

The future of avatar-human interaction in VR, AR and mixed reality applications

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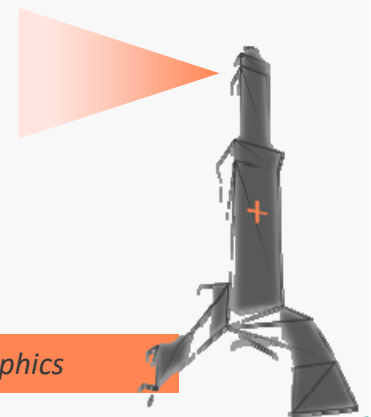
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Introduction

- What are avatars in VR?
Why are they useful to?
 - VR for entertainment -> avatars for creating lively scenes
 - VR for training and learning -> avatars are part of scenarios
 - VR for experimental research -> avatars are confederates
 - VR for industry (e.g., automotive) -> avatars to create realistic test environments
- Common requirements for avatars in VR:
 - Autonomy
 - Realism: motion, visual aspect
 - Variety
- In this Think Tank:
 - Deeper presentation of 3 aspects of the topic:
 - For each: open problems and questions



Topics

- Populate Virtual Worlds
 - Virtual experiments on crowds: from understanding individual behaviours in crowds (for modeling purpose) to training robot navigation in crowds.
- Collaborative VR
 - Applications: architecture, teaching, medicine.
 - Avatar representation for other users.
 - Self-avatars.
- Avatar in AR
 - Computer vision, machine learning, correct interaction with real world objects and people.



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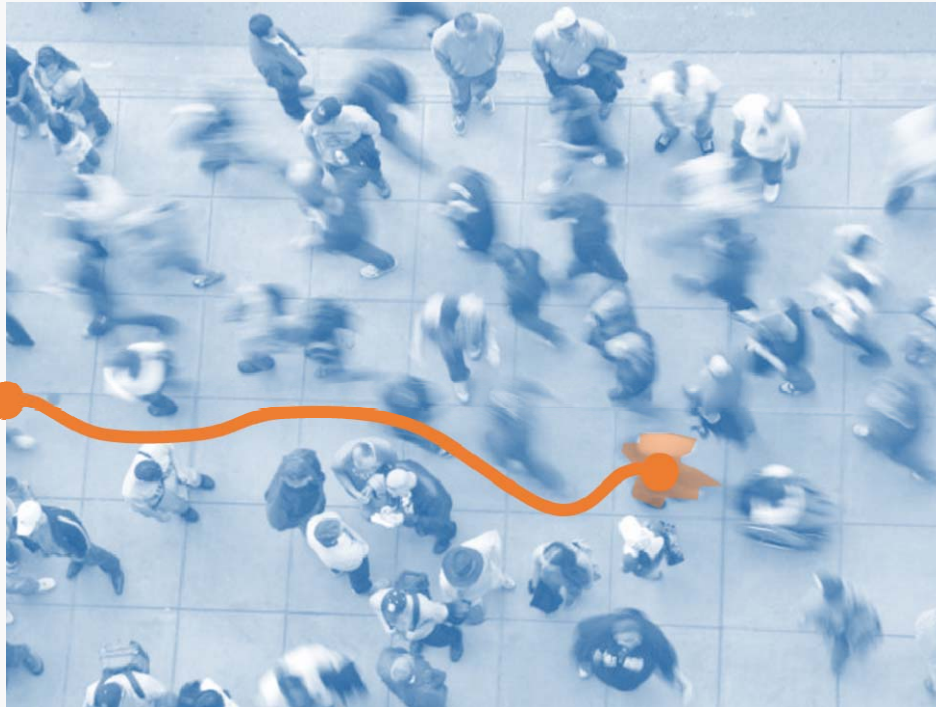


About this presentation

Through the example of crowd research, show how populated VR worlds are used, and what are the current challenges to create and use them



Crowd Research



Microscopic crowd modeling

Crowd motion result from the combination of local interactions between people

- Neighborhood
- Interaction rules
- Combination rules



Crowd Research



Populated VR worlds

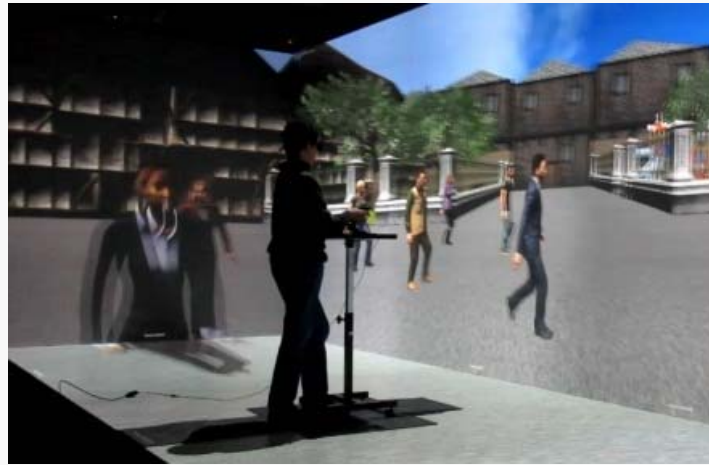


Shared virtual spaces where real and virtual humans can interact



Use of VR in Crowd Research

Understand
human
behaviors



Improve
simulation
models

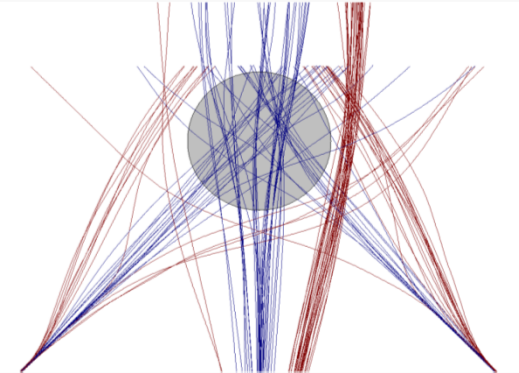
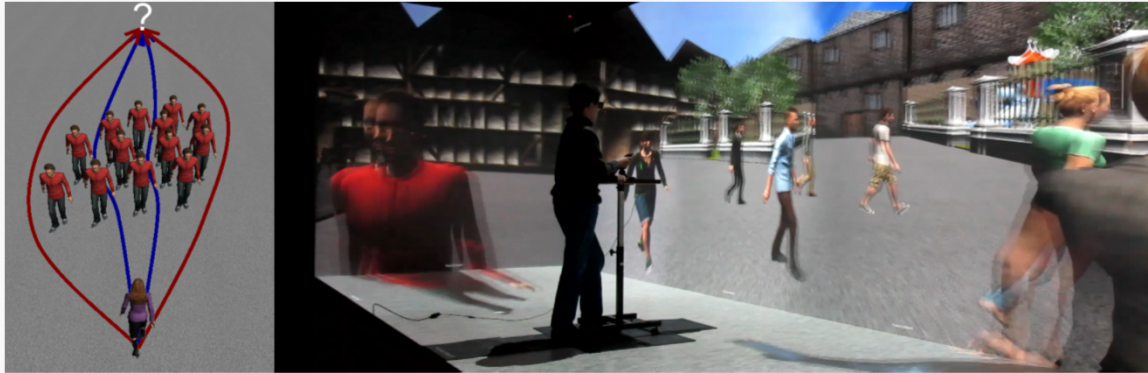


Benefit of VR

- Experimental technique:
 - Control of experimental conditions
 - Repeatability
 - Non physically feasible situations (incongruent stimuli, information removal)
- Logistics of experiments:
 - Recruiting people
 - Processing data



E1 – Going around or through?



[IEEE VR 2015]

- Energy efficient path?
- VR experiment could confirm hypothesis
- Study secondary factors in the “grey” zone

- Main challenge:

Do participants move the same way in VR?

- Benefit:

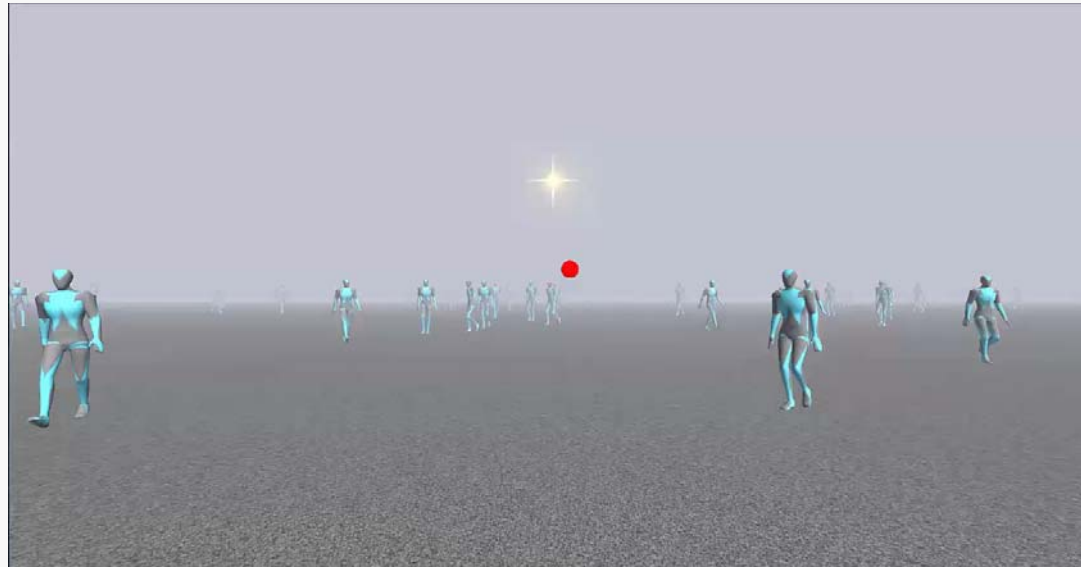
Group density and size easy to control

- Limitations:

- Non reactive characters
- No rendering of collisions



E2 – Neighbors?



- We look who we avoid and conversely
- VR experiment could confirm hypothesis
- First identification of interaction neighborhood

- Main challenge:

Correlate gaze and motion activity

- Benefit:

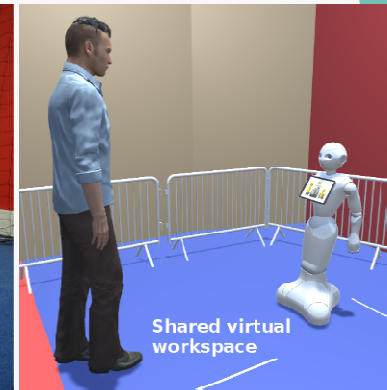
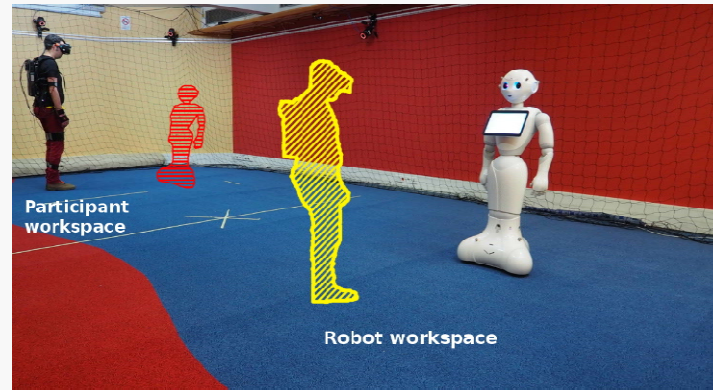
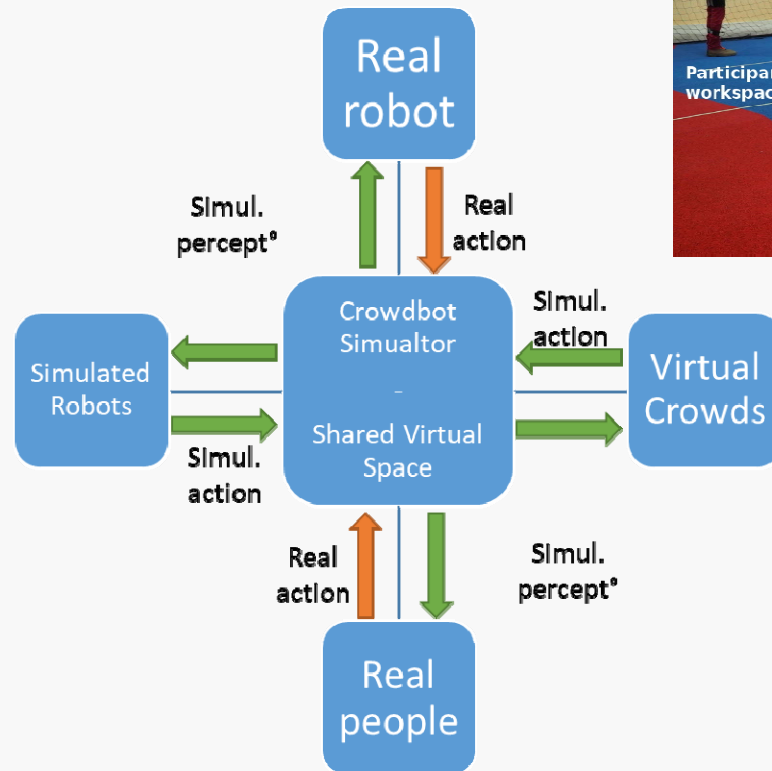
Easy processing of gaze data

- Limitations:

- Factors: speed, expressive motion, attention, whatever can attract gaze,



E3 – CrowdBot



- Validate Robot navigation techniques for crowds
- Simulation based at first

- Main challenge:

Robot+Human perception

- Benefit:

- Estimate of collision risks with no physical damage

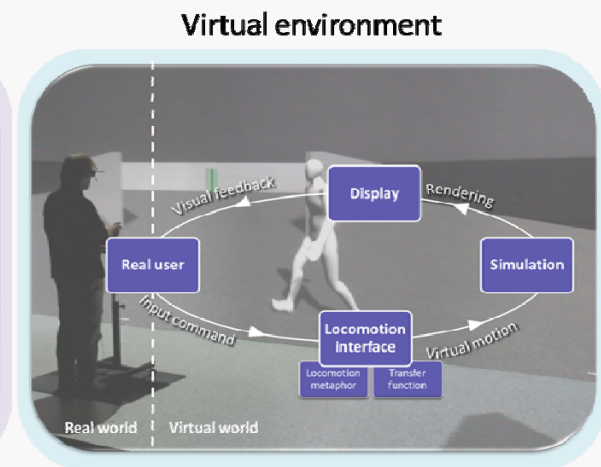
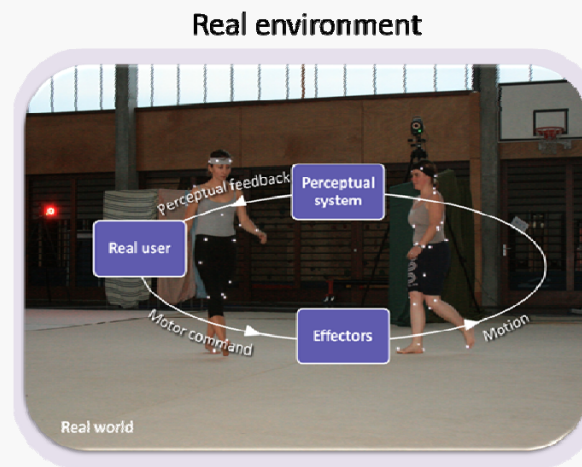
- Limitations:

- No contact



Challenges: interaction with V.H. in V.R.

- Acting in V.R.
- Reactive V.H.
 - Animation
 - Behaviour
- Rendering interaction



Challenges: interaction with V.H. in V.R.

- Acting in V.R. (how do V.H. perceive user actions):
 - Use of motion interfaces and metaphors:
change action modalities compared to reality
 - Action/motion tracking:
V.H. perceive (and can react to) what is tracked only
 - Perception biases:
distances, limited FOV, modalities, perception of self
(Michael)
- Reactive V.H.
 - Animation
 - Behaviour
- Rendering interaction



Challenges: interaction with V.H. in V.R.

- Acting in V.R. (how do V.H. perceive user actions):
- Reactive V.H. (animation and behavior)
 - V.H. are basically inexpressive, non-reactive
 - Still challenging to perform real-time animation of virtual characters in situations of interactions with a real subject
 - Low dimensional input (sensing R.U. states)
 - Motion expressivity is still an open question (non verbal communication)
 - Collective behavior
- Rendering interaction



Challenges: interaction with V.H. in V.R.

- Acting in V.R. (how do V.H. perceive user actions):
- Reactive V.H.
- Rendering interaction:
 - We are missing many modalities: touch, sound.
 - High-fidelity rendering of virtual humans



Avatars impact on users' behavior

- How does avatar behavior impact our decision making?

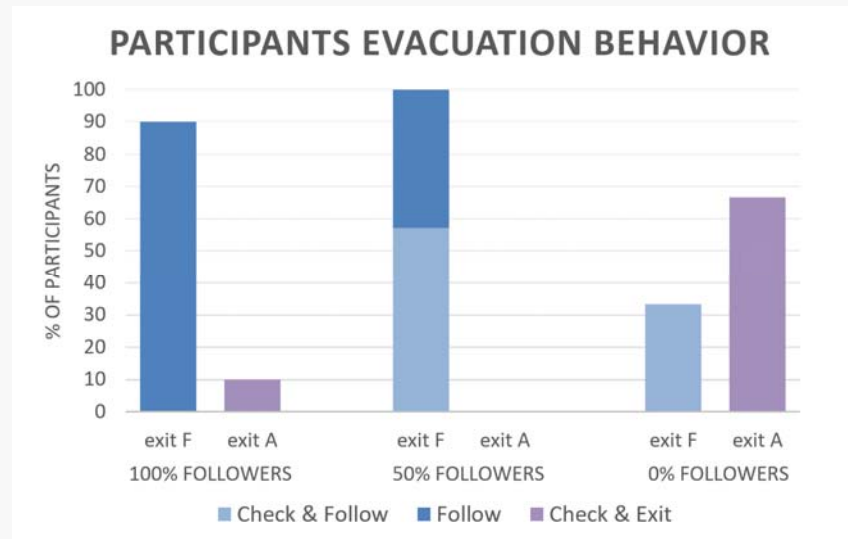


Avatars impact on users' behavior



- Do we act differently based on the avatars' behavior?
- Does avatar's behavior affect our stress levels during an emergency?
- Given the same avatars' behavior, do we act differently based on the environment?
- Need for more studies on how avatar simulation can affect human behavior
 - What aspects need to improve?

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A. Rios, D. Mateu, N. Pelechano. *Follower Behavior in a Virtual Environment*. Virtual Humans and Crowds in Immersive Environments (VHCIE) 2018.



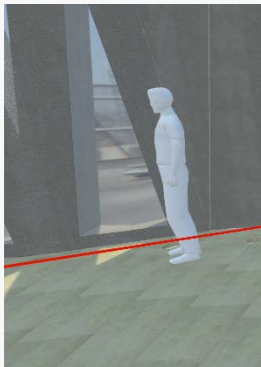
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Fewer avatars / closer interaction

- Several people interacting in immersive VR (HMDs)
- Applications:
 - Architecture



C. Andujar, P. Brunet, J. Buxareu, J. Fons, N. Laguarda, J. Pascual, N. Pelechano. *VR-assisted Architectural Design in a Heritage Site: the Sagrada Família Case Study*. EG Workshop on Graphics and Cultural Heritage (EG GCH) 2018.



Collaborative VR



Fewer avatars / closer interaction

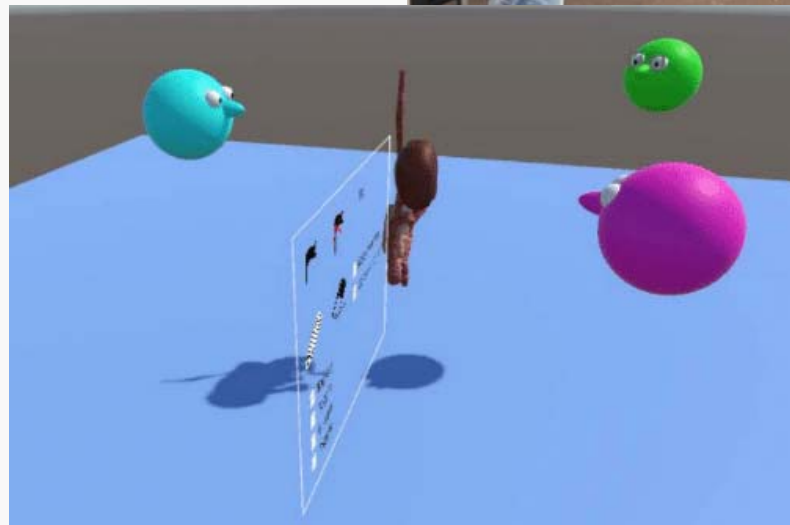
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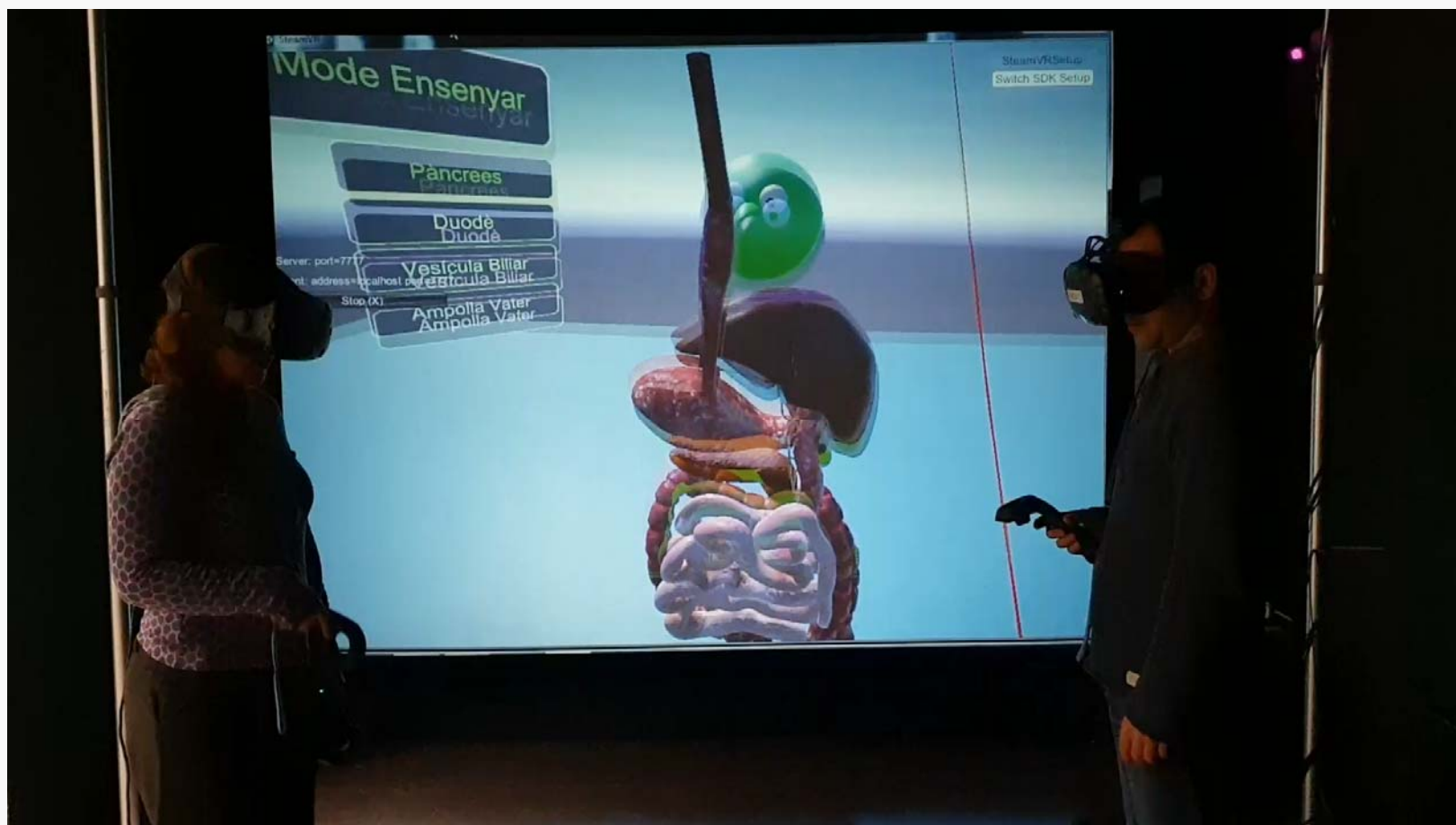


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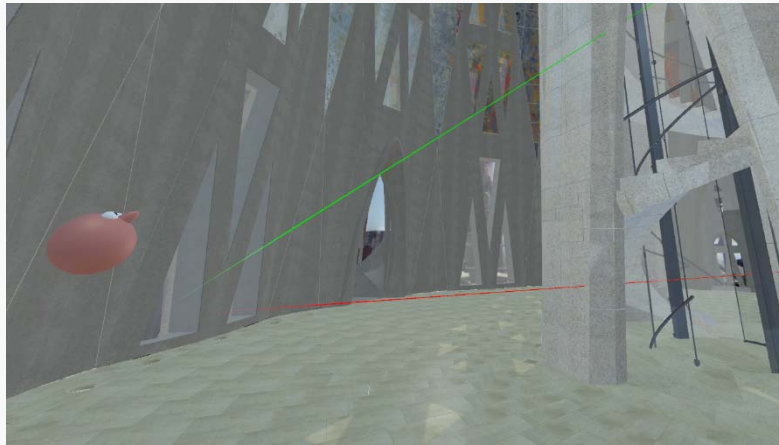
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 - Teaching



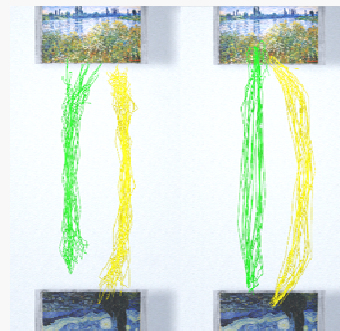


Collaborative VR



- Where are the others?
- What are they talking about?
- How would I move around them?

Sync anim.
avatars vs. No VR



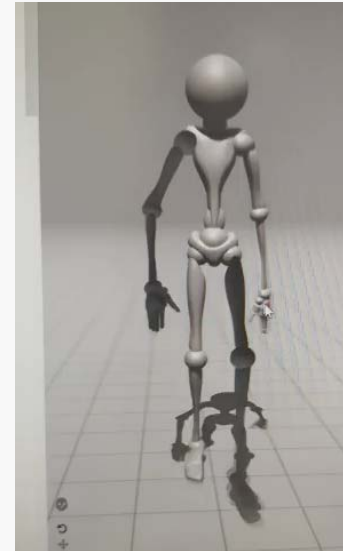
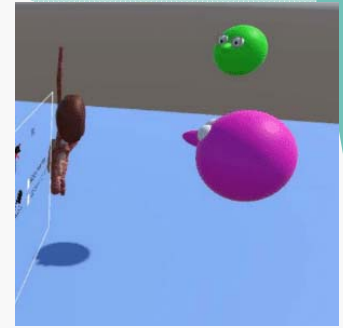
Clearance difference $\approx 5\text{cm}$

A. Rios, M. Palomar, N. Pelechano. *Users' locomotor behavior in Collaborative Virtual Reality*.
Motion Interaction and Games (MIG) 2018



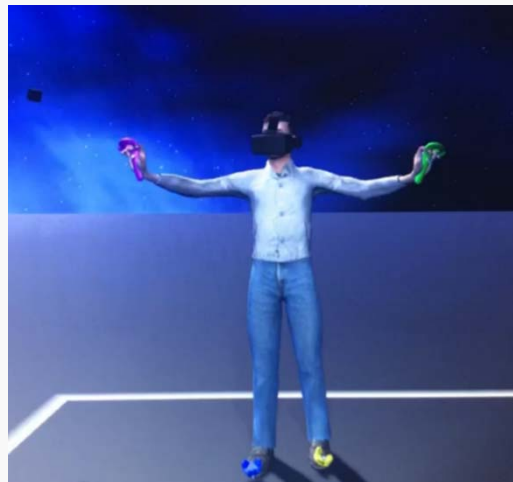
How does VH representation affect the user?

- Is it better cartoonish avatars or realistic ones?
- Is it better to simply use stick figures?
Floating heads and controllers?
 - It depends... if the avatar is not a good match, then users may prefer simplistic representations
 - But can we still get immersion? Presence?
- Uncanny Valley?



Embodiment

- We need to see some representation of ourselves.
 - Which one is best?
- Needs to be not only consistent in appearance but also in movement. Full mocap vs. a few markers



Mohler, B., Creem-Regehr, S., B. Thompson, W. & Bühlhoff, H. The Effect of Viewing a Self-Avatar on Distance Judgments in an HMD-Based Virtual Environment. Presence. (2010).



How does VH representation affect the user?

- When it comes to interacting with virtual humanoids?
- When it comes to interacting with another immersed user?
- When it comes to self avatar?



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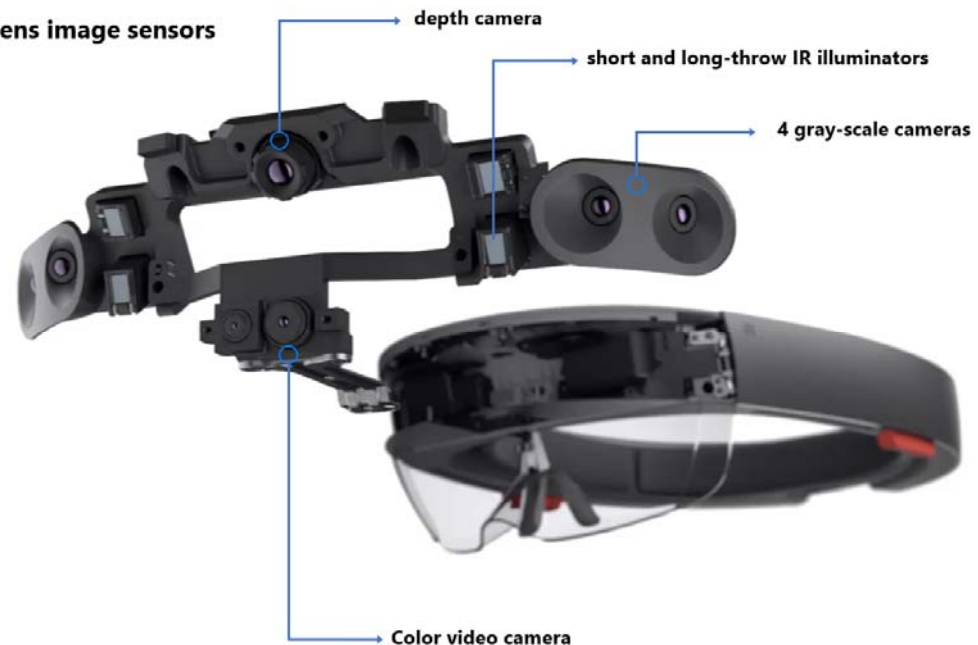


Virtual humans in Augmented Reality



A common view is that Augmented Reality will be more useful and with more impact to our lives compared to VR

HoloLens image sensors



Virtual humans in Augmented Reality

Just like in VR:

Modelling

Behavior /
Animation

Rendering



Modelling

Behavior /
Animation

Rendering



3D scan from Mirror 3D Lab (Cyprus)



Papagiannakis 2017



Modelling

Behavior /
Animation

Rendering



Modelling

Behavior /
Animation

Rendering



[Live Augmented Reality for National Geographic / UPC](#) from [Appshaker Ltd](#)

- Consistent illumination
- Good depth and geometry approximation



Modelling

Behavior / Animation

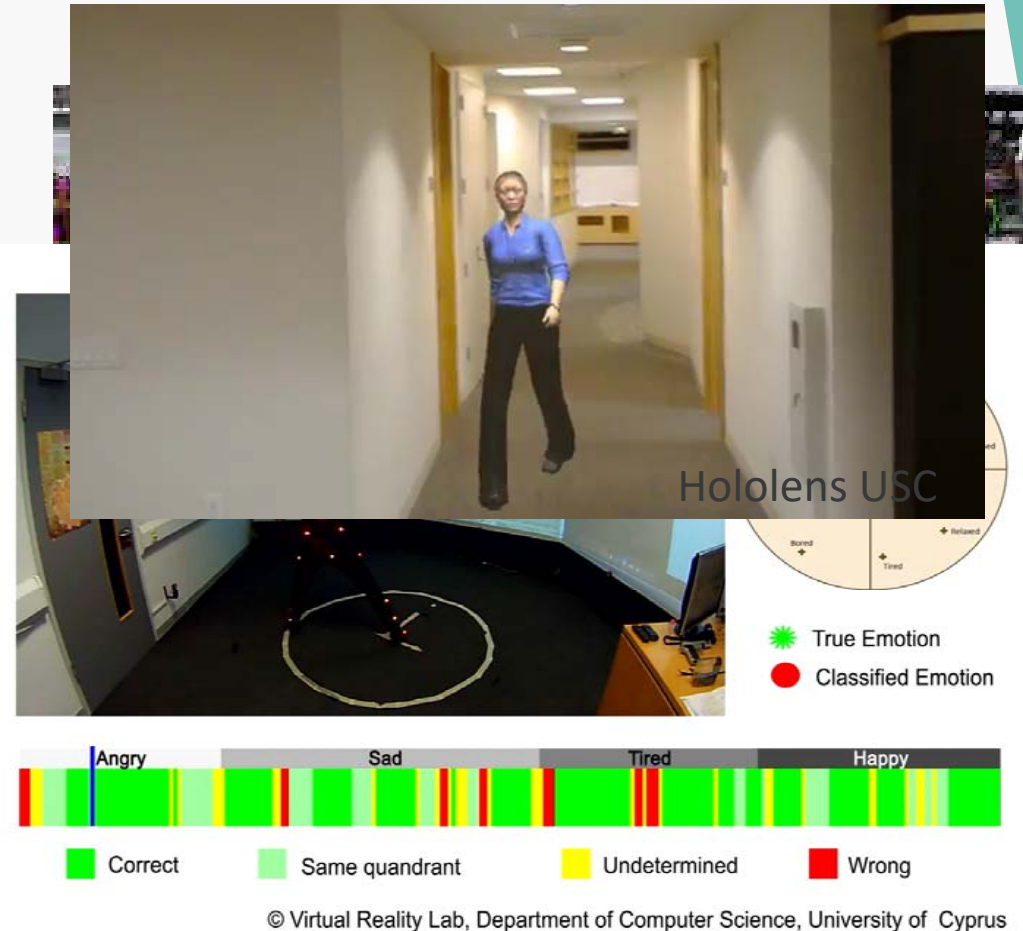
Rendering

Interaction with the environment

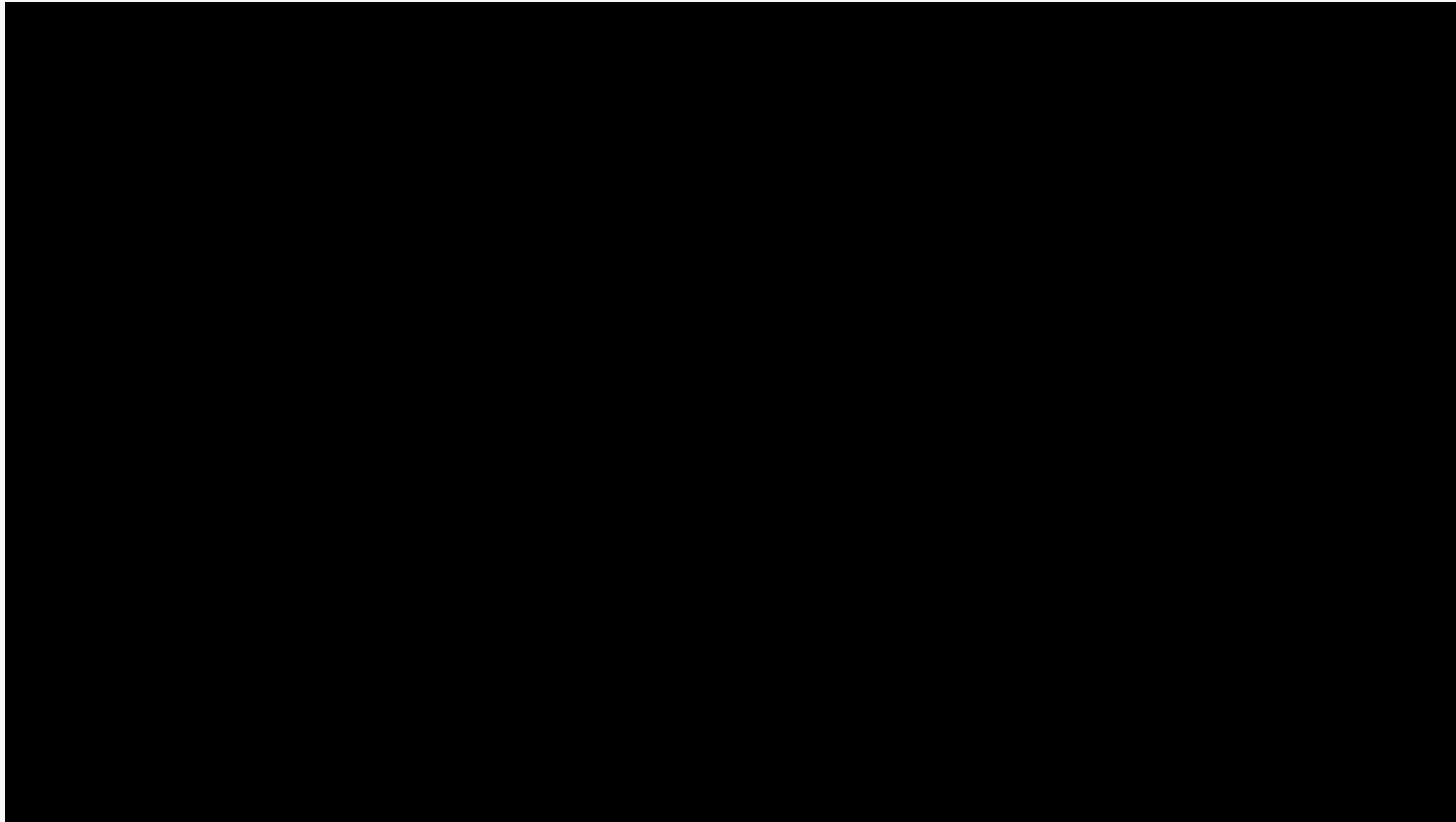
- 3D representation
- Segmentation
- Semantic understanding

Interaction with other humans/user

- Track people
- Understand intentions
- Understand emotions
- Expressive characters
- Conversational/intelligent
- More flexible animation system
- Haptic feedback



In the not too distant future



Siren Real-Time Performance | Project Spotlight | Unreal Engine



Does this create ethical issues?

For example:

- Further isolate users from real humans?
- Create emotional attachment to virtual characters?
- Creating bonds and “friendships” that could lead to disclosure of personal information?



Questions?

- If you want to comment on this topic:

<https://doodle.com/poll/8ewr7kn6iyg6tsxw>

