(INFOMMOB) Mobile Interaction - 24 june 2019

Course: Mobile interaction (INFOMMOB)

The exam contains 9 problems, each covering content from one of the nine lectures.
Note that some problems contain many sub-questions. Thus, plan your time accordingly.

Good luck!

Number of questions: 9

You can score a total of 63 points for this exam, you need 31.5 points to pass the exam.

1 General context

Note: in the following, short answers are sufficient. In most 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. The first wave was ***portability***, and the second was ***miniaturiztation***. Both of these waves were mostly driven by the desire to develop mobile computers (e.g., laptops). Yet, the resulting technological improvements had relevance for the development of today's smartphones as well.

1 pt. **a.** [max. 1 pt] Name one technological improvement related to either of these two waves that was motivated by the need to create portable computers, but had a relevance for today's smartphones as well.

1 pt. **b.** [max. 1 pt] Name one technology-related characteristic of today's smartphones that did <u>not</u> just happen because of general technology improvements in mobile computing, but was clearly motivated by the needs and demands of smartphone users.

In the following, we want to look at four of the other waves in the context of **digital cameras.**

1 pt. **c.** [max. 1 pt] One of the other waves was ***convergence***. Give <u>one advantage</u> of convergence in relation to digital cameras; that is, state an improvement of digital cameras and/or their usage that is due to this trend.

1 pt. **d.** [max. 1 pt] Another wave was ***divergence.*** Give <u>one advantage</u> of divergence in relation to digital cameras; that is, state an improvement of digital cameras and/or their usage that is due to this trend.

1 pt. **e.** [max. 1 pt] Another wave was ***connectivity.*** Shortly describe what is meant by that.

1 pt. **f.** [max. 1 pt] Give <u>one advantage</u> of connectivity in relation to digital cameras; that is, state an improvement of digital cameras and/or their usage that is due to this trend.

1 pt. **g.** [max. 1 pt] Another wave is ***apps****.* Shortly describe what is meant by that.

1 pt. **h.** [max. 1 pt] Give <u>one advantage</u> of apps in relation to digital cameras; that is, state an improvement of digital cameras and/or their usage that is due to this trend.

4 pt. **i.** [max. 4 pts] If we look at today's situation, many people still use stand-alone digital cameras to take pictures. But many others use mostly or exclusively cameras integrated into their mobile phone to take photos. **Shortly discuss this in relation to the four advantages that you described above for the waves of *convergence, divergence, connectivity,* and *apps.*** That is, explain why today's situation happened <u>with respect to the advantages that you listed above.</u>

2 Sensor technology for interaction

Accelerometers were originally introduced into mobile phones to improve usability by automatically changing the screen orientation between landscape and portrait when a user rotates the phone accordingly. Then people realized that they can use it for various other types of user interaction as well (e.g., tilting the phone as input for games).

Name **one other sensor or technology** that we find in today's mobile phones, which was introduced for a specific purpose and is now used for interaction. Give its name, shortly state its original purpose, and then give a short example of a scenario or context where it is used for interaction and how.

0 pt. **a.** [0 pts; this is just needed for the following questions] Name of the sensor or technology:

1 pt. **b.** [max. 1 pt] Original purpose why this sensor was integrated into the phone:

1 pt. **c.** [max. 1 pt] Example illustrating how this sensor is now used for interaction *(note: your example must be different from the original usage that you mentioned above):*

Today's smartphones contain **vibration motors** that can be used to provide haptic feedback via small vibrations. These are sometimes used **to improve interaction** by complementing other types of input, such as ***touch***. For example, some soft-keyboards on touch screens do not only give visual feedback, but also vibrate when a key is pressed.

1 pt. **d.** [max. 1 pt] Give one reason why this is done, i.e., a problem that interface designers are trying to resolve by adding vibration feedback to on-screen keyboards. *(Note: be specific; "lack of haptic feedback" is not sufficient.)*

1 pt. **e.** [max. 1 pt] Give one common problem in this situation (i.e., entering text with a soft-keyboard) that is <u>not</u> resolved by adding such vibration feedback.

Now we want to look into how **vibration** could be added **to improve interaction** via ***tilting*** your phone.

Assume you want to implement a car racing game, where players steer a car along a race track by tilting the device left or right. On the screen, the player sees the race track as if he/she is sitting in the car and looking out of the windshield (so basically a first person view of someone driving a car).

Give <u>two examples</u> of how one could use vibration motors in this context to potentially improve interaction; your examples must illustrate when you would use them and why (i.e., what is the purpose of the vibration or how does it improve interaction).

1 pt. **f.** [max. 1 pt] Example 1 and purpose:

1 pt. **g.** [max. 1 pt] Example 2 and purpose:

Interaction via touch screen as well as interaction via tilting can both result in **visibility problems**.

1 pt. **h.** [max. 1 pt] Give one common visibility problem that can appear when using <u>touch</u> as input.

1 pt. **i.** [max. 1 pt] Give one common visibility problem that can appear when using <u>tilting</u> as input.

3 Touch screens

In the lecture, we discussed different **touch screen technologies**. One of them was ***pneumatic displays*** (we saw an example of a research prototype of this approach), another one was ***electrostatic touch screens*** (we saw a video of a prototype built by Disney Research). Both of them address the same basic problem that standard touch screens have. But they do this in different ways. Therefore, they only solve parts of this problem, but not everything.

1 pt. **a.** [max. 1 pt] What is the general basic problem of standard touchscreens (e.g., the ones in your phone) that these two technologies both address?

1 pt. **b.** Give one issue that is part of this problem but can not be resolved with *pneumatic displays.*

1 pt. **c.** [max. 1 pt] Given one issue that is part of this problem but can not be resolved with *electrostatic touch screens.*

One problem with touch screens is that objects at the top of the screen are hard to click when interacting with just one hand, because your thumb is not long enough to reach them comfortably. We saw three ideas how to deal with this: One that uses a software solution ("***ExtendedThumb***" described in the paper by Lai and Zhang (2014)), one that uses pressure sensitve input ("***ForceRay***" described in the paper by Corsten et al. (2019)), and one that uses another sensor, i.e., the accelerometer for tilting-based input (see "***SWiM***" described in a paper by Yeo et al. (2017) and illustrated in the video that we watched in the lecture).

1 pt. **d.** [max. 1 pt] Give one advantage that the ***ForceRay*** approach could have compared to tilting-based approaches, such as ***SWiM.***

1 pt. **e.** [max . 1 pt] Give one advantage that the ***ForceRay*** approach could have compared to the ***ExtendedThumb*** approach.

1 pt. **f.** [max. 1 pt] Give one potential disadvantage of ***ForceRay***.

In all of these three techniques, you are not touching targets that are out of reach directly, but select them indirectly using a cursor or other indication to select them. Give two advantages that such **cursor-based touch interaction** could have compared to directly touching the objects with your fingers or thumbs.

1 pt. **g.** [max. 1 pt] First advantage:

1 pt. **h.** [max. 1 pt] Second advantage:

4 Human aspects & perception

In the lecture, we talked about a technique called **Rapid Serial Visual Presentation (RSVP)** that allows people to grasp content faster by showing it to them rapidly. We saw an example of this in the context of speed reading (remember the fast reader shown in the video by a company called Spritz), and we talked about how this could be applied to access larger image databases.

Now assume you are an interface designer who works on creating interfaces for tiny screens, such as the ones found on smartwatches.

1 pt. **a.** [max. 1 pt] Give one concrete example where applying RSVP in this context (tiny screens) might work and provide a convincing reason why.

1 pt. **b.** [max. 1 pt] Give one concrete example where applying RSVP in this context (tiny screens) might not be a good idea and provide a convincing reason why.

We also discussed that **audio** content can be **played faster** (to some degree) and people are still able to understand or at least classify what they hear (if the playback is modified in a way that the pitch is preserved).

1 pt. **c.** [max. 1 pt] Give one concrete example where such a faster audio playback makes sense and thus adding this option to the interface could be a good idea.

1 pt. **d.** [max. 1 pt] Give one concrete example where such a faster audio playback does not make sense.

5 Touch interaction design

In the lecture and one of the papers, we addressed **callouts**, i.e., enlarged visualizations of an area covered by your finger or thumb that is displayed in a non-occulded area. The one discussed in the lecture was applied to target selection on a map and called *Shift.*

1 pt. **a.** [max. 1 pt] Give one example or issue with touch interaction that is relevant in this context (i.e., target selection on maps) that such callouts might resolve.

1 pt. **b.** [max. 1 pt] Give one example or issue with touch interaction that is relevant in this context (i.e., target selection on maps) that this approach might <u>not</u> resolve.

If we look at today's apps, callouts are rarely used in target selection tasks for maps. Yet, they are sometimes used for text entry via on-screen keyboards (e.g., in iOS, the key that is hit with your finger is shown as an enlargement on top of it).

1 pt. **c.** [max. 1 pt] Give a convincing reason why callouts are hardly ever used in target selection tasks for maps anymore.

1 pt. **d.** [max. 1 pt] Give a convincing reason why they are still used for text entry with on-screen keyboards.

If interface designers want to use a technique such as callouts, they also need to decide how to implement them. In the paper *Evaluation of Callout Design for Ultra-small Touch Screen Devices,* Ishii et al. evaluated three design options for callout designs. In the paper, they call these options design "factors".

State what these are and shortly explain what each means. (*Note: the meaning is more important; there will be no deduction if you do not remember the correct name but give a correct description. Stating the correct name without explanation gives 0.5 credits. Stating the name with a wrong explanation will give 0 credits.*)

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

1 pt. **f.** [max. 1 pt] Factor 2:

1 pt. **g.** [max. 1 pt] Factor 3:

6 Mobile gaming

In the lecture we discuss the use of **on-screen joysticks** for games. You also read two articles about them. The paper by Teather et al. ("Tilt-Touch synergy") calls them *dual-analog controllers*. The article by G. McAllister referres to them as *twin stick shooters*. McAllister discusses also different design options, including *static* and *dynamic controls*.

1 pt. **a.** [max. 1 pt] Shortly explain what is meant by *static controls.*

1 pt. **b.** [max. 1 pt] Shortly explain what is meant by *dynamic controls.*

1 pt. **c.** [max. 1 pt] Give one example or reason why a game designer might decide to use static controls instead of dynamic ones.

1 pt. **d.** [max. 1 pt] Give one example or reason why a game designer might decide to use dynamic controls instead of static ones.

In their paper *Tilt-touch synergy: Input control for 'dual-analog' style mobile games"* (2017) Theather et al. describe three deficiencies that virtual controls have compared to their physical counterparts know from game console controllers. List three of such disadvantages. (*You do not necessarily have to list the three mentioned in the paper. There might be others and any convincing answer will give full credits.*)

1 pt. **e.** [max. 1pt] 1st deficiency:

1 pt. **f.** [max. 1pt] 2nd deficiency:

1 pt. **g.** [max. 1pt] 3rd deficiency:

In their paper, Teather et al. compare touch with tilt input and combinations thereof. Name two problems of touch controls that do not appear for tilting (*again, it is not necessary to name exactly the two stated in the paper, but any correct one will give you credits*). Also, name one additional potential benefit that tilt input might have, i.e., a unique characteristic of tilt that might be beneficial for interaction (*and again, there is one mentioned in the paper, but there might be others; it also does not necessarily have to be related to a deficiency of touch*).

1 pt. **h.** [max. 1pt] 1st problem with touch control that does not appear with tilt:

1 pt. **i.** [max. 1pt] 2nd problem with touch control that does not appear with tilt:

1 pt. **j.** [max. 1pt] Another general advantage that tilt might have for interaction:

In their paper, Teather et al. note that the standard implementation of dual-analog controls (both physical and virtual) conforms to Guiard's model of bimanual control, which states that "bimanual tasks often use the non-dominant hand to coarsely set the frame of reference within which the dominant hand operates, performing fine control" (quote from the paper).

Based solely on this information, which mode (*tilt* or *touch*) would you assign to which action (*orientation* or *navigation*) if you want to implement a combined approach (i.e., use tilt for one and touch for the other action)? Keep in mind that the majority of people is right-handed. (*Note: the answer is given in the paper, but if you don't remember it, you should still be able to figure it out based on things we discussed in the lecture.*)

2 pt. **k.** [max. 3pts] Complete the following sentence by writing down either *orientation* or *navigation* and then add a short justification of your answer: *(Note that one can argue in different ways. Any answer that provides a convincing reason will give full credits. Thus, answers without justification will get no credits.)***I would match tilting to ... because ...**

7 Mobile evaluation

In the paper *Tilt-Touch synergy: Input control for "dual-analog" style mobile games* (2017) Teather et al. present an experiment where they use “a custom-developed game” that is “reasonably complex and potentially more representative of ‘real’ games than relatively simple games used in previous work” (quotes from the paper). They justify these two experiment design decisions with higher internal and external validity.

1 pt. **a.** [max. 1 pt] Which of these two experiment design decisions should result in higher <u>internal</u> validity and why?

1 pt. **b.** [max. 1 pt] Which of these two experiment design decisions should result in higher <u>external</u> validity and why?

They also used only “regular gamers” who “reported weekly use of games using either dual-analog physical game controllers of mobile virtual dual-analog controls” in their study (quotes from the paper).

1 pt. **c.** [max. 1 pt] Why did they only use experienced participants?

8 Mobile 3D interaction

In the lecture, we talked about different **3D visualization concepts**. One of them was called ***Shoebox VR*** (or ***Fishtank VR***; in the context of this question there is no need to distinguish between them). The other was called ***Fixed world VR***. The latter follows the same principle as the implementations in Xiang A. Chen’s papers on *Body-Centric Interaction* and *Around-Body Interaction*.

Assume the following ***scenario***: You have three screens filled with icons of apps on your phone (the home screen and two other ones). You can switch between them by swiping (as it is done on almost all current smartphones). Now you want to replace swiping by a Shoebox VR-like implementation or a Fixed world VR-like implementation. (We actually saw an example for the first case in a video in the lecture. The second is illustrated in Chen’s papers.)

1 pt. **a.** [max. 1 pt] Give one <u>*advantage*</u> that such a <u>Shoebox VR</u> implementation could have compared to the <u>Fixed world VR</u> implementation.

1 pt. **b.** [max. 1 pt] Give one <u>*advantage*</u> that such a <u>Fixed world VR</u> implementation could have compared to a <u>Shoebox VR</u> implementation.

1 pt. **c.** [max. 1 pt] Give one <u>*advantage*</u> that the <u>standard approach</u> (swiping between home screens) could have compared to both of these two <u>VR implememtations</u>.

9 Mobile AR

In relation to augmented reality (AR), we often distinguish between so-called *immersive* installations and *non-immersive* approaches. Shortly explain what this means in this context.

1 pt. **a.** [max. 1 pt] Immersive AR:

1 pt. **b.** [max. 1 pt] Non-immersive AR:

Give a convincing **example of an AR app** for mobile AR (i.e., AR done with your smartphone or tablet) that only utilizes accelerometer / gyroscope and magnetometer and no other sensor, but could still be considered a useful AR app (even if it may not fulfil all the criteria of an AR system defined by Azuma).

1 pt. **c.** [max. 1 pt] Example:(*Note: if you use one from the lecture, a short statement that identifies it is sufficient; for others, make sure that your explanation clearly illustrates why only these two sensors are necessary.*)

Give a convincing **example of an AR app** for mobile AR that needs one additional sensor (that is, in addition to accelerometer / gyroscope and magnetometer).

1 pt. **d.** [max. 1 pt] Example:(*Again, giving the name and/or a short description of one mentioned in the lecture is sufficient; if you come up with your own idea, make sure to clearly describe it. In both cases, don't forget to mention the name or type of the additional sensor.*)

In the context of AR, what is meant by **3D registration**?

1 pt. **e.** [max. 1 pt] Shortly explain it.

Give a convincing **example of an AR app** that would need perfect or at least a very good 3D registration.

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

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

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