VR/AR research

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Mark Miller, Virtual Human Interaction Lab, Stanford
For CS 11SI: How to Make VR

Quick background on me, AR/VR, & this talk

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- People give others personal space. Do people give holograms of people personal space? And do people still avoid that space when the hologram is removed?
- If I'm wearing an AR headset, you can't see what I'm doing. What if I block your face? Do you notice or feel the conversation going differently?

Learning Questions

- What kind of AR/VR research is out there?
- How do I find it?
- How do I understand it?
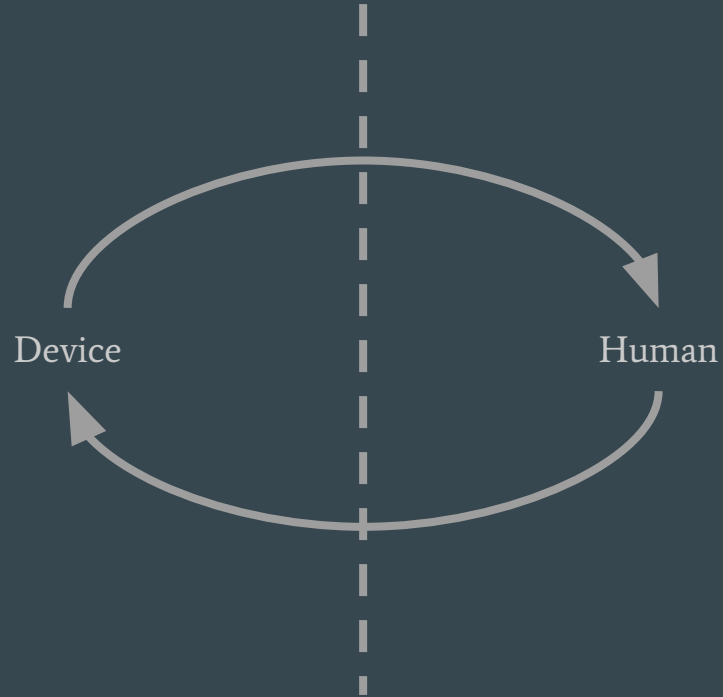- How do I apply it to my project at hand [my game]?
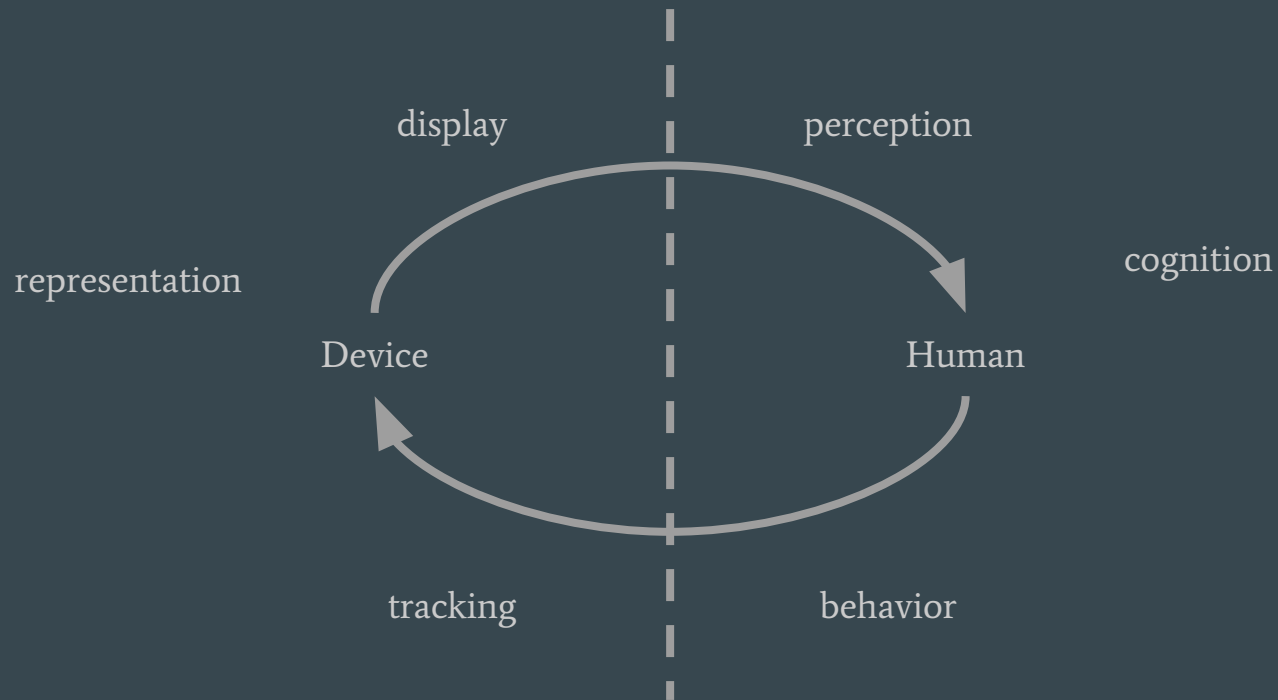
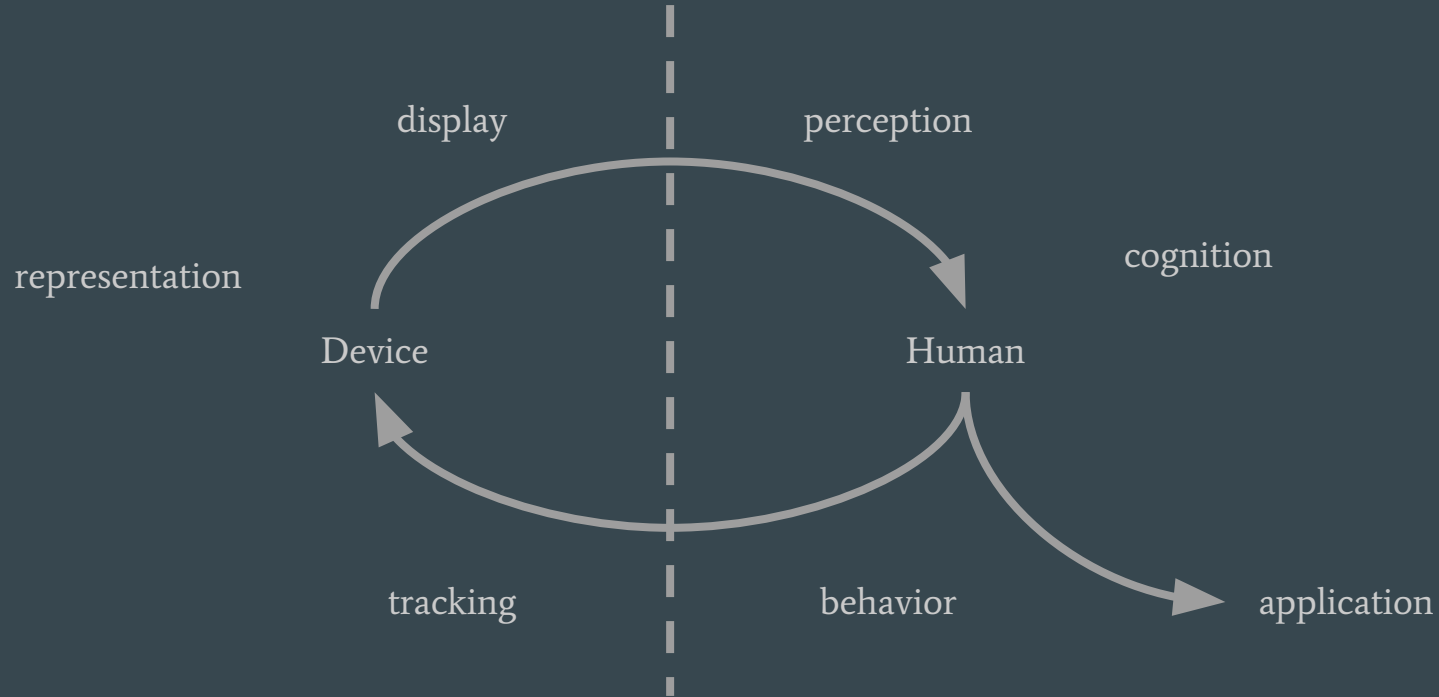# A mental model of AR/VR research

Device

Human

A mental model of AR/VR research

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Some examples of AR/VR research

Caveat: these cluster in my research area, which is more HCI focused. These papers are mostly-randomly drawn from all the papers I've downloaded on AR/VR.

Rietzler et al. 2018 - Breaking the Tracking: Enabling Weight Perception using Perceivable Tracking Offsets

Virtual reality (VR) technology strives to enable a highly immersive experience for the user by including a wide variety of modalities (e.g. visuals, haptics). Current VR hardware however lacks a sufficient way of **communicating the perception of weight of an object**, resulting in scenarios where users can not distinguish between lifting a bowling ball or a feather. We propose a solely software based approach of simulating weight in VR by deliberately using perceivable tracking offsets. **These tracking offsets nudge users to lift their arm higher and result in a visual and haptic perception of weight.** We conducted two user studies showing that participants intuitively associated them with the sensation of weight and accept them as part of the virtual world. We further show that compared to no weight simulation, our approach led to significantly higher levels of presence, immersion and enjoyment. Finally, we report perceptional thresholds and offset boundaries as design guidelines for practitioners.

Shyam et al. 2017 - Being There in the Midst of the Story: How Immersive Journalism Affects Our Perceptions and Cognitions

Immersive journalism in the form of virtual reality (VR) headsets and 360-video is becoming more mainstream and is much touted for inducing greater "presence" than traditional text. But, does this presence influence psychological outcomes of reading news, such as memory for story content, perceptions of credibility, and empathy felt toward story characters? We propose that two key technological affordances of VR (modality and interactivity) are responsible for triggering three presence-related cognitive heuristics (being-there, interaction, and realism), which influence news readers' memory and their perceptions of credibility, empathy, and story-sharing intentions. We report a 3 (storytelling medium: VR vs. 360-video vs. Text) · 2 (story: "The displaced" and "The click effect") mixed-factorial experiment, in which participants (N= 129) experienced two New York Times stories (that differed in their emotional intensity) using one of three mediums (VR, 360-video, Text). Participants who experienced the stories using VR and 360-video outperformed those who read the same stories using text with pictures, not only on such presence-related outcomes as being-there, interaction, and realism, but also on perceived source credibility, story-sharing intention, and feelings of empathy. Moreover, we found that senses of being-there, interaction, and realism mediated the relationship between storytelling medium and reader perceptions of credibility, story recall, and story-sharing intention. These findings have theoretical implications for the psychology of virtual reality, and practical applications for immersive journalism in particular and interactive media in general.
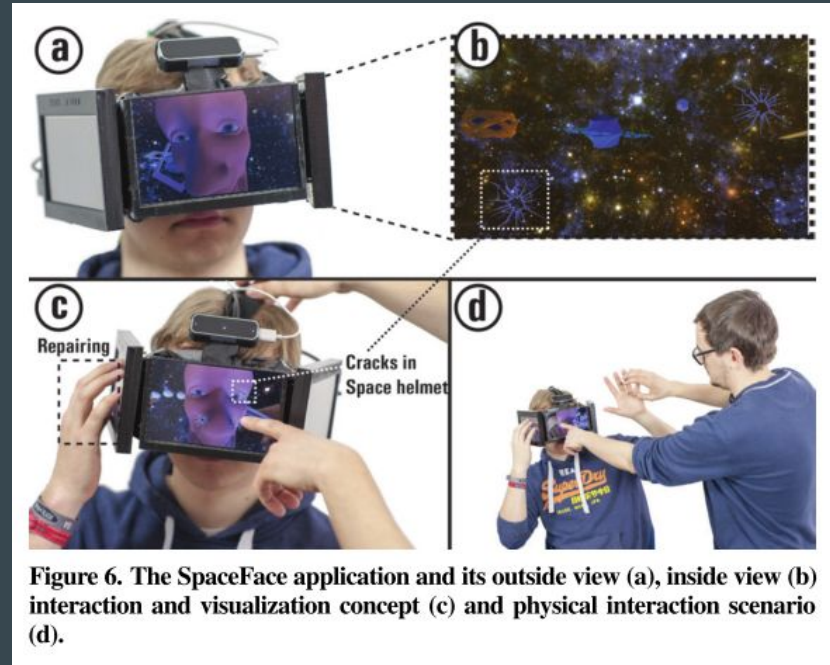
Knierim et al. 2018: Quadcopter-Projected In-Situ Navigation Cues for Improved Location Awareness

Every day people rely on navigation systems when exploring unknown urban areas. Many navigation systems use multi-modal feedback like visual, auditory or tactile cues. Although other systems exist, users mostly rely on a visual navigation using their smartphone. However, **a problem with visual navigation systems is that the users have to shift their attention to the navigation system and then map the instructions to the real world.** We suggest using in-situ navigation instructions that are presented directly in the environment by augmenting the reality using a projector-quadcopter. Through a user study with 16 participants, we show that using in-situ instructions for navigation **leads to a significantly higher ability to observe real-world points of interest.** Further, the participants enjoyed following the projected navigation cues.

Gugenheimer et al, 2018 - FaceDisplay: Towards Asymmetric Multi-User Interaction for Nomadic VR

Mobile VR HMDs enable scenarios where they are being used in public, excluding all the people in the surrounding (Non-HMD Users) and reducing them to be sole bystanders. We present FaceDisplay, a modified VR HMD consisting of three touch sensitive displays and a depth camera attached to its back. People in the surrounding can perceive the virtual world through the displays and interact with the HMD user via touch or gestures. To further explore the design space of FaceDisplay, we implemented three applications (FruitSlicer, SpaceFace and Conductor) each presenting different sets of aspects of the asymmetric co-located interaction (e.g. gestures vs touch). We conducted an exploratory user study (n=16), observing pairs of people experiencing two of the applications and showing a high level of enjoyment and social interaction with and without an HMD. Based on the findings we derive design considerations for asymmetric co-located VR applications and argue that VR HMDs are currently designed having only the HMD user in mind but should also include Non-HMD Users.

Figure 6. The SpaceFace application and its outside view (a), inside view (b) interaction and visualization concept (c) and physical interaction scenario (d).

Konrad et al. 2017: Accomodation-invariant near-eye displays

Although emerging virtual and augmented reality (VR/AR) systems can produce highly immersive experiences, they can also cause visual discomfort, eyestrain, and nausea. One of the sources of these symptoms is a **mismatch between vergence and focus cues**. In current VR/AR near-eye displays, a stereoscopic image pair drives the vergence state of the human visual system to arbitrary distances, but the accommodation, or focus, state of the eyes is optically driven towards a fixed distance. In this work, we introduce a new display technology, dubbed accommodation-invariant (AI) near-eye displays, to improve the consistency of depth cues in near-eye displays. **Rather than producing correct focus cues, AI displays are optically engineered to produce visual stimuli that are invariant to the accommodation state of the eye.** The accommodation system can then be driven by stereoscopic cues, and the mismatch between vergence and accommodation state of the eyes is significantly reduced. We validate the principle of operation of AI displays using a prototype display that allows for the accommodation state of users to be measured while they view visual stimuli using multiple different display modes.

Conventional Near-eye Displays

Accommodation Invariant - Continuous Sweep
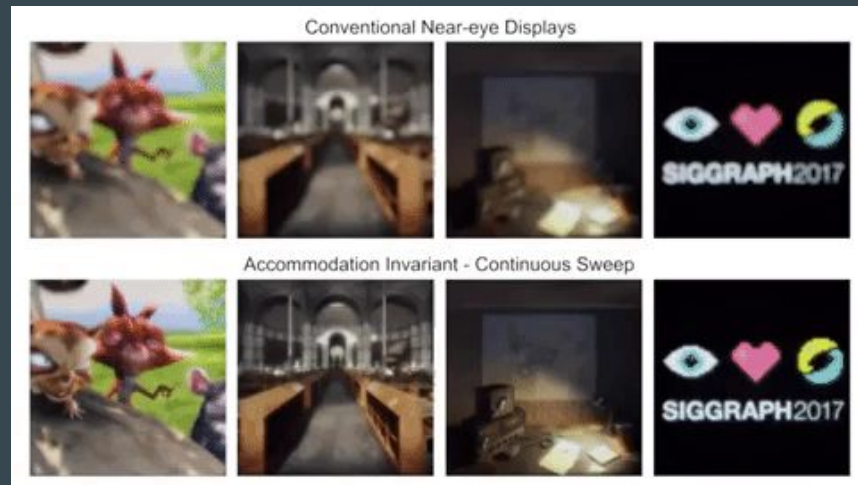
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How do you feel about those papers? [I like / I wish / I wonder]

Understanding research papers...

Don't [usually] read them front-to-back. Instead, target what you're looking for:

- Title: is this remotely close to what I'm looking for?
- Abstract
  - Often written like:
    - A is important / good / great / popular
    - But A has a problem, and that problem is B
    - To solve problem B, we made change C
    - Because of change C, we found that D.
  - They should tell you why the paper is important and a short description of what they found.
  - Personally, this is the point at which I determine whether to download the paper or not.

Understanding research papers...

- Introduction
  - What do they expect you to know or be familiar with?
  - What is the thought process they've used in coming to the study they've run?
- Related work
  - "Here is some stuff that's similar. We're different because X."
  - If you're like "this paper is pretty close but not what I'm looking for" definitely check the related work!
- Methods and Results
  - If you want to know what they did in detail, so that you can check how similar it is to your own situation, read here.

Understanding research papers...

- Discussion
  - A brain dump of what the research does, could, and doesn't say.
- Conclusion
  - What did the authors **really, desperately** want you to learn from their paper?

Understanding research papers - final tips

- Follow the citation trail!
    - If you find a paper you think is really close to what you're doing, find the papers it cites and the papers that cite it.
- Research is not certainty
    - If researchers take it for granted, you're probably OK taking it for granted.
    - If it's a focus of research and there aren't many studies on it, be cautious - we don't know **boundary conditions**.
- It's normal to feel overwhelmed when you're reading papers
    - **And that's OK!** If you didn't feel overwhelmed, then it wouldn't be that new to you, and if it wouldn't be new to you, it wouldn't be research.
    - Take breaks, read outside, be calm

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Question & answer time!

"Can you go back to X paper and talk about it more?"

"What if you were looking for X in VR/AR?"

"What did you mean by X in your slides?"

"Our project might be about X, what do you think we should research?"

Happy to chat in person after class!