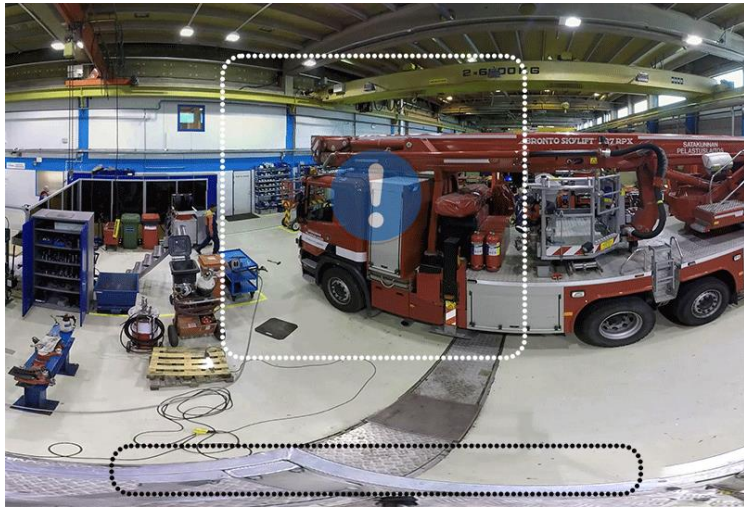




# XR-teknologiat koulutukseen, kulttuuriin, mediaan ja teollisuuteen



**Markku Turunen (markku.turunen@sis.uta.fi)**

University of Tampere, Tampere Unit for Computer-Human Interaction

**DigiMyrsky, Tampere, 30.11.2017**



## Agenda

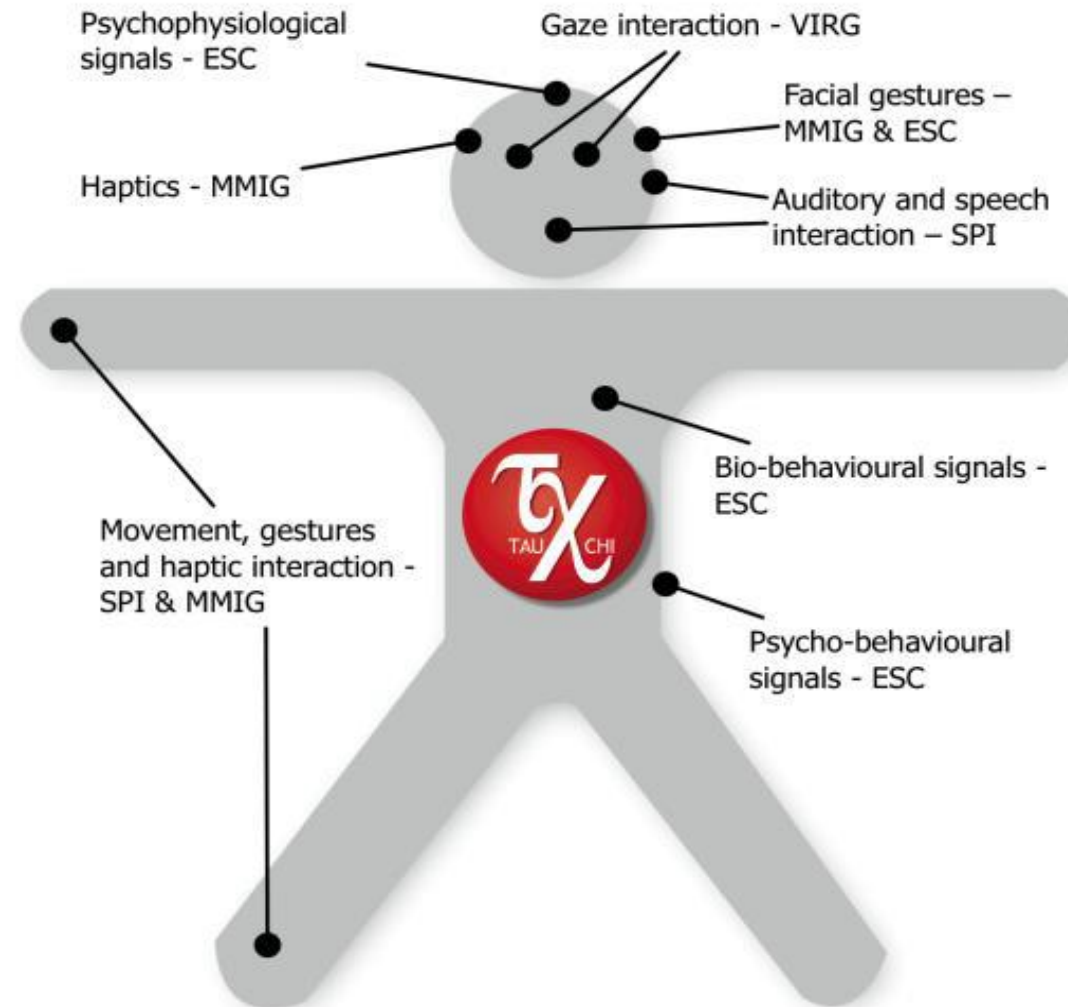
- **Background: Tampere Unit for Computer-Human Interaction**
- XR technologies
- iODV - interactive 360 videos
- Example case studies
- User Experience of iOVDs
- Human-computer interaction in XR



# TAUCHI - Tampere Unit for Computer Human Interaction

- A leading research center in Human-Computer Interaction, 50 people
  - Multidisciplinary
  - Multinational
- The largest and highest ranked academic human-technology interaction research unit in Finland

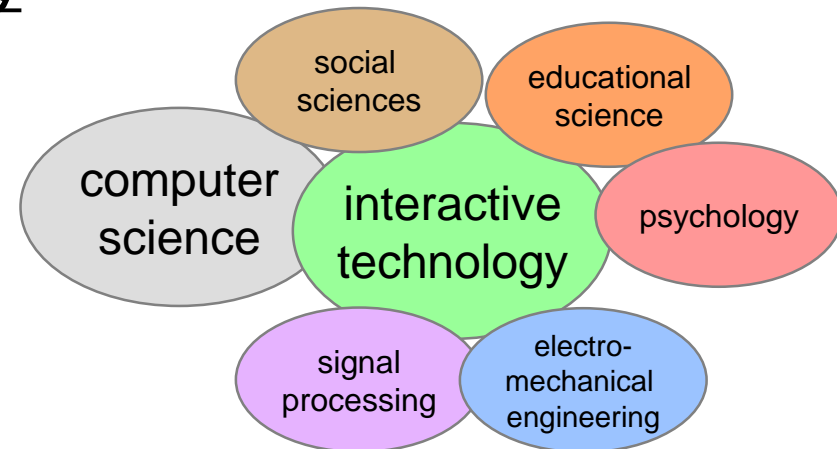
(\*) Source: Nationwide evaluation carried out by the Academy of Finland.





# TAUCHI - Tampere Unit for Computer Human Interaction

*TAUCHI carries out interdisciplinary research and development on human-technology interaction realizing the potential of technology in harmony with human abilities, needs, and limitations.*





## Agenda

- Background: Tampere Unit for Computer-Human Interaction
- **XR technologies**
- iODV - interactive 360 videos
- Example case studies
- User Experience of iOVDs
- Human-computer interaction in XR



## Virtuaalitodellisuus

- Virtuaalitodellisuus (Virtual Reality, VR), lisätty todellisuus (Augmented Reality, AR) ja sekoitettu todellisuus (Mixed Reality, MR) mahdollistavat laajan joukon erilaisia oppimisympäristöjä
- XR on yleisnimitys näille teknologioille
- Seuraavassa käydään läpi
  - Muutamia relevantteja käsitteitä
  - AR ja VR teknologia lyhyesti
  - Joitakin esimerkkejä AR ja VR ratkaisuksista



## XR: VR-AR-MR



**Virtual Reality:** Immersiivinen kokemus, täysin virtuaalimaailmassa



**Mixed Reality:** Digitaalinen informaatio osana reaali maailmaa synkronoidusti

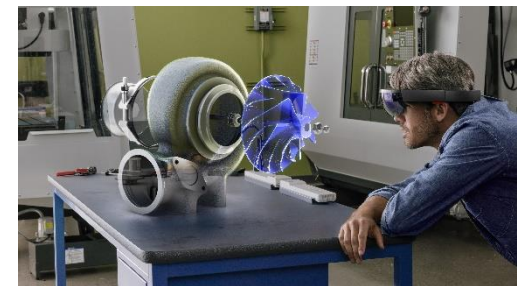
Adapted from:  
<https://www.thefoundry.co.uk/solutions/virtual-reality/vr-ar-mr-sorry-im-confused/>

**Augmented Reality:** Digitaalinen informaatio osana reaali maailmaa synkronoimattomasti



**Diminished Reality:** Reaali maailmasta häivytetään epärelevanttia informaatiota

**Holography:** Microsoftin versio MR:stä





## Relevantteja käsitteitä

- Etenkin virtuaalitodellisuuden alueella **Immersion** käsite on tärkeä
- Myös AR puolella voidaan käsitettä hyödyntää
- Immersion täsmällinen merkitys vaihtelee materiaalista riippuen, voidaan erottaa
  - Sensorinen immersio vs. läsnäolon tunne (immersion, presence)
  - Lisäksi tähän liittyy tehtävään uppoutuminen (luokkina esitetty mm. engagement, engrossment and total immersion)
- Osaa VR/AR hyödyistä pidetään nimenomaan immersion aikaansaamina





## Esimerkki immersiosta



Kallioniemi, P., Mäkelä, V., Saarinen, S., Turunen M. Immersion and User Experience of Interactive Omnidirectional Videos in CAVE Virtual Reality Systems and Head-Mounted Displays. In Proceedings of Interact 2017, 2017.



# Sensorisen immersioon dimensio



Silmikkonäytöt, täydelliset ohjaamot kattavilla näyttöpinnoilla

- Suuriresoluutioinen grafiikka
- Realistinen grafiikka
- Sulavasti päivittyvä grafiikka
- Moniaistinen, ts. kuva, ääni ja tuntopalaute
- Luonnollinen vuorovaikutus

Tekstipohjaiset ja abstraktit graafiset käyttöliittymät



# Simulaation realismin dimensio

Realistinen

Abstrahoitu

Prosessin/fysiikan  
yksityiskohtainen ja  
reaaliaikainen malli

- Mahdollisuus simuloida tilanteita
- Mahdollisuus oppia esim. täsmällisiä motorisia taitoja, ts. proseduraalinen oppiminen

Yksinkertaistettu ja  
symbolinen malli  
aihealueesta, tilanteesta  
tai toiminnasta

- Esittää aiheen kannalta relevantteja tehtäviä ja kysymyksiä
- Vuorovaikutus voi olla esim. monivalintahenkistä



# AR teknologiat

- Silmikkonäytöt
- CAVE ympäristöt ja immersiiiviset fyysiset simulaattorit
  - Usean seinän ja mahdollisesti lattian ja katon peittävät näyttöpinnat
  - CAVE ympäristöissä yksi pääkäyttäjä jonka silmien sijainnin mukaan perspektiiviä säädetään
- Pöytänäytöt
- Mobiililaitteella nk. Magic lens VR
- Erilaisia ohjausteknologioita peliohjaimesta käyttäjän liikkeiden seurantaan
- Tilaääni
- 360-video on yksi tehokkain tapa tuottaa immersiiivistä materiaalia



# AR teknologiat

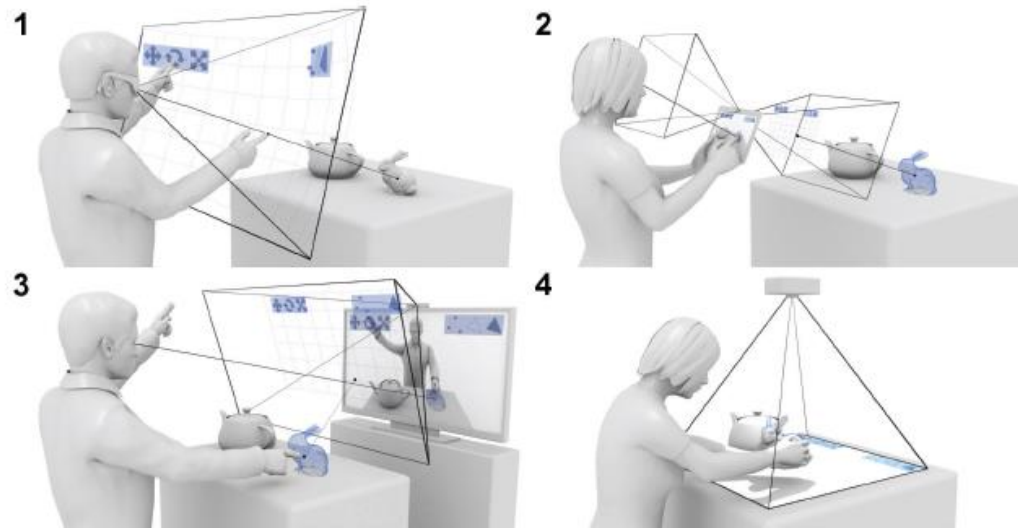




# AR teknologiat

- **Mobiililaitteiden AR**
  - Takakameran kuvaan lisätään sisältöä, voi perustua laitteen sijainti ja suuntasensoreihin (sisällöt karkeasti oikeassa suunnassa) ja/tai kamerakuvaan analyysiin
- **Projektoripohjainen AR**
  - Projektorilla “maalataan” informaatiota aitoon ympäristöön ja oikeisiin esineisiin
- **Silmikkonäytöt**
  - Kamerapohjaisesti kuten mobiililaitteilla
  - Puoliläpinäkyvät näytöt, esim. Microsoft HoloLens
- **Pöytänäytöt**
  - Peilimetafora: kamera kuvaa näytön edustaa ja kuvaan lisätään sisältöä
  - Puoliläpinäkyvä näyttö

# Lisätyn todellisuuden muotoja



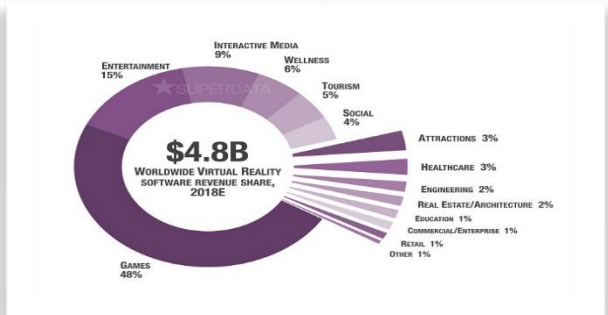
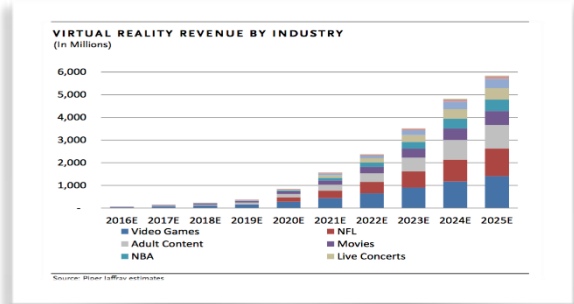
Lisätyn todellisuuden tyyppejä: (1) suora vuorovaikutus, (2) epäsuora vuorovaikutus, (3) peilattu vuorovaikutus, (4) kiinteä vuorovaikutus.



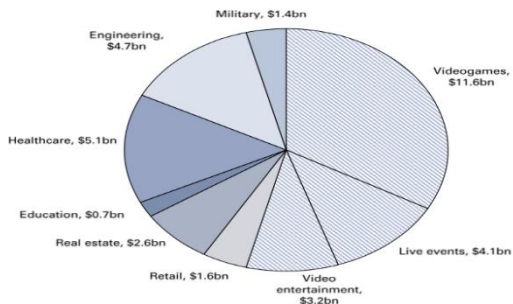
# Markkinat



Many analysts quote 2016-2017 as the market breakthrough. Smartphone VR becomes the default. Early adopters + games drive consumer sales, video and sports coming up. Professional apps slower to develop. HW+SW sales up to 80B\$ by 2025.



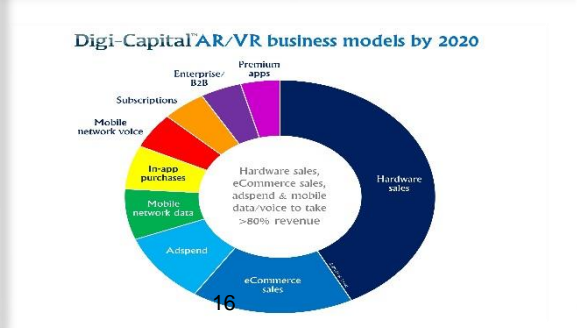
**Exhibit 14: Our 2025 VR/AR estimates by use case**  
Consumer-driven use cases in videogames, live events and video driving ~60% of software spend with the remainder from enterprise and public sector



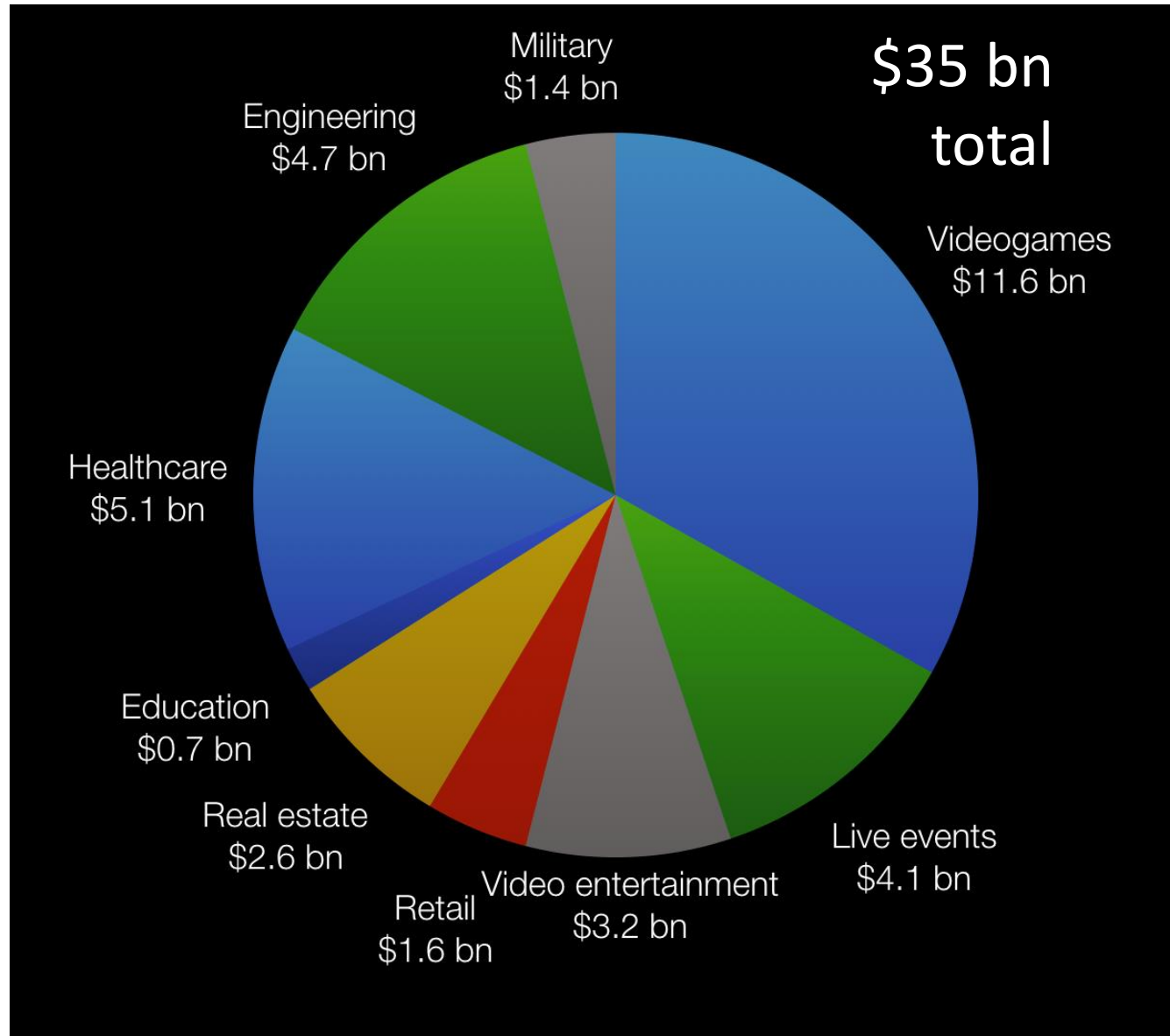
Source: Goldman Sachs Global Investment Research.



info@ccsinsight.com / @ccsinsight









## Agenda

- Background: Tampere Unit for Computer-Human Interaction
- XR technologies
- **iODV - interactive 360 videos**
- Example case studies
- User Experience of iOVDs
- Human-computer interaction in XR



## Interactive Omni-directional Videos (iODVs) - Cost-efficient VR

- Omni-directional videos - 360 videos or ODVs - provide cost efficient method for VR/AR (both when recorded and streamed)
  - Technology: available
  - Needed: guidelines, best practices, production processes and tools, interaction means
- Streamed (live) ODV vs. AR/MR: being physically or remotely in the location of interest



## iODV application areas (our cases)

- Traditional industry: remote maintenance and tele-operation
- Culture and entertainment: e.g. museum installations
- Education: e.g., collaborative second language learning in iODV
- Journalism: e.g., interactive stories of historical persons
- Media industry: e.g., interactive ODV programs



## Interactive ODVs

- Interaction is a key issue in advanced ODVs
- Our focus:
  - Interaction techniques in iODVs
  - User experience - and experiential factors in particular - of iODVs
  - Production pipeline of iODVs



## Agenda

- Background: Tampere Unit for Computer-Human Interaction
- XR technologies
- iODV - interactive 360 videos
- **Example case studies**
- User Experience of iOVDs
- Human-computer interaction in XR



# Culture and Entertainment



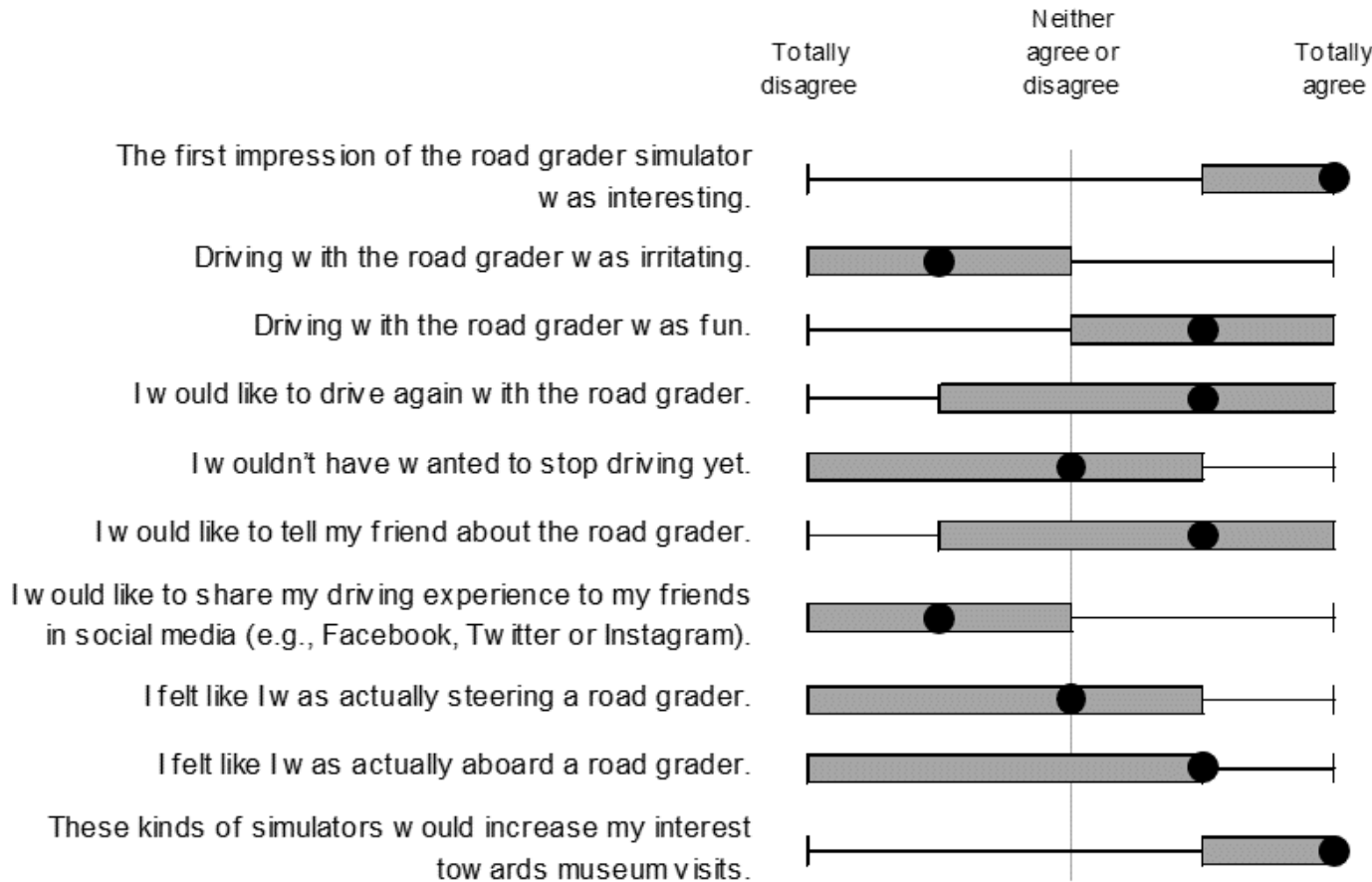
3xFullHD projector,  
~160 degrees horizontal field of view

Steering via accelerometer  
Light sensor in seat  
Audio speaker  
Computer  
Haptic feedback under the seat  
Linear potentiometers for pedals

The diagram shows a cross-section of the simulator's internal components. It includes a steering wheel, a seat, a computer system, and various sensors and actuators. The components are labeled with lines pointing to their respective parts in the diagram.



# EXPERIENCES (n=85)



How much did you like the road grader simulator overall?





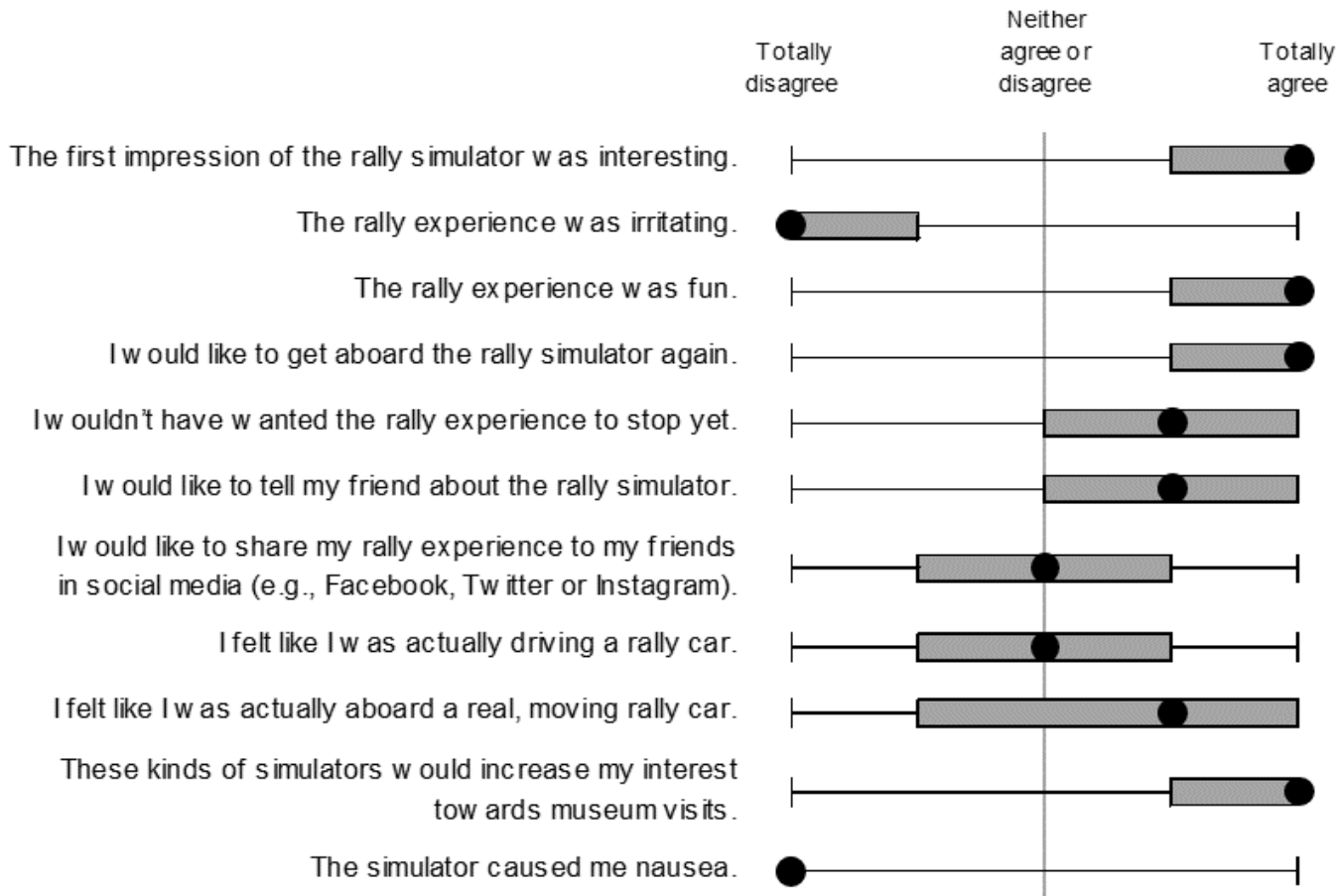


# Culture and Entertainment





# EXPERIENCES (n=263)



How much did you like the rally simulator overall?





# Educational Applications: CityCompass





## CityCompass

- A www/VR-based language learning application that supports remote collaboration for exploring 360 degree panoramic views of a city for wayfinding tasks
- CityCompass allows people from different countries to collaborate online with minimum resources





## CityCompass

- In CityCompass, two users, a tourist and a guide, work collaboratively to reach a preassigned destination in a city
- The route in the application consists of a sequence of 360 degree panoramas/videos of an actual city
- The guide helps the tourist through the scenes until they reach a common goal



## Is it fun and useful?

- **88 %** agreed with the statement that the application is pleasant to use ( $M = 6$ ,  $SD = 1.29$ ),  $N=99^*$
- **93 %** agreed with the statement that the application is entertaining ( $M = 6$ ,  $SD = 1.1$ ) ,  $N=99^*$
- **83 %** agreed with the statement that using the application is useful for learning ( $M = 6$ ,  $SD = 1.35$ ) ,  $N=99^*$

\* Kallioniemi et al. (2015). *Berlin Kompass: Multimodal Gameful Empowerment for Foreign Language Learning*. In *Journal of Educational Technology Systems*, Vol 43, Issue 4.

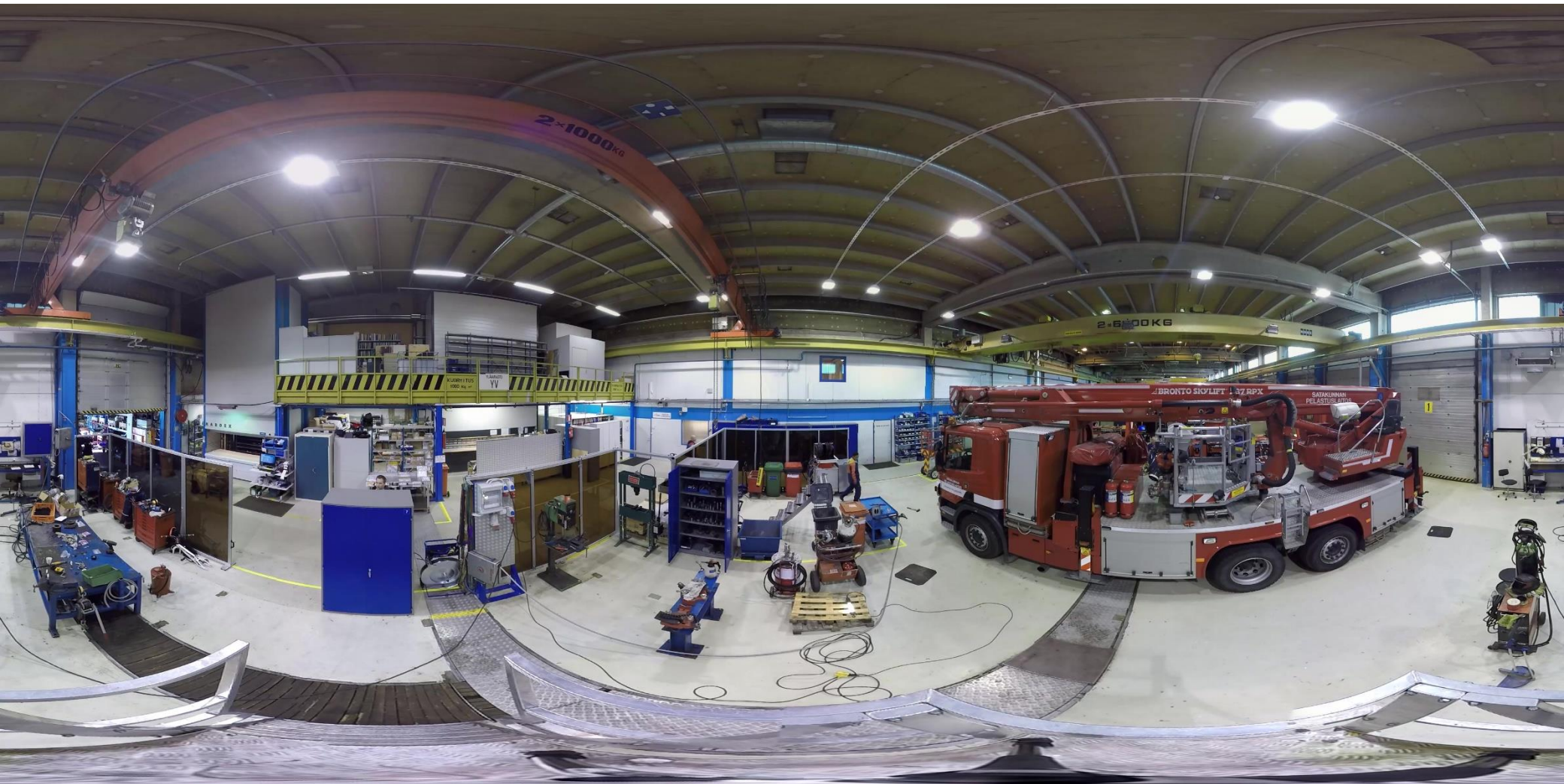


## Journalism & iODV





# Industrial applications







## iODV in Industrial Settings

- Capturing of tacit knowledge of industrial workers
  - Planning of operations
  - Training of operations
- Information visualization: shares similarities and differences with AR
- Utilization of multiple viewpoints (with several cameras)
- Efficient for remote operations



## Agenda

- Background: Tampere Unit for Computer-Human Interaction
- XR technologies
- iODV - interactive 360 videos
- Example case studies
- **XR User Experience**
- Human-computer interaction in XR



## UX and usability of iODVs

- UX and usability metrics of iODVs: e.g., immersion, presence, safety, feel of control etc. => usability questionnaires and interviews
- Objective metrics: tracking of user interaction with iODVs
- Gaze tracking: where people look at when they interact with ODVs
- Differences and similarities between application domains and recorded / live iODVs



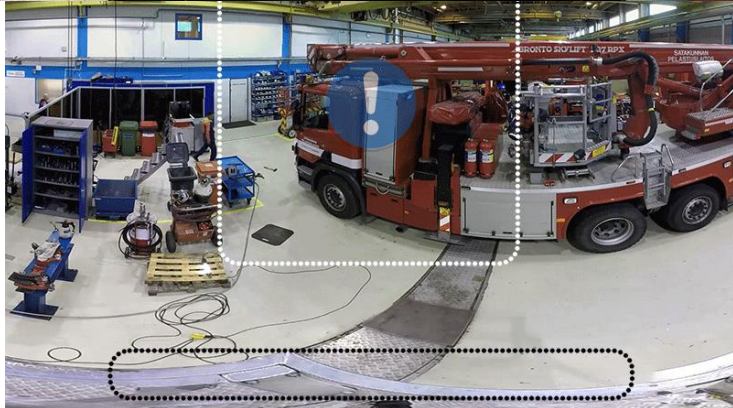
## Example Study: Immersion and User Experience with Interactive Omnidirectional Videos in CAVE VR Systems and HMDs \*

- We compared the users' **expectations and experience** and the **level of immersion** between a CAVE and HMD VR applications using qualitative and quantitative metrics in two domains: industrial and educational applications

\* Kallioniemi, P., Mäkelä, V., Saarinen, S., Turunen M. Immersion and User Experience of Interactive Omnidirectional Videos in CAVE Virtual Reality Systems and Head-Mounted Displays. In Proceedings of Interact 2017 (to appear), 2017.



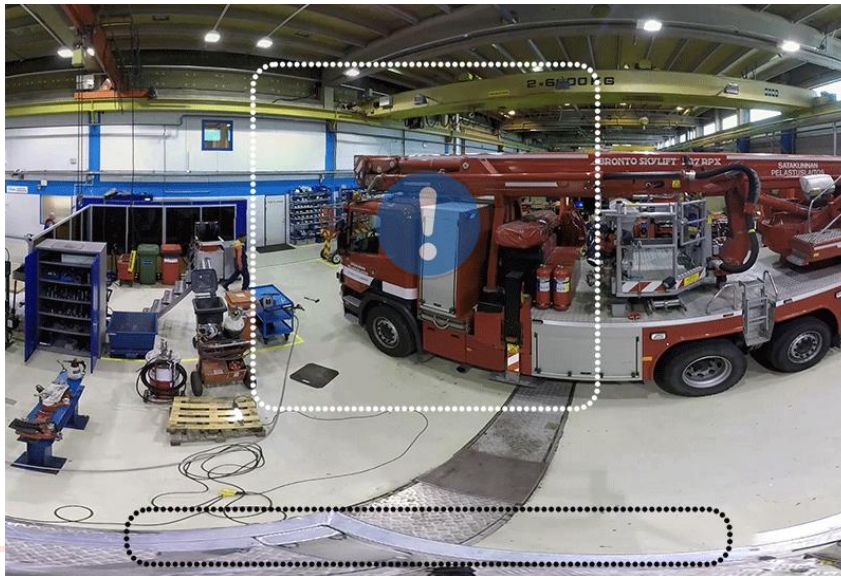
# Applications





# Contextual information in VR applications

- Both applications offered contextual information in a form of 'hotspots' that could be activated by the user
- We studied how meaningful and informative the users considered this information



*Hotspot locations in the two applications. HMD VR hotspot location is presented in white dotted line and CAVE system hotspot location in black dotted line.*



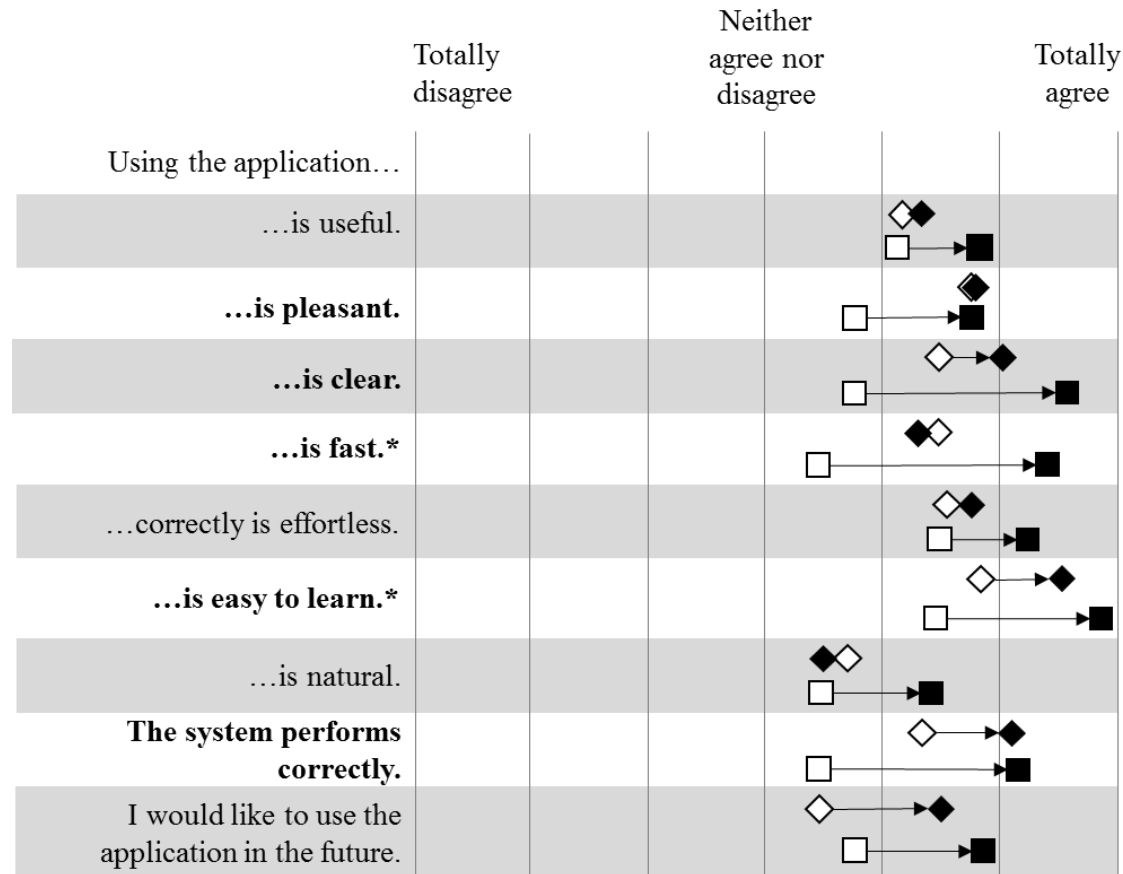
# User Expectations versus Experiences

◇ CAVE: Expectations (n=17)

◆ CAVE: Experiences (n=17)

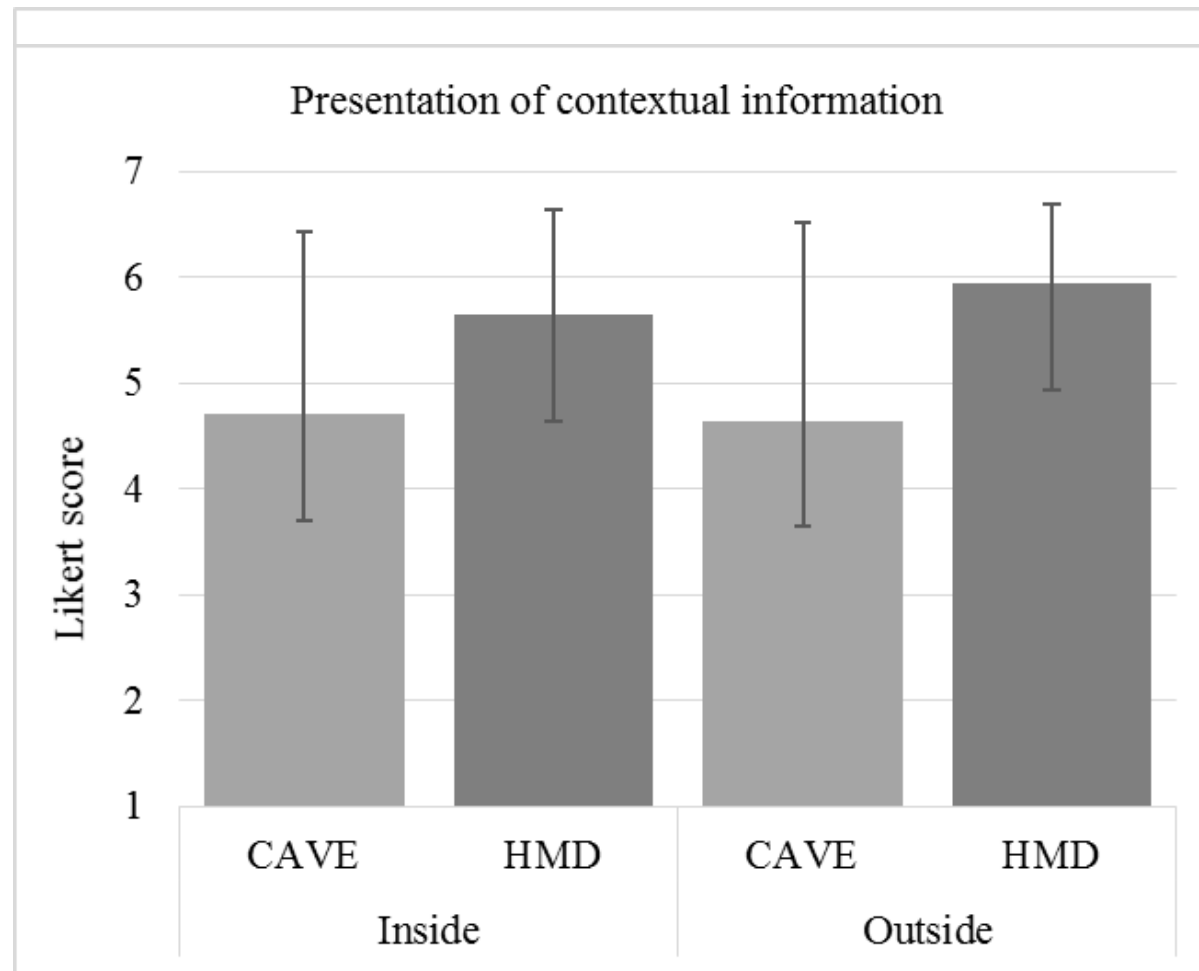
□ HMD: Expectations (n=17)

■ HMD: Experiences (n=17)





# Immersion







## Recent publications

- **Kallioniemi, P., Keskinen, T., Hakulinen, J., Turunen, M., Karhu, J., Ronkainen, K. Effect of Gender on Immersion in Collaborative iODV Applications. In Proceedings of The 16th International Conference on Mobile and Ubiquitous Multimedia (MUM 2017), 2017.**
- **Hakulinen, J., Keskinen, T., Mäkelä, V., Saarinen, S., Turunen, M. Omnidirectional Video in Museums - Authentic, Immersive and Entertaining. In Proceedings of ACE 2017 (Advances in Computer Entertainment: 14th International Conference on Advances in Computer Entertainment Technology), 2017.**
- **Immersion and User Experience of Interactive Omnidirectional Videos in CAVE Virtual Reality Systems and Head Mounted Displays. In Proceedings of Interact 2017, 2017.**
- **Guidelines for Designing Interactive Omnidirectional Video Applications. In Proceedings of Interact 2017, 2017.**
- **Innovating Virtual Reality Experiences for Journalism: The Design Thinking Approach. In Proceedings of Future of Journalism, 2017.**



## Agenda

- Background: Tampere Unit for Computer-Human Interaction
- XR technologies
- iODV - interactive 360 videos
- Example case studies
- XR User Experience
- **Human-computer interaction in XR**



## XR and Novel Interaction Methods

- XR needs proper interaction methods - we do not want to interact only with clumsy controllers: in AR/MR our hands should be used for the main tasks, not for interacting with the AR/MR app...
- Current XR solutions are very straightforward simulations/augmentations of current technologies
  - e.g., VR simulation of current machinery
  - e.g., MR maintenance / education applications
- Novel interaction methods allow **totally new ways of working and interacting in digital worlds**



## XR and Novel Interaction Methods

- Gestural interaction
- Embodied and spatial interaction
- Touch and pointing interfaces
- Gaze interaction
- Haptic and force feedback



## XR and Novel Interaction Methods

- Speech and auditory interaction (speech recognition, text-to-speech, speaker recognition)
- Interactive visualizations of complex data
- Smart and intelligent lighting
- Scents
- Novel control devices - yes, still something to do 😊



## XR and Novel Interaction Methods

- None of the mentioned techniques solve the challenge
- Truly multimodal XR interfaces:
  - Spoken interaction: complex, rich natural language interaction, references, emotions from speech
  - Gestural interaction: simple, discrete interaction, pointing
  - Haptics & sound: feedback, multimodal use
  - Gaze: where the users are looking at
  - Face detection: assists speech recognition, emotions (when not speaking)



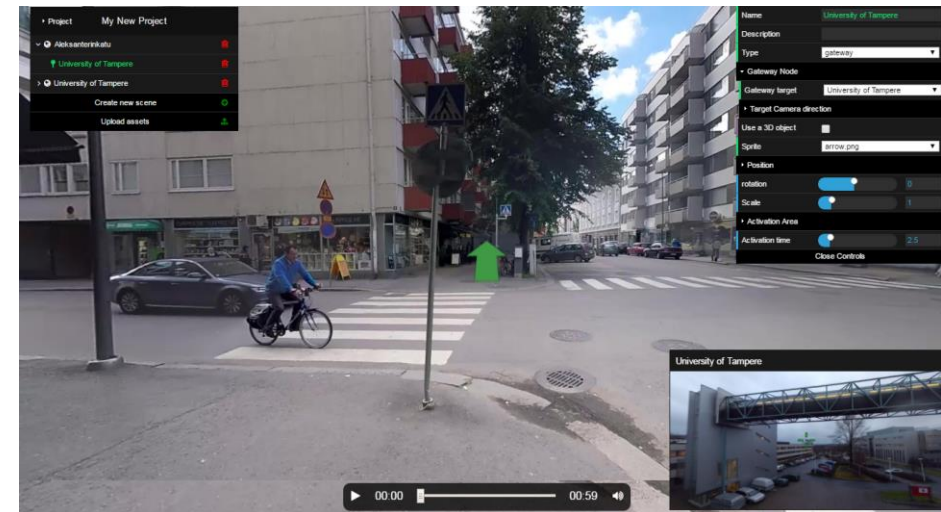
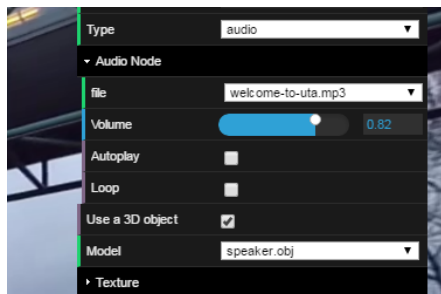
## Agenda

- Background: Tampere Unit for Computer-Human Interaction
- XR technologies
- iODV - interactive 360 videos
- Example case studies
- XR User Experience
- Human-computer interaction in XR
- **(hidden extra)**



# Cloud-based editor for interactive 360-video content

- Make interactive scenes from 360 videos and images
- Add interactivity with hotspots
- Hotspots can be 2D icons or 3D objects and include:
  - Transitions to other scenes
  - Text, images and audio



- Projects exported in json-format
  - Easy to use and manipulate in other applications

Soon available for public use!