gaze tracking, which is correct, too, since those would be hard if not impossible to use in the other two cases.

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.

Anything where measuring your data under real-world conditions that you cannot easily replicate in a lab setting. The experiment with different vibration feedback when typing comes to mind. (They actually got different results in their field study than in the comparable lab study, which clearly shows why a field study is necessary here.) E.g., something like this could be a good answer:

When the focus of your study is something that can hardly be recreated in a lab study, e.g., studying mobile interaction behavior in public transport (e.g., while riding a bus), but a remote study would introduce too much noise or confounding variables.

Many people did not clearly highlight the difference between field studies and remote studies. If the explanation made it clear that they understood these differences well enough, they still got almost or even full credits. Larger deductions though for answers that could basically have been copied to the next sub-question and would still be correct there.

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.

Anything where you need a high external validity which is usually achieved by real world conditions and large numbers of test subjects with very different backgrounds and contexts. The paper where they measured different skews when typing and tested three related keyboard modifications comes to mind.

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".

Notice that in the following there are two different problems: (a) you cannot rest your fingers on the screen (e.g., on a physical button) and (b) you only have one option to register an input (i.e., you do not have an input when hovering your finger over a position). They are somehow related but lead to different issues. Several people had problems distinguishing them (but still got partial credits, e.g., if they got some of the answers correct or explained the technology correctly even if the actual example that they gave was wrong).

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

You cannot rest your fingers on the (virtual) keyboard's buttons without generating an input (or if you do rest them, how can you register an input then?)

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.

Mobile gaming / onscreen joysticks: For games, quick reactions are often needed, which can be done easier if you can rest your fingers on the buttons.
The "drifting problem" discussed in the mobile gaming question below is another good example that does not happen if you can rest your fingers on the buttons.

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?
No. Optical touch screens add a hover mode, but the problem that you cannot rest your fingers on them and create a separate input by, e.g., pressing harder remains.

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?
No. Electrostatic touch screens allow you to create the feeling of texture. While it might be possible to create the feeling of a button with this, the problem that you cannot rest your fingers on them and create a separate input by, e.g., pressing harder remains.

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.

Several examples exist here (opening context menus, providing feedback before clicking, etc.)

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.

The answer here obviously depends on the example given above. Typical pure software-based solutions to deal with the "lack of a hovering mode" problem include time delay (e.g., register an input only after a certain time interval) or registering it only upon release (allowing people to move away if they do not want the input to be registered; this is not a solutions that works in all cases, but depending on the example given above, it could be possible).

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.

Yes. There are cameras in the screen which allow you to recognize your finger already before you touch it.

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.

Yes. You can simulate a hovering mode here by interpreting a "normal/soft" touch as hovering and a "hard/strong" touch as input.

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 answer 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.

Faster playback at 1.5 times normal speed allows you to still understand the content correctly. Reasons why one might want to do this for learning include but are not limited to:

- *Repetition of content before an exam, e.g., if you heard it before (e.g., because you attended the lecture).*
- *Faster playback might force you to be more focused and thus increase attention. This could also be a reason to do this even if you listen to it for the first time.*

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.

Faster playback at 2.0 times normal speed allows you to still categorize the content correctly. Because you cannot understand it anymore though, this is not helpful to learn the actual content, but to search for relevant parts (e.g., to quickly skip over parts that you already understood and don't need to repeat or to find a part that was particular difficult, and you want to repeat it).

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.

Slower playback can be useful if you have difficulties grasping the content when it is played at normal speed, e.g., because it is very complicated, it is not in your native language, etc. Another good example would be if you want to make notes while listening (because typing or handwriting usually takes longer than speaking, so you might want to slow down the audio in such cases).

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.
Backwards playback only allows you to grasp the topic, but not fully understand it. Thus, like playback at 2.0 times normal speed, it is only useful for searching. Because it is easier to listen to larger parts of speech played forward at a high speed than backward, it is only useful for going backward a few sentences. A good example for learning could be to go back a couple of sentences because you did not understand them well (similarly to "visually" going

back in a printed text within one paragraph; you would not do this for a whole section).

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.

The key issue here is that RSVP does not help with long term memory. Thus, in the context of learning, anything where you actually need to process the content (e.g., read, understand, and memorize a definition) will not work well with RSVP, but everything where you want to quickly find something (e.g., find the definition in the transcript to quickly look it up before the exam (or during, if it's an open book exam)) might work. The paper related to gesture interfaces for RSVP lists a couple of other potential problems with it, which can also make nice examples in a learning context.

Several people wrote that it could be useful to recap information that you already know in order to refresh or improve your memory. While I'm not aware of any related work that has studied this, I find it quite likely that this could work and thus gave full credits for it. (It could be a nice thesis project to test that.)

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 ...

… notify people.

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

A good example for this would be:

Inform phone owners about incoming messages when the phone is on mute or used in a noisy environment.

1 pt. **i.** [max. 1 pt] Second answer (part 1): Vibration feedback can be used to ...

… give a response to a user's input

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

A good example for this would be:

Confirm that an input (e.g., the press of a button) has been registered by the system.

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

Vibration feedback can be used to ...

… enhance the user experience

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

A good example for this would be:

Have the phone vibrate in a mobile game when an explosion happens.

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.

Many examples exist here (e.g., how fast can we type / move our fingers while typing, gorilla arm, reachability due to hand sizes and grip, comfortable angles when tilting (remember the wrist study in the video from the lecture)). Both issues are related but not the same. Yet, since there is a gray area between "is this a human motor system-related issue or an ergonomics-related issue" answers were generously graded. No "double credits" were given though if people used the same problem in different words (unless those words clearly highlighted the motor system and ergonomics-related aspects of the example correctly).

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.

Occlusion problem due to "fat fingers" (finger covers / hides content)

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.

Not being able to see your fingers causes problems when trying to touch dedicated areas.

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.

Reachability of objects on the opposite corner of the screen for one-handed input.

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

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

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

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

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.

Various potentially correct solutions exist for the following two questions. Some examples are listed below.

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

Having to apply constant pressure can put strain on your finger.
Applying changing force could potentially be destabilize your grip of the phone.
For some users, it may be hard to distinguish and apply different levels of pressure.

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

Neck problems if you are forced to move your head to certain positions.
Need to hold the device in uncomfortable position to make sure head is in camera's FOV
Hand-neck coordination problems.

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:

Various solutions exist here. Examples include:

For h.) Marble balancing with 1:1 mapping (velocity-based; see example in mobile gaming lecture).

For i.) Marble balancing with angular mapping (position-based; see example in mobile gaming lecture).
Turning pages of a digital book by "waving" in the same direction.

For j.) Move phone to start or stop some activity (e.g., up/down to increase/decrease volume, shake to stop, etc.). Also: shake to undo (official iOS gesture, discussed in lecture 6

Some people brought examples from gesture interaction in mobile AR, which was quite nice.

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.

Diegetic representation means that the interaction element is
part of the game story and
part of the game world.

An example is a map that is held by a game character (but many others exist, e.g., a billboard in a soccer stadium showing the current score; see last year's exam).

Potential advantages include less screen clutter, often being more visually appealing (some people stated "more immersive"), intuitive (which is a bit debatable due to discovery but depending on the example a fair point).

A potential disadvantage is that they are easier to overlook or harder to recognize, because the visualization may not be optimized for the player (like an on-screen map) but must fit in style, size, and orientation to the game world and story. Another one could be "discoverability".

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.

The two problems are occlusion *and* accuracy/precision*.*

They both exist with onscreen controllers, too. One can argue that they are even more critical here (a) because people often want or must make faster movements and (b) there are multiple active areas with different reaction within a relatively small area. (The resulting problems due to occlusion and lack of accuracy are slightly different, but the reasons are the same, which is why almost identical answers (or, if phrased correctly, even completely identical ones) for g. and h. got full credits.

What is meant by "relatively small area" above is that a controller has, e.g., different directions.

Moving your fingers on the screen from one to the other (for a continuous controller, comparable to a stick) or trying to hit different ones (for discrete controllers, comparable to a cross with four directions, i.e., up/down/left/right) is thus harder because your finger hides these part of the screen (occlusion problem) and is relatively big, making it sometimes hard to judge which part of the surface it touches is the one registered by the system (accuracy/precision problem).

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 "<u>drifting</u>".

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.

See blog post in the reading list for this lecture.
The issue is that because you don't have haptic feedback, making it possible that your finger drifts too far away from the controller without noticing it. While you can still register input there (see, e.g., the discussion in the blog for component 3 and the image with the green arrows), it definitely become a problem when you want to change the direction.

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?

No, because you are not touching the screen with your fingers anymore. This is actually a big advantage of using tilt.

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.

Various correct solutions exist, including but not limited to:
Visibility problems when the screen is tilted.
Stability (debatable, but could be an issue depending on the required motions).
How tilt motions and angles are mapped to actions in the game might be harder to understand.
Generally more difficult to make precise adjustments (thus not suited for all games or actions).

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:

Wrong perspective (*user's perspective does not match the one of the virtual camera*)

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

No stereoscopy

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.

See a. above

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.

Shoebox: accelerometer/gyroscope

Fish tank: camera

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.

Shoebox VR assumes that the user stays at a dedicated distance with respect to the device, whereas Fish tank VR works for every location.

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.

Many possible answers exist. Maybe the most obvious one is a 3D balancing game (like the marble game we saw in the lecture) or a 3D puzzle game (like the one on the Nintendo Gameboy that we saw in the lecture

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".

Because the location of the objects can be associated with locations in real space (or relative to your body, which is also why they always stay at the same position relative to you).

Other correct answers exist

1 pt. **h.** [max. 1 pt] Shortly explain why this is not necessarily true when you are interacting in all three dimensions, 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.

See lecture (different mental map, e.g., if associated with zooming, do you zoom in or out when moving your phone away from you?). Or, with Google Streetview: What would you expect when the device is moved away? Zooming? Moving forward? Neither of them seems intuitive.

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.

Several correct options exist. Maybe the most obvious one is open worlds, where you usually move the world in the opposite direction of a controller, and closed worlds, e.g., the shoebox example where the world moves with the device (i.e., in the same direction); see the slides with related comments on navigation.

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?

Live feed from the phone's video camera

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.

Examples include the UFO shooter game or information browser that we saw in the lecture.

Both do not require "perfect" integration to achieve their purpose.

Sensors: accelerometer/gyroscope and phone to get the orientation of the device and direction where it is pointing at, respectively.

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 virtual 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.

See examples from the lecture, e.g., the tower defense game that is played on a real table.

"Perfect" integration is needed, since it would be strange and make no sense if, e.g., the tower or tanks would be "floating" or "hovering" over the table.

Sensors: camera to get the marker on the table as reference point to place the objects correctly on the table.

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.

Combines real and virtual should be fulfilled for both.

Interactive in real time depends on the examples, but for most of them, both should fulfill it, too.

The difference is clearly in "registration in 3D" since the text in the question already gives it away that this is not fulfilled in the first case ("superimpose" the virtual object), whereas in the second case it is ("perfectly" integrate the virtual objects).

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!