Virtual Reality (VR)

Introducing VR interfaces and discussing relevant research

Linnéuniversitetet

2ME302-VT19

Forskningsutmaningar i medieteknik

Today

- Virtual Reality (VR)
- VR technologies
- Interaction in VR
- Research paper

  "Virtual Reality: How Much Immersion Is Enough?"
- VRxAR Labs

  current research efforts

virtual reality

definition according to LaValle (2016):

*"Inducing **targeted behavior** in an **organism** by using **artificial sensory stimulation**, while the organism has little or no **awareness** of the interference."*

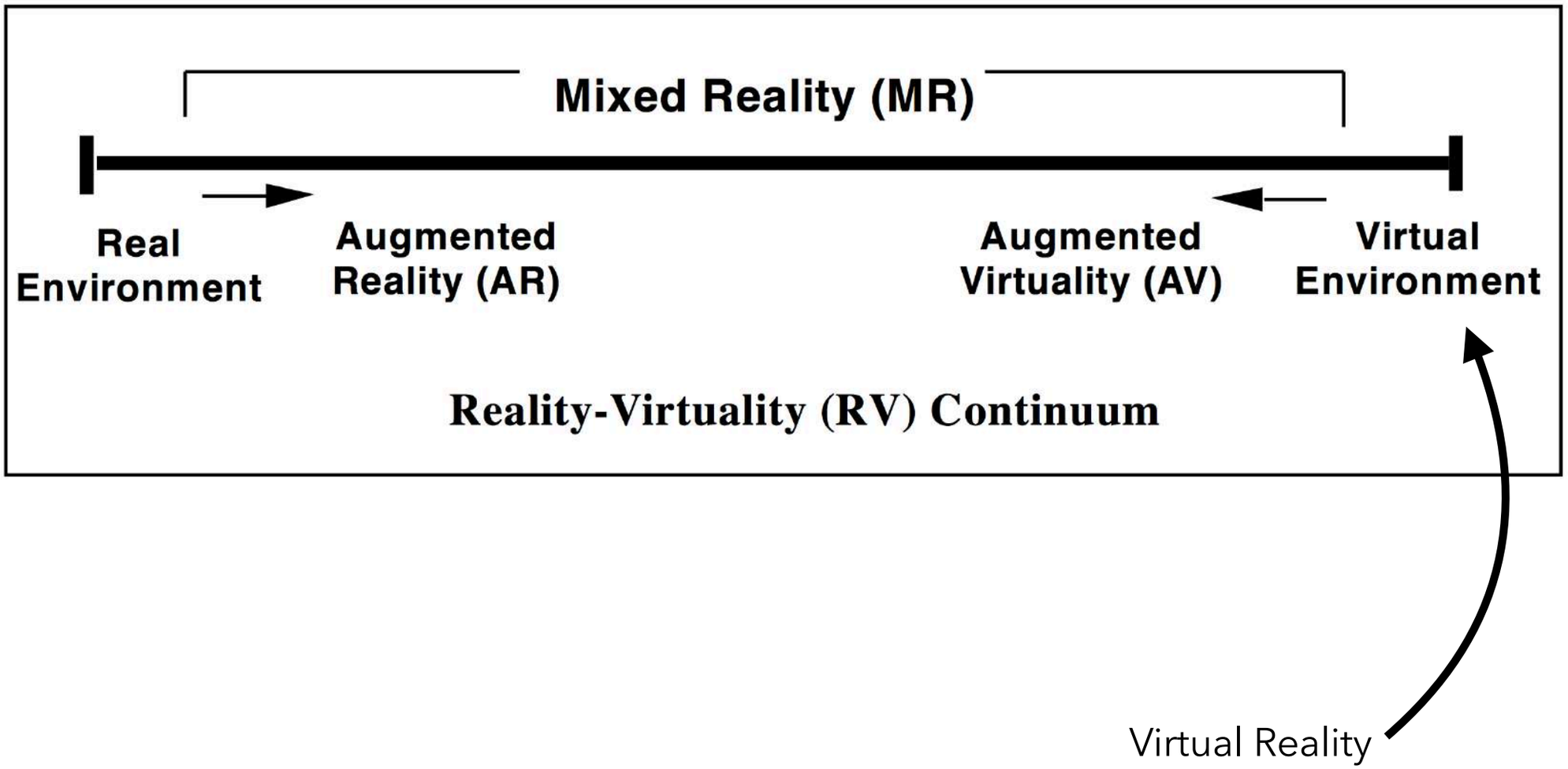
Steven M. LaValle. 2016. Virtual Reality. Online. http://vr.cs.uiuc.edu

sense	**interface**
sight	visual interfaces
hearing	auditory interfaces
touch	haptic interface
smell	scent (olfactory) interfaces
taste	flavour (gustatory) interfaces

"more or less" established

new frontiers

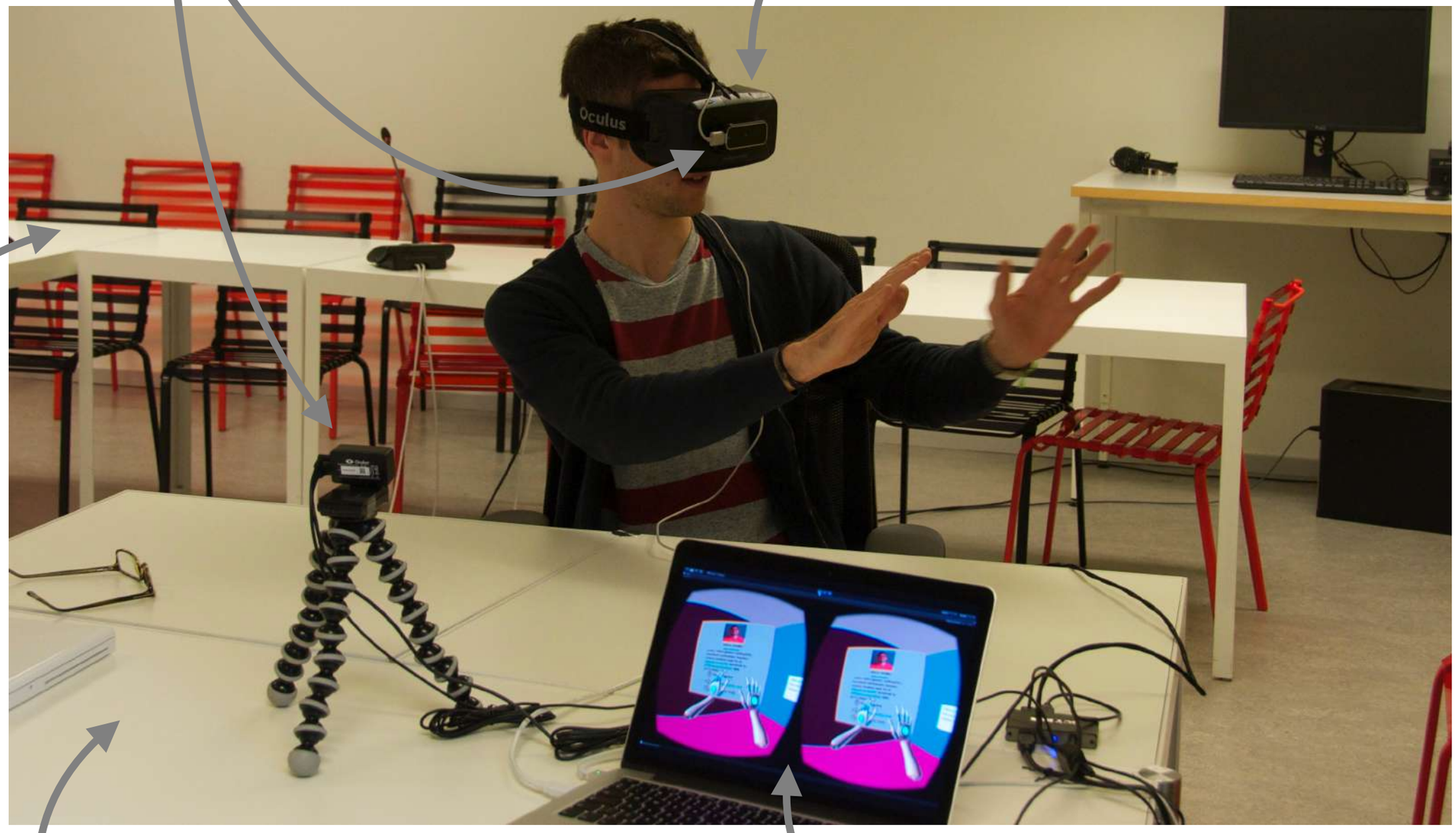
Steven M. LaValle. 2016. Virtual Reality. Online. http://vr.cs.uiuc.edu



P. Milgram, H. Takemura, A. Utsumi, and F. Kishino. 1994. Augmented Reality: A class of displays on the reality-virtuality continuum. In Proceedings of Telemanipulator and Telepresence Technologies. pp. 2351–34.

tracking sensors

head-mounted display
(HMD; “VR headset”)



physical real-world space

computer-generated, virtual
three-dimensional (3D) environment

Immersion

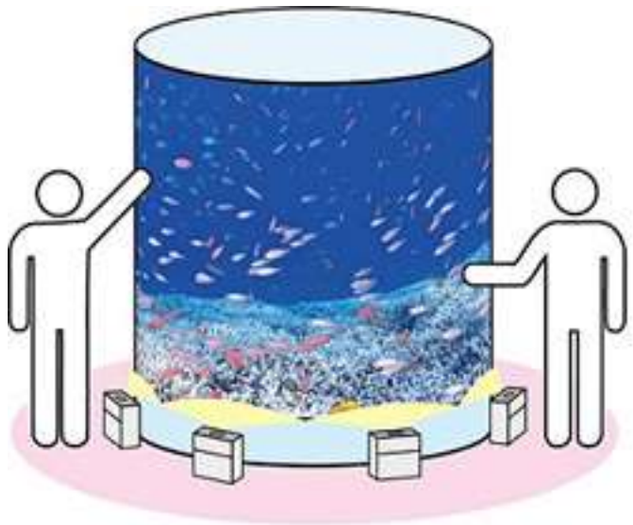
"Immersion refers to the objective level of sensory fidelity a VR system provides."

Presence

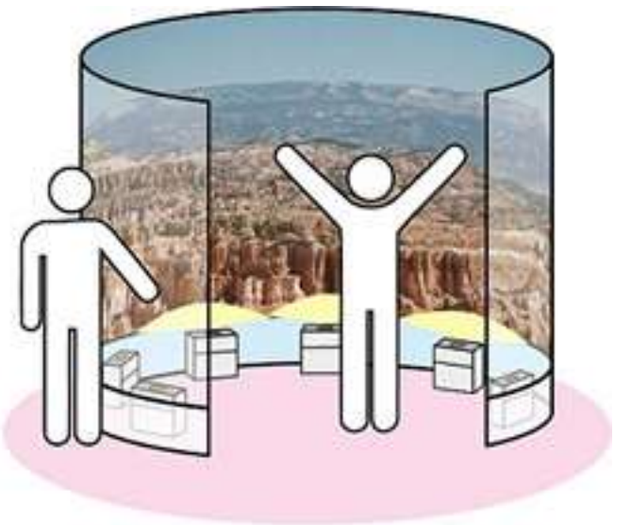
"Presence refers to a user's subjective psychological response to a VR system."

User feels like being **in** the virtual world.

D. A. Bowman, and R. P. McMahan. 2007. Virtual reality: how much immersion is enough? Computer 40(7):36–43.



360deg. Signage



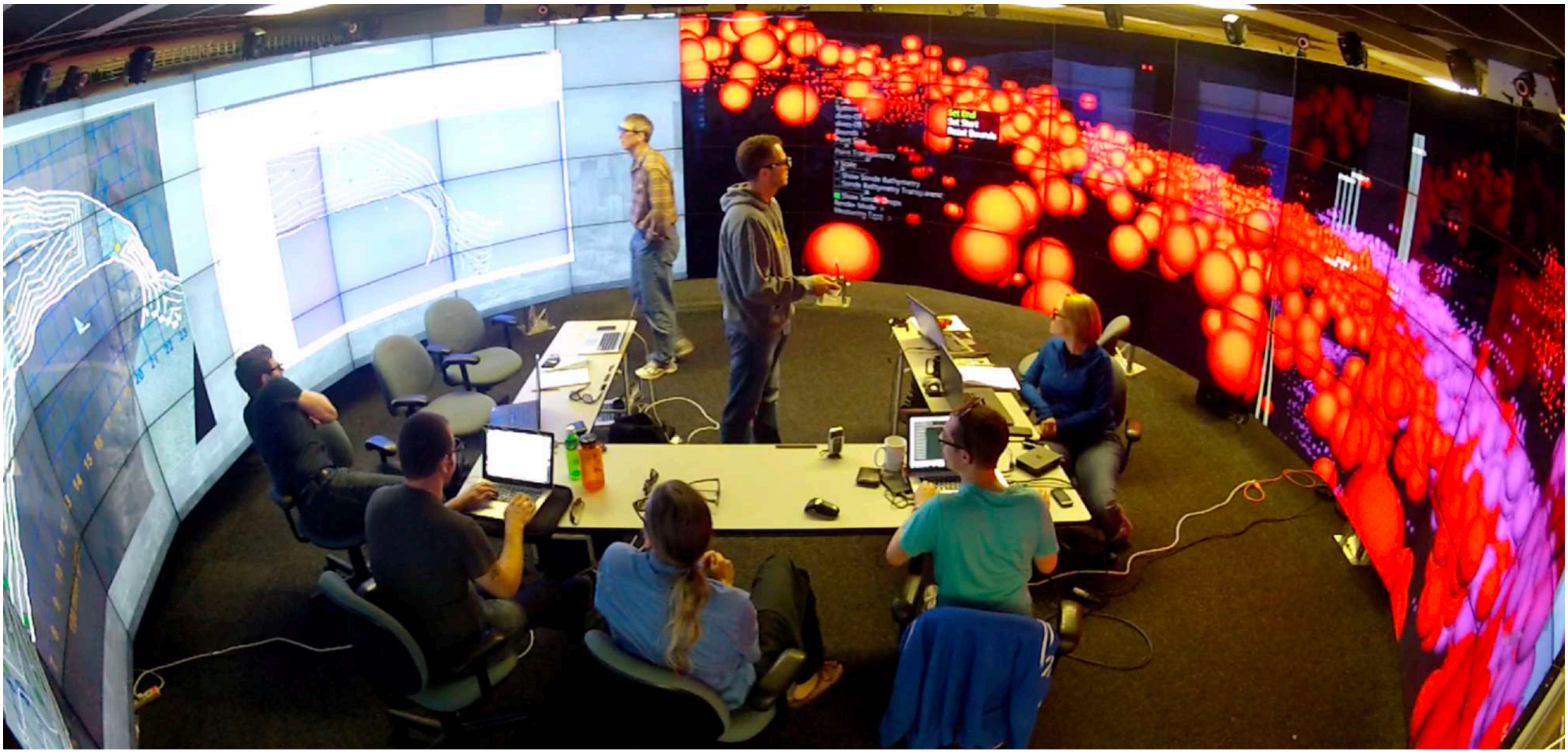
Immersive Projection

via ricoh.com

CAVE

Cave **A**utomatic **V**irtual **E**nvironment

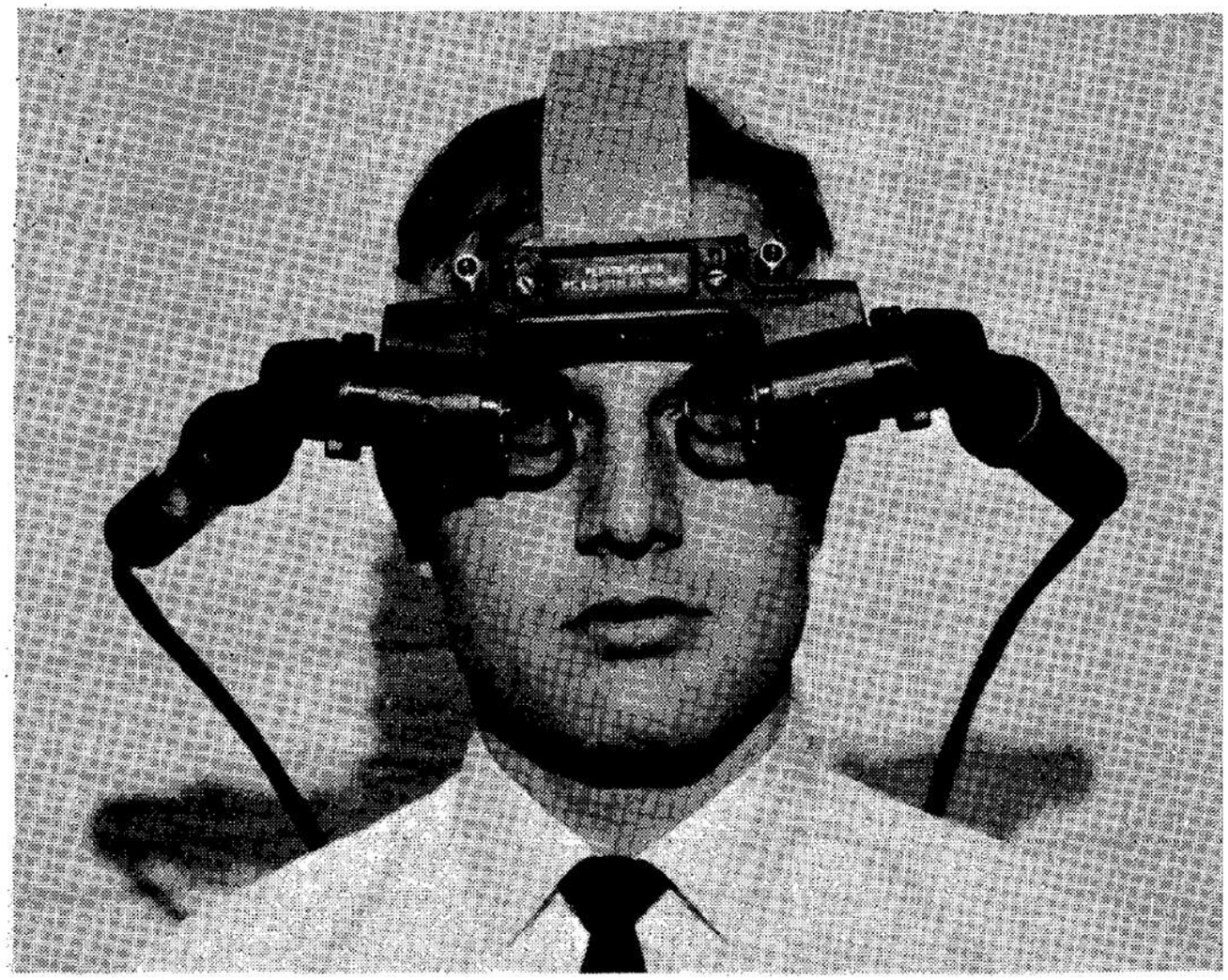
via bit.ly/IMG-Wiki-CAVE

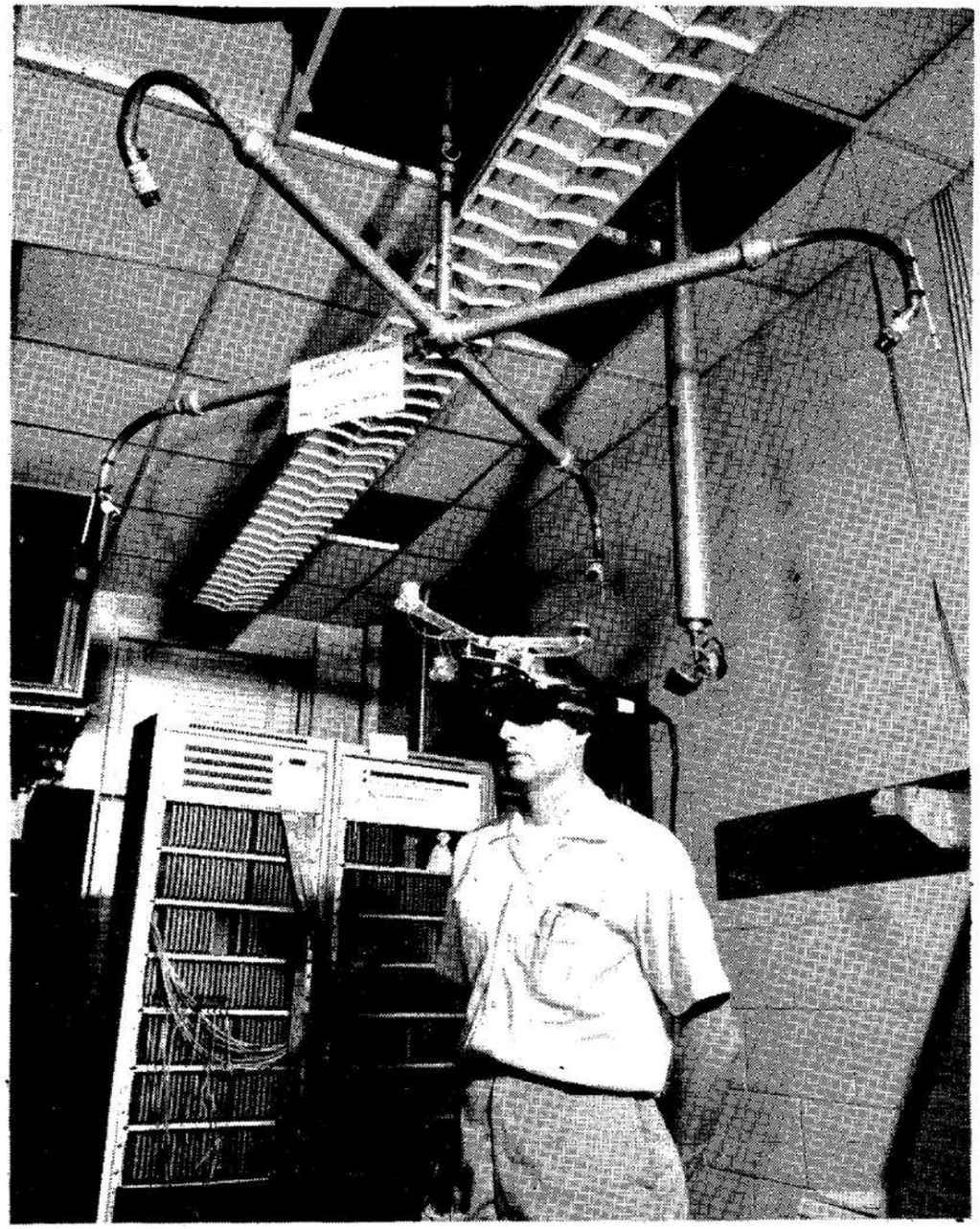


G. E. Marai, A. G. Forbes, and A. Johnson. 2016. Interdisciplinary immersive analytics at the electronic visualization laboratory: Lessons learned and upcoming challenges. In 2016 Workshop on Immersive Analytics, pp. 54-59.

HMD
Head-**M**ounted **D**isplay

via bit.ly/IMG-Wiki-HMD





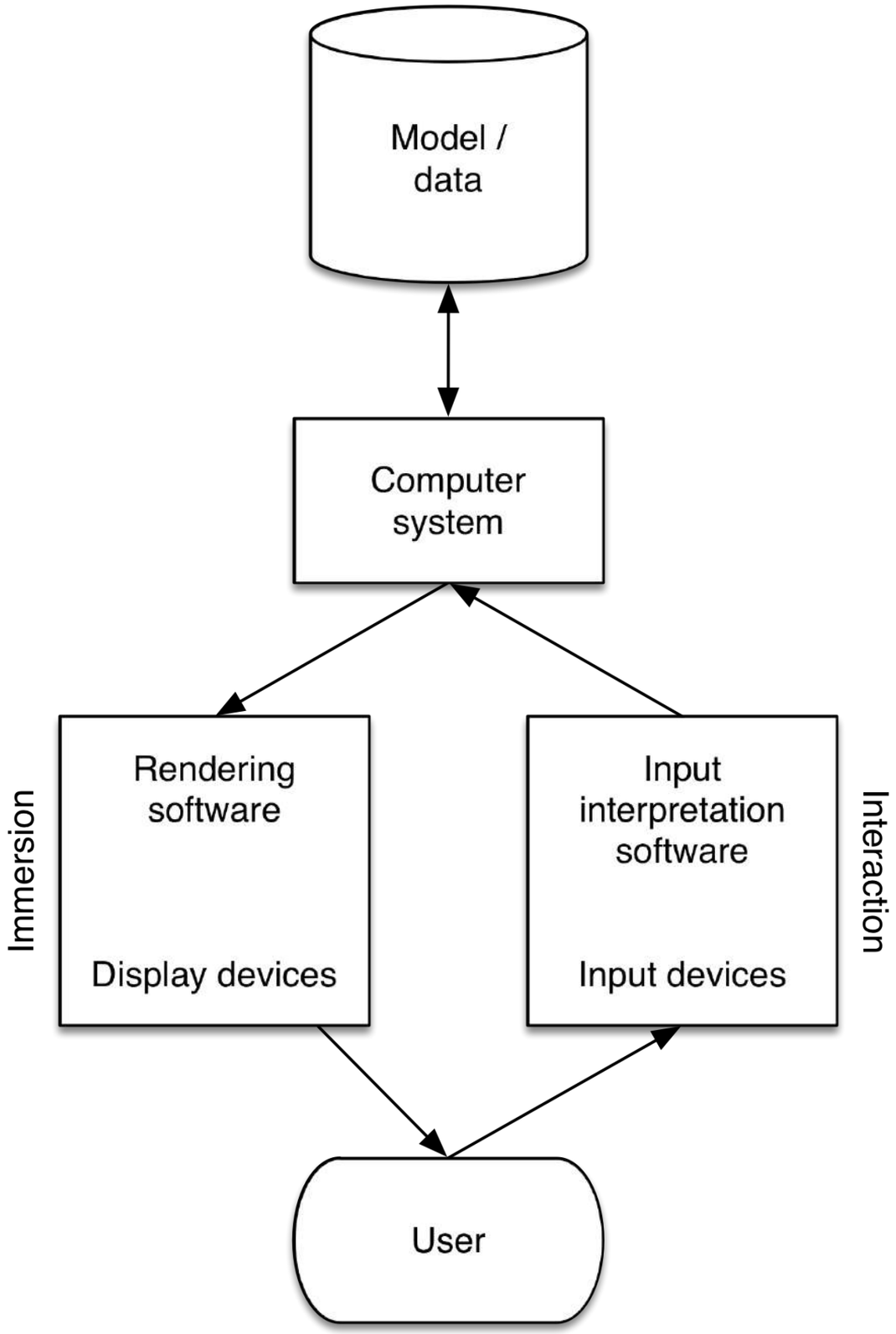
I. E. Sutherland. 1968. A head-mounted three dimensional display. In Proceedings of the December 9–11, 1968, fall joint computer conference, part I–AFIPS ’68 (Fall, part I), ACM, New York, NY, USA, pp 757–764.

via bit.ly/VR-Oculus

via bit.ly/Vive-DevFuture

via bit.ly/PS-VR

via bit.ly/VR-GoogleCardboard



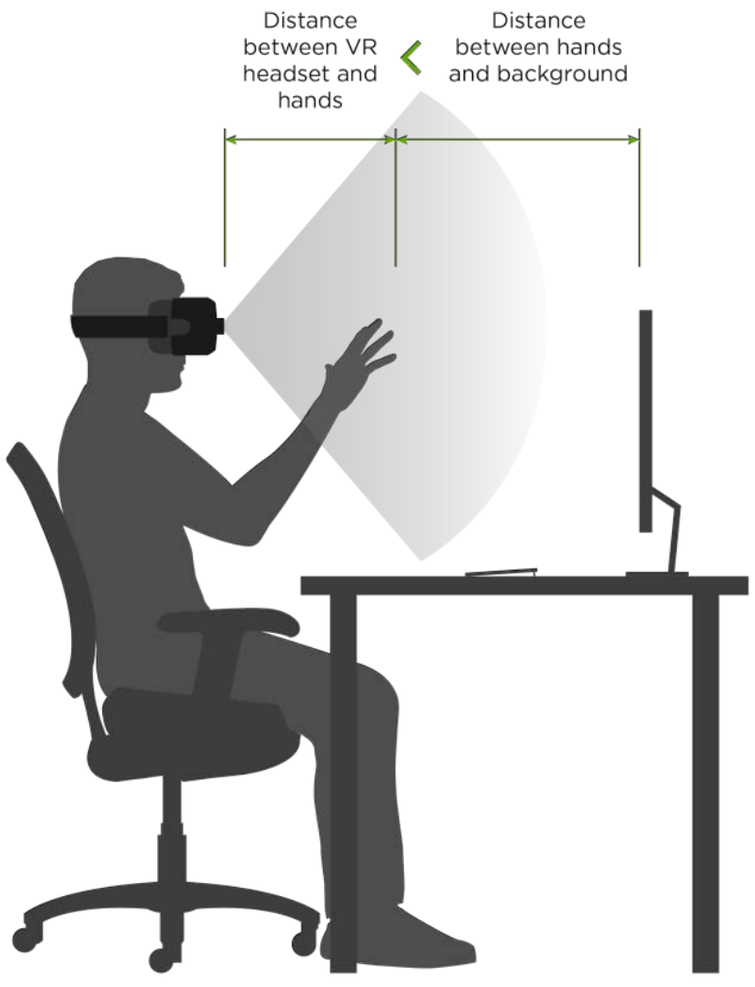
Human-Virtual Environment Interaction Loop

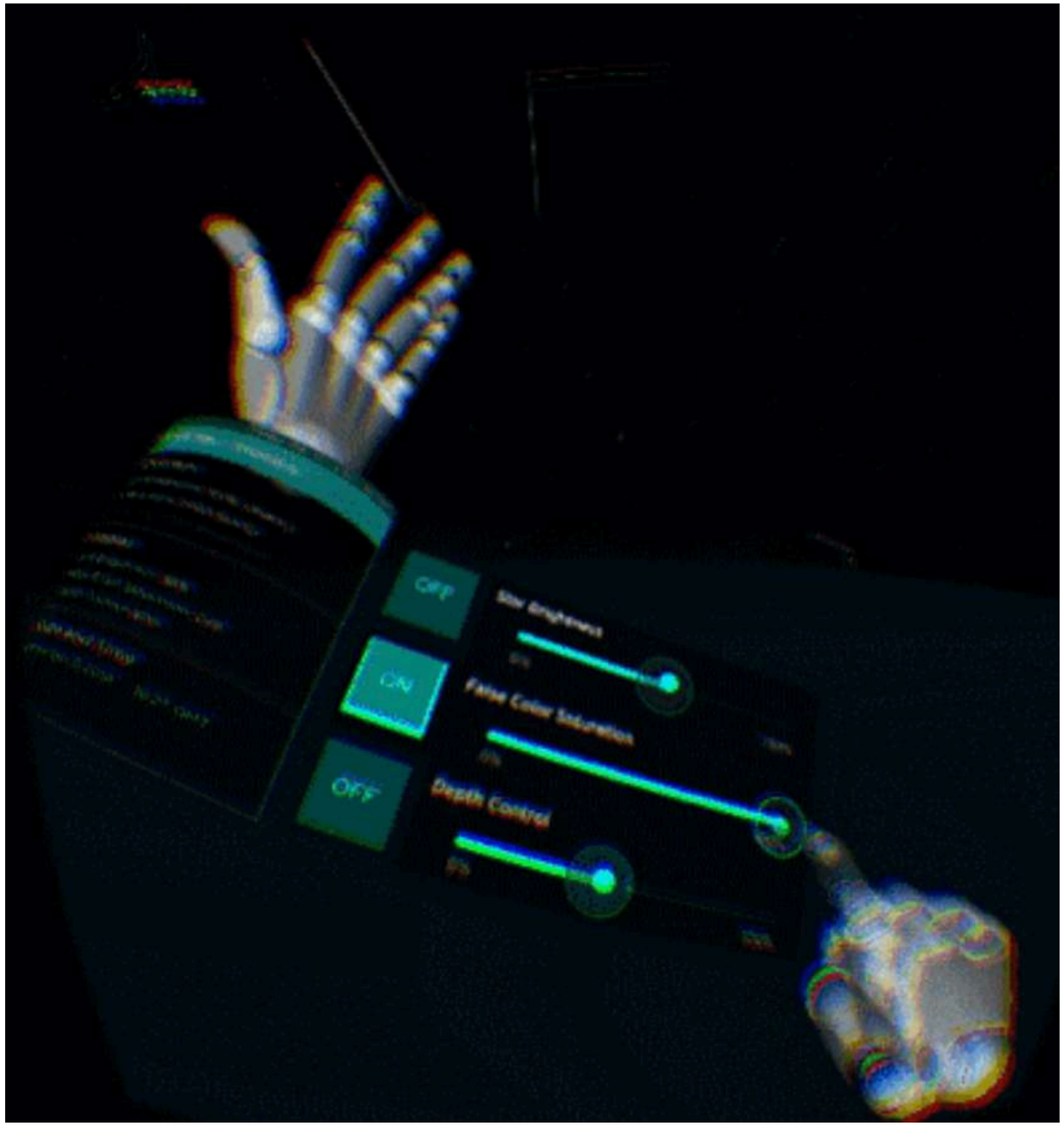
D. A. Bowman, and R. P. McMahan. 2007. Virtual reality: how much immersion is enough? Computer 40(7):36–43.

via play.google.com

via roadtovr.com

via xbox.com

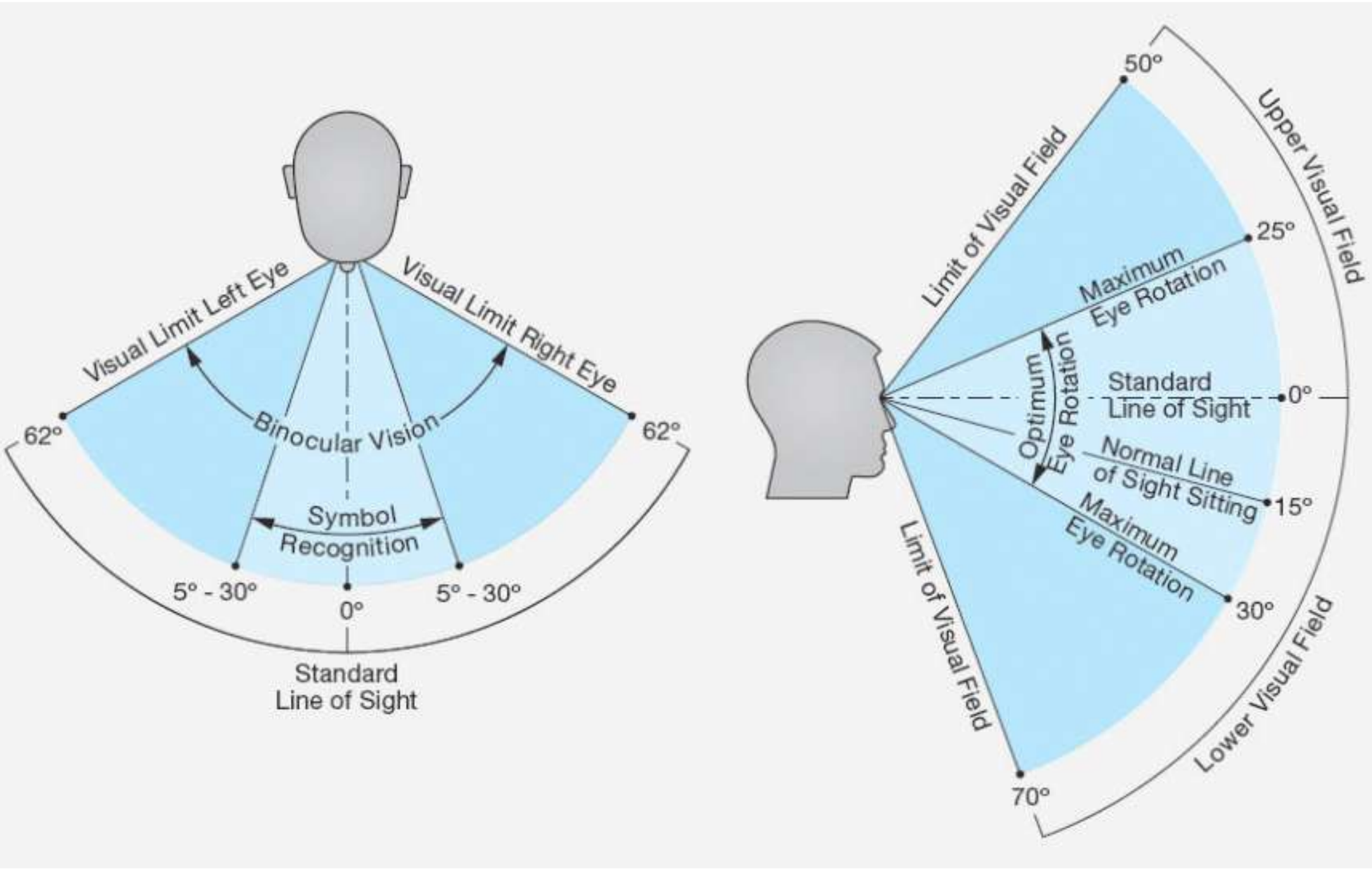




via blog.leapmotion.com

via tomshardware.com

via vive.com



via blog.mozvr.com

D. A. Bowman and McMahan, R. P.,
"Virtual Reality: How Much Immersion is Enough?",
IEEE Computer, vol. 40, pp. 36-43, 2007.

Initial VR Advantages

- users react strongly when first experiencing immersive VR…

- … although VR technologies (3D visual, auditory, and haptic displays; position tracking systems; input devices) still have usability and fidelity issues

- research has shown:
  users behave and feel differently in immersive VR

Success Stories: Phobia Therapy

- e.g. fear of public speaking

- practice in virtual conference room

- realistic environment likely to trigger same fear structures as in reality

- less expensive; less time-consuming; less risky; less embarrassing

Success Stories: Military Training

- e.g. train infantry in urban combat tactics

- good compromise between classroom-based training and real-world training exercises

- due to detailed intel and location data (e.g. through satellite imagery), operation area can be virtually build and experienced (low resources; more flexible; low costs)

- level of realism is not possible in classroom scenario (VR enables trainees to gain better spatial understanding, even memory, of the operation area)

Success Stories: Entertainment

- more limited and costly back in 2007,
  e.g. DisneyQuest placed visitors inside the game world in huge interactive, immersive theme park areas

- more accessible and affordable in 2018 due to entertainment industries push towards VR

- lots of different VR experiences available
  (education, edutainment/infotainment, entertainment, games, cross-media / supplemental experiences, artistic, experimental, movies)

High level of immersion → Sense of presence → Success ?

(Other) Potential Benefits of Immersion

- spatial understanding
  human brain is highly optimized for reconstructing 3D scenes; immersive VR provides many depth cues; greater spatial understanding can result in greater effectiveness for many applications (scientific visualization, design review, …)

- decrease in information clutter
  more space/resolution for placing virtual content such as texts, numbers, icons, windows, controls, notifications, and other elements familiar from your computer desktop

Demonstrating Immersion's Benefits

- need for controlled empirical studies

- an option: two step approach
  1. study with drastic difference in immersion
  2. if 1. is successful, investigate in more detail, especially controlling the different components of immersion

Demonstrating Immersion's Benefits: Example

VR-based information visualization:

1. investigate user's task performance (speed and accuracy) on low-immersion (desktop) and high-immersion (HMD) system
2. independently vary components of immersion, e.g. stereoscopy, head tracking, field of regard

Thoughts and Remarks

- (high level of) immersion is not always necessary/better, e.g. immersion might not make a difference for simpler tasks, or some tasks might not be performed accurately in either (low-/high-immersion) condition

- investigating not just components of immersion, but also input technologies and interaction design

- understand how different components of immersion affect measurable user performance, understanding, and preference

D. A. Bowman and McMahan, R. P.,
"Virtual Reality: How Much Immersion is Enough?",
IEEE Computer, vol. 40, pp. 36-43, **2007**.

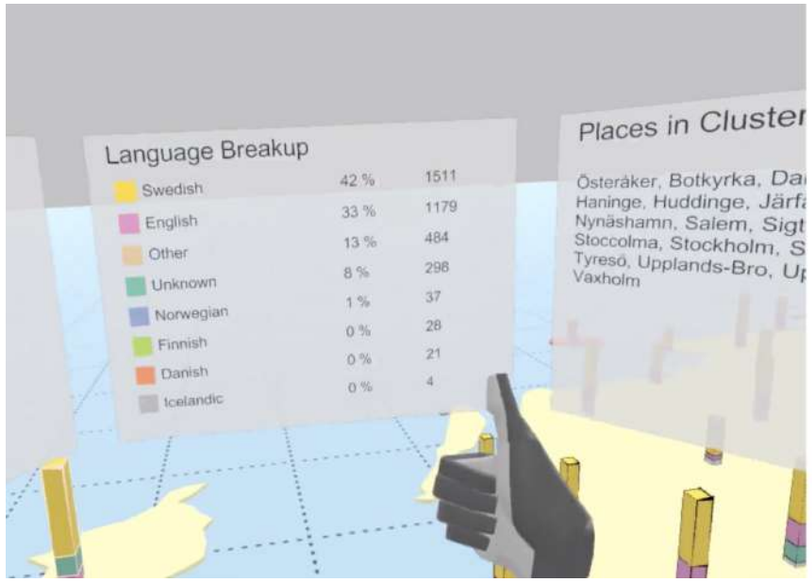
Today: 2019. What has changed?

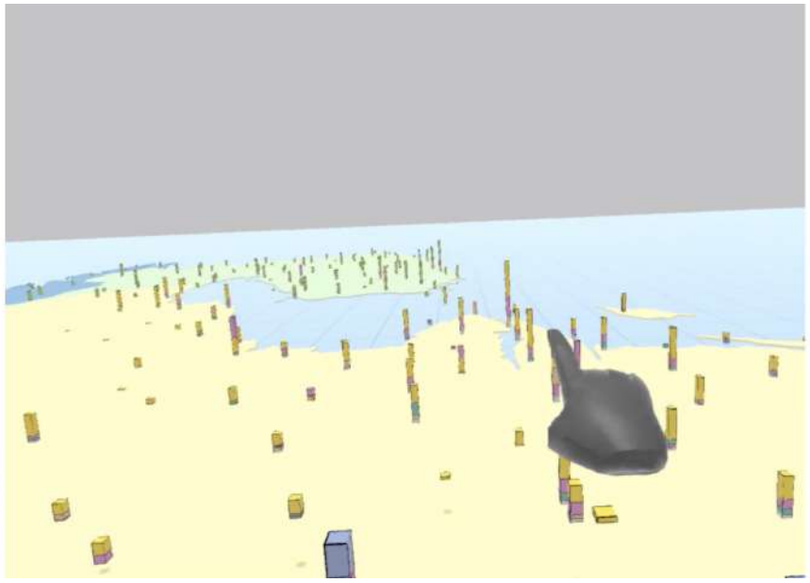
Comparison of using different types of input technologies in order to interact within an immersive VR environment in the context of (open) data exploration.

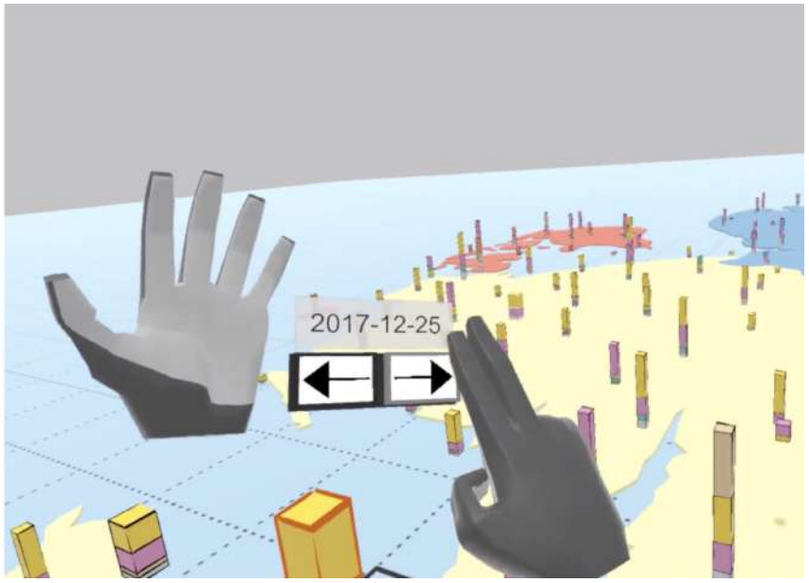
Input device characteristics	GAMEPAD	Vision-based motion controls (VBMC)	Room-scale VR (RSVR)
Visual representation (in VR)	No	Yes	Yes
Physical controller	Yes	No	Yes
Sensor type	Active	Passive	Active and passive
Input device data frequency	Discrete	Continuous	Discrete and continuous
HMD	Oculus Rift CV	Oculus Rift CV	HTC Vive

via [doi.org/10.1007/S10055-019-00378-W](doi.org/10.1007/S10055-019-00378-W) and vimeo.com/vrxar/odxvr-demo

using immersive technologies, such as VR, to explore language variability within tweets in the Nordic countries; collaboration with Department of Languages at LNU

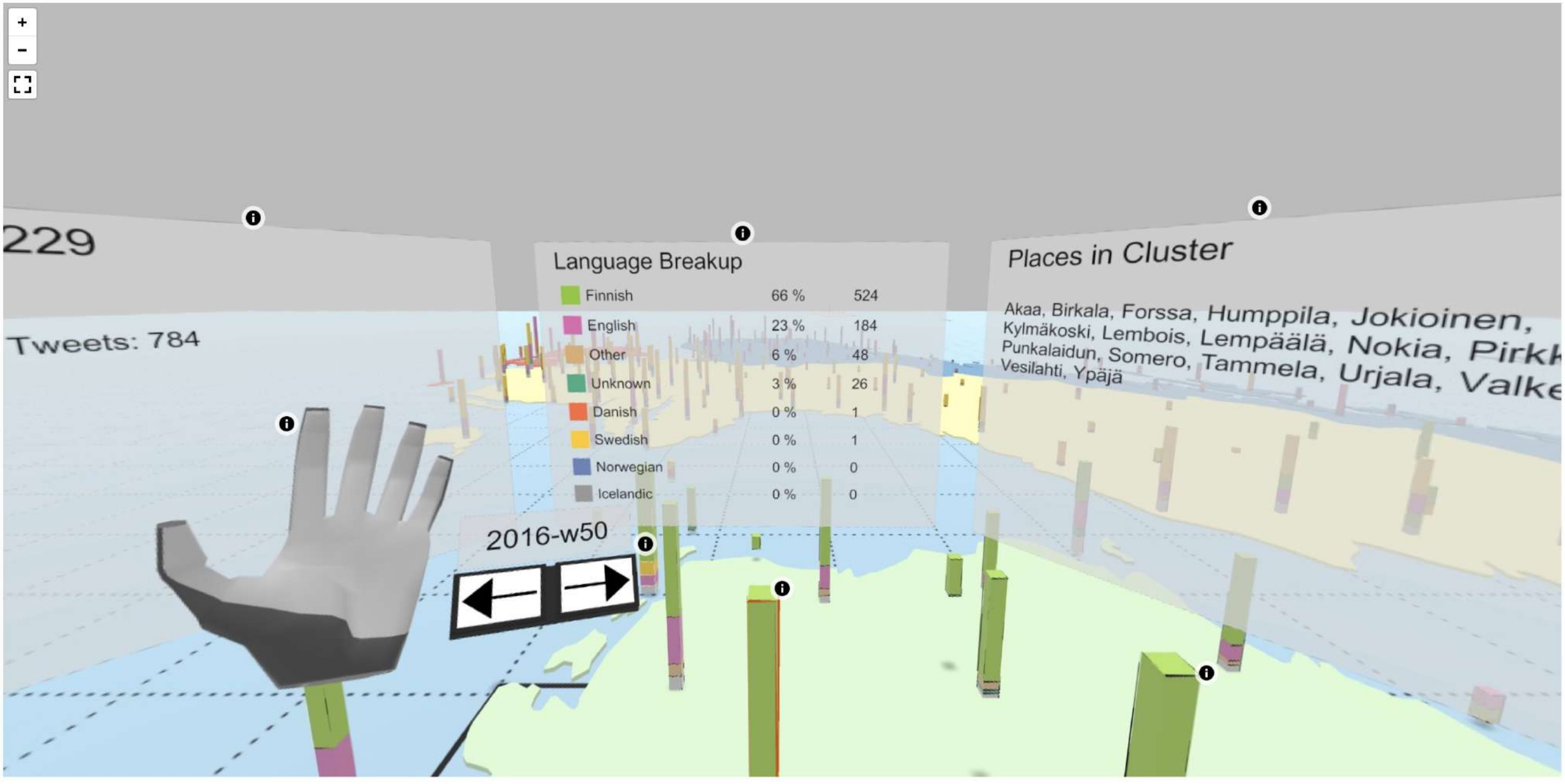






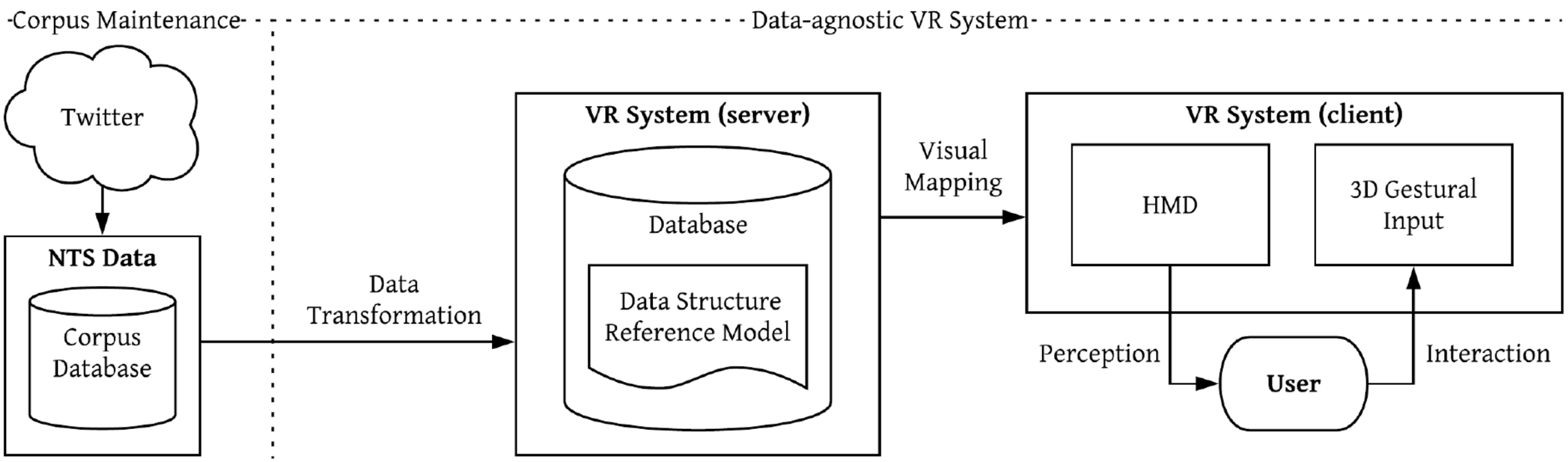
via vimeo.com/vrxar/hcia-wip2018

Try yourself, and get a “visual impression” (in 2D) of the computer-generated, virtual 3D environment (on your mobile or desktop device).



via vrxar.lnu.se/apps/odxvrxnts-360/ and vrxar.lnu.se/apps/odxvrxnts-360/time.html

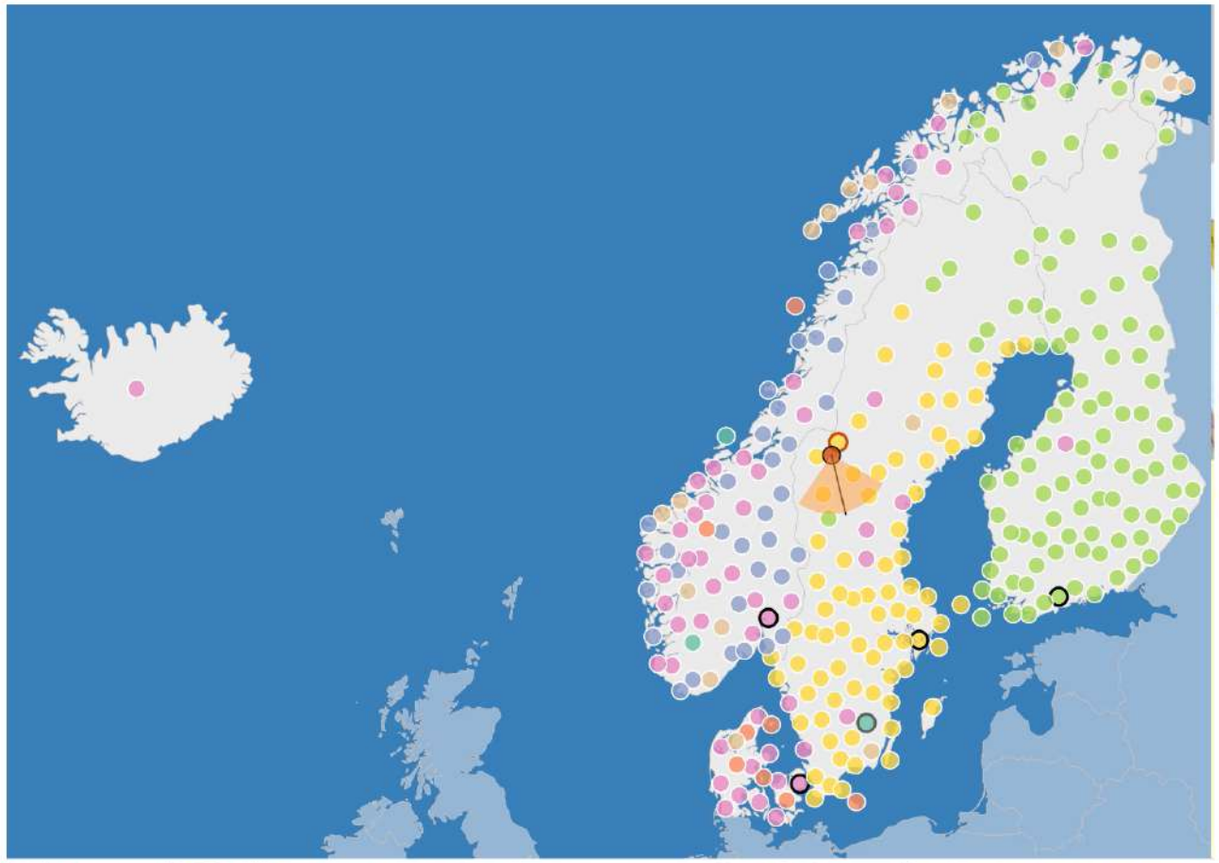
Planning and consideration of overall data workflow,
from aggregation, to storage, to consumption / application.

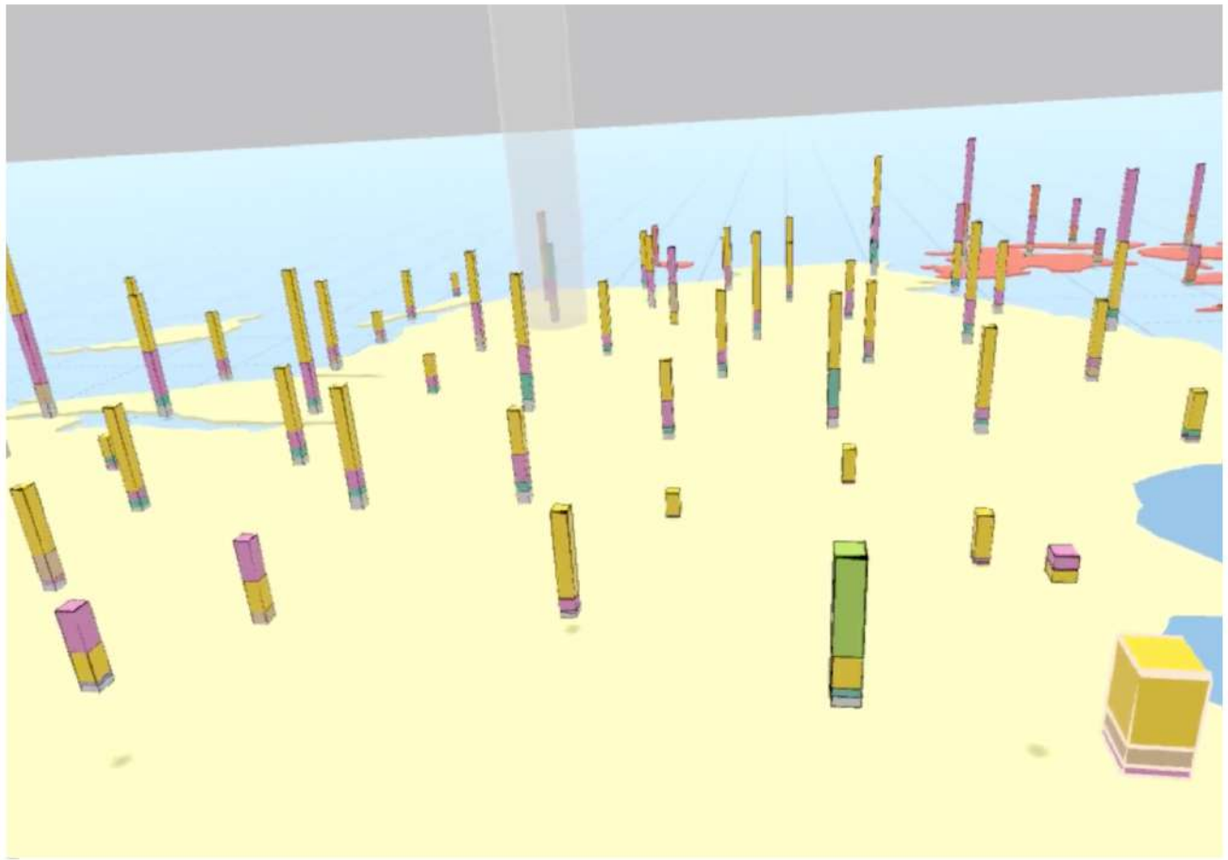


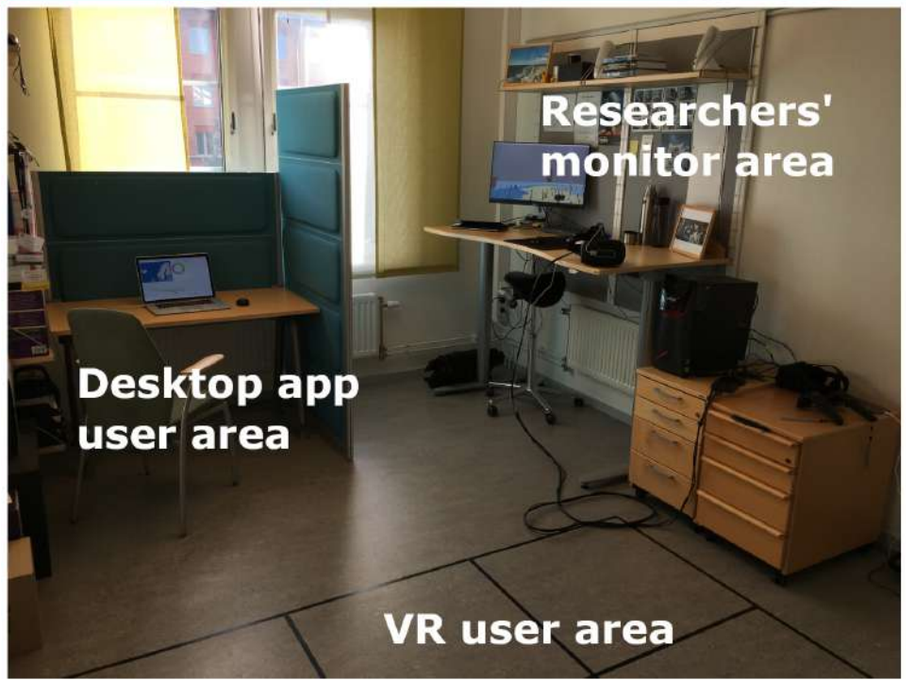
Current activities at VRxAR Labs

Hybrid Collaborative Immersive Analytics

Virtual Reality (VR)







via vimeo.com/vrxar/hcia-wip2018

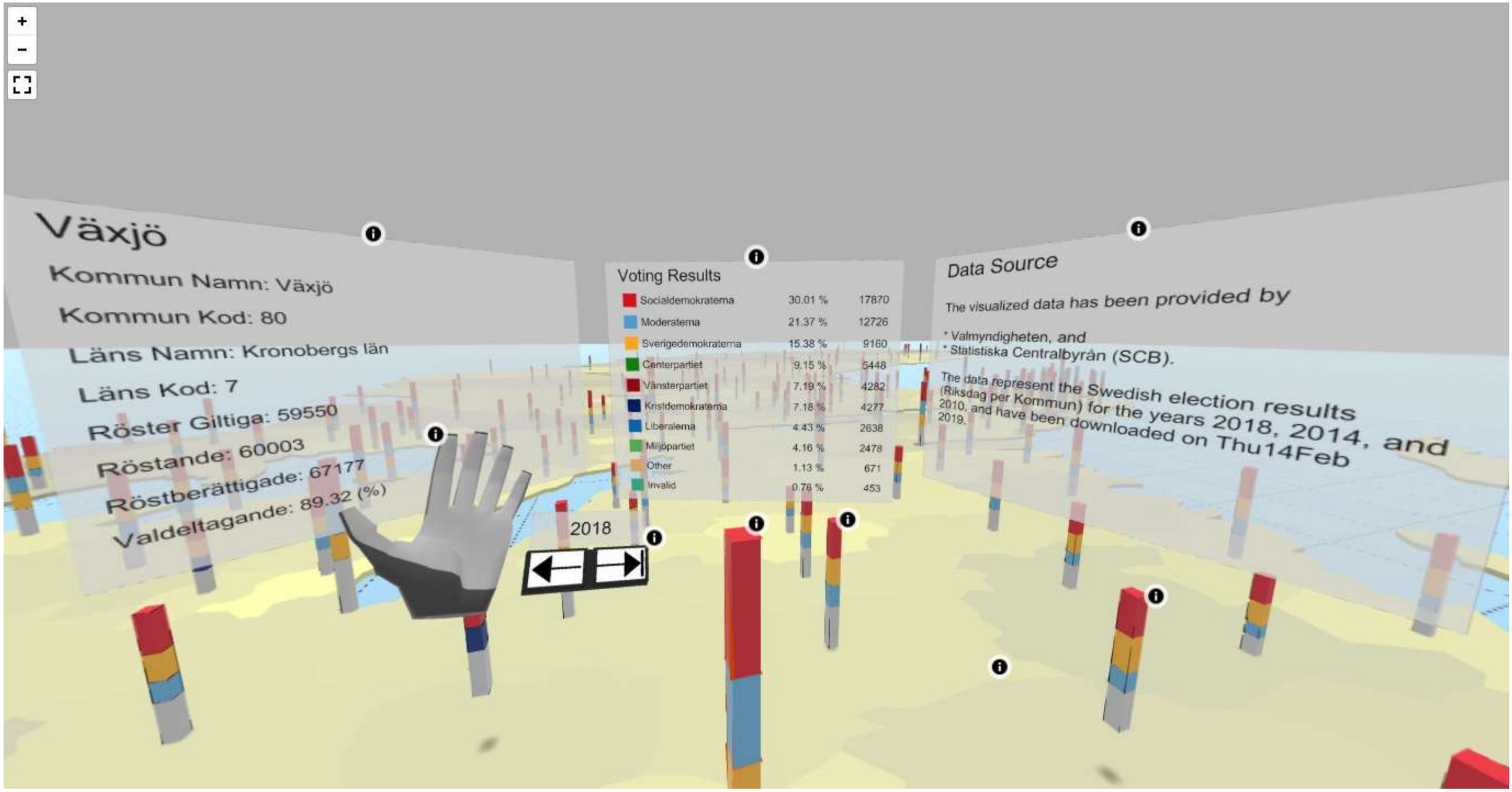
Cross-disciplinary research

- HCI: investigation of 3D user interfaces and application of immersive technologies, cognitive science, …

- Information Visualization: how to visually present data
  - data: stakeholders want to explore and discover “interesting things in the data” (learn about the data), as well as investigating new tools to support the data analysis workflow

  - collaboration: investigate the interplay between human individuals and the dynamics that come with the activity

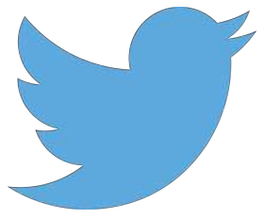
Try yourself, and get a “visual impression” (in 2D) of the computer-generated, virtual 3D environment (on your mobile or desktop device).

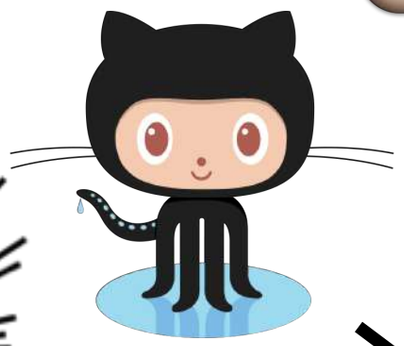


via vrxar.lnu.se/apps/odxvrxvalet-360/

VRxAR Labs' research interest (simplified)

vrxar.lnu.se



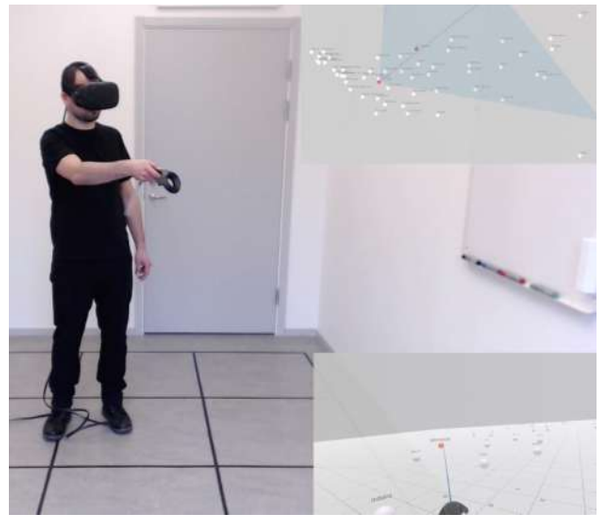


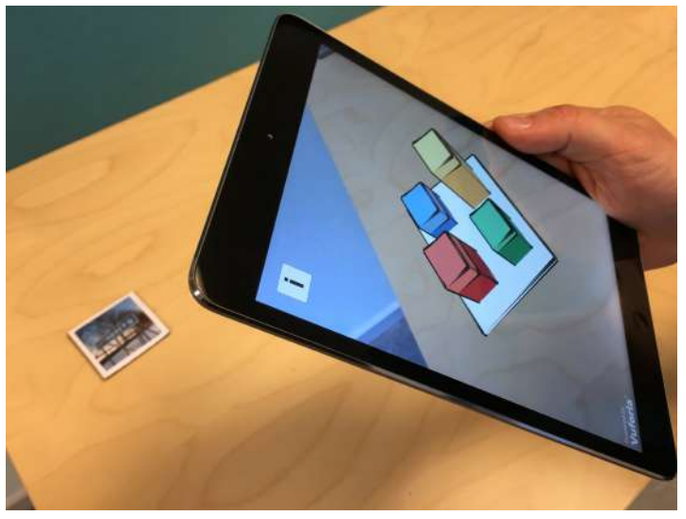
Aggregation

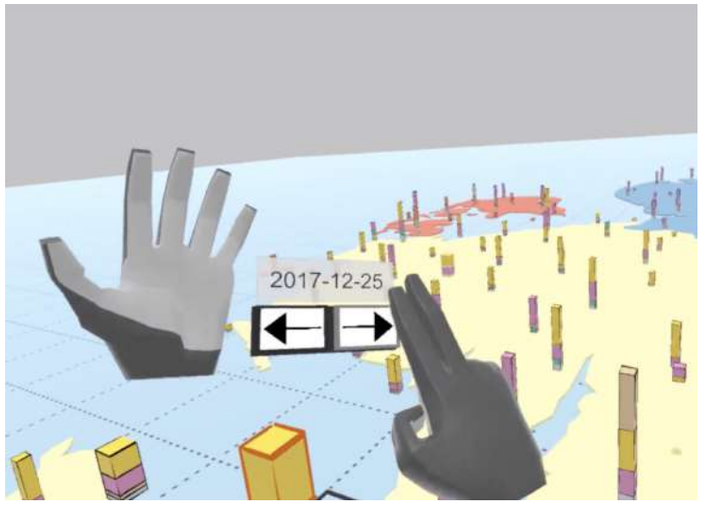
Visualization

Interaction

Virtual Reality (VR)







- VIRTUAL REALITY

  by Steven M. LaValle
- VRCH - Virtual Reality Architecture

  by Daniel Voshart
- Building Virtual Reality

  by Jody Medich and Daniel Plemmons
- Immersive Design: Learning to let go of the screen

  by Matt Sundstrom

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CA98 308C 6772 4499 B061 D75B)

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Additional references

Portal icons in the presentation available via
bit.ly/portaliconpack