Designing Virtual Reality Systems for the Externals

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make

Virtual Reality (HMD)

an ecological device

make

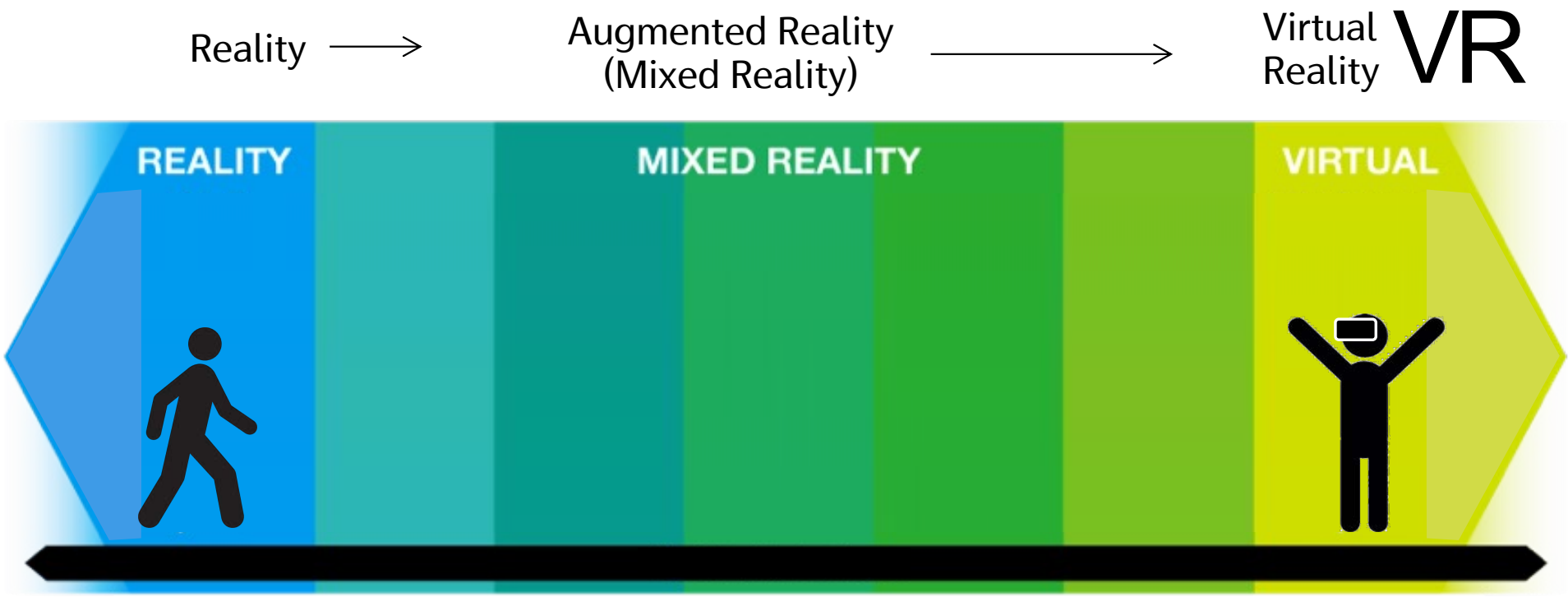
Virtual Reality (HMD)

an ecological device

that cares the surrondings (e.g., the externals).

background

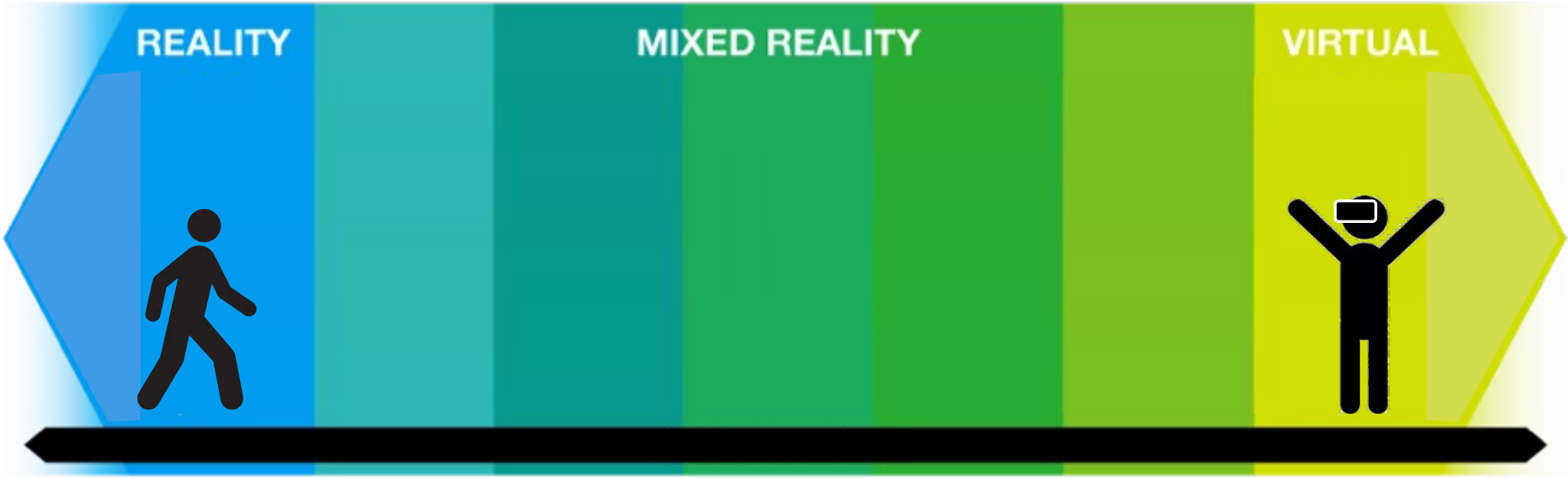
Virtual Reality
an immersion device



The Virtuality Continuum

Presence shift

Reality → Augmented Reality (Mixed Reality) → Virtual Reality VR



The Virtuality Continuum


Ultimate Display
Ivan Sutherland
1968

Ultimate Display

would, of course, be a room
within which the computer can
control the existence of matter.

1965

The Ultimate Display

Ivan E. Sutherland

Information Processing Techniques
Office, ARPA, OSD

We live in a physical world whose properties we have come to know well through long familiarity. We sense an involvement with this physical world which gives us the ability to predict its properties well. For example, we can predict where objects will fall, how well-known shapes look from other angles, and how much force is required to push objects against friction. We lack corresponding familiarity with the forces on charged particles, forces in non-uniform fields, the effects of nonprojective geometric transformations, and high-inertia, low friction motion. A display connected to a digital computer gives us a chance to gain familiarity with concepts not realizable in the physical world. It is a looking glass into a mathematical wonderland.

Computer displays today cover a variety of capabilities. Some have only the fundamental ability to plot dots. Displays being sold now generally have built in line-drawing capability. An ability to draw simple curves would be useful. Some available displays are able to plot very short line segments in arbitrary directions, to form characters or more complex curves. Each of these abilities has a history and a known utility.

It is equally possible for a computer to construct a picture made up of colored areas. Knowlton's movie language, BEFLIX [1], is an excellent example of how computers can produce area-filling pictures. No display available commercially today has the ability to present such area-filling pictures for direct human use. It is likely that new display equipment will have area-filling capability. We have much to learn about how to make good use of this new ability.

The most common direct computer input today is the typewriter keyboard. Typewriters are inexpensive, reliable, and produce easily transmitted signals. As more and more on-line systems are used, it is likely that many more typewriter consoles will come into use. Tomorrow's computer user will interact with a computer through a typewriter. He ought to know how to touch type.

A variety of other manual-input devices are possible. The light pen or RAND Tablet stylus serve a very useful function in pointing to displayed items and in drawing or printing For input to the computer. The possibilities for very smooth interaction with the computer through these devices is only just beginning to be exploited. RAND Corporation has in operation today a debugging tool which recognizes printed changes of register contents, and simple pointing and moving motions for format relocation. Using RAND's techniques you can change a digit printed on the screen by merely writing what you want on top of it. If you want to move the contents of one displayed register into another, merely point to the first and "drag" it over to the second. The facility with which such an interaction system lets its user interact with the computer is remarkable.

Knobs and joysticks of various kinds serve a useful function in adjusting parameters of some computation going on. For example, adjustment of the viewing angle of a perspective view is conveniently handled through a three-rotation joystick. Push buttons with lights are often useful. Syllable voice input should not be ignored.

In many cases the computer program needs to know which part of a picture the man is pointing at. The two-dimensional nature of pictures makes it impossible to order the parts of a picture by neighborhood. Converting from display coordinates to find the object pointed at is, therefore, a time-consuming process. A light pen can interrupt at the time that the display circuits transfer the item being pointed at, thus automatically indicating its address and coordinates. Special circuits on the RAND Tablet or other position input device can make it serve the same function.

What the program actually needs to know is where in memory is the structure which the man is pointing to. In a display with its own memory, a light pen return tells where in the display file the thing pointed to is, but not necessarily where in main memory. Worse yet, the program really needs to know which sub part of which part the man is pointing to. No existing display equipment computes the depths of recursions that are

The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked.

If the task of the display is to serve as a looking-glass into the mathematical wonderland constructed in computer memory, it should serve as many senses as possible. So far as I know, no one seriously proposes computer displays of smell, or taste. Excellent audio displays exist, but unfortunately we have little ability to have the computer produce meaningful sounds. I want to describe for you a kinesthetic display.

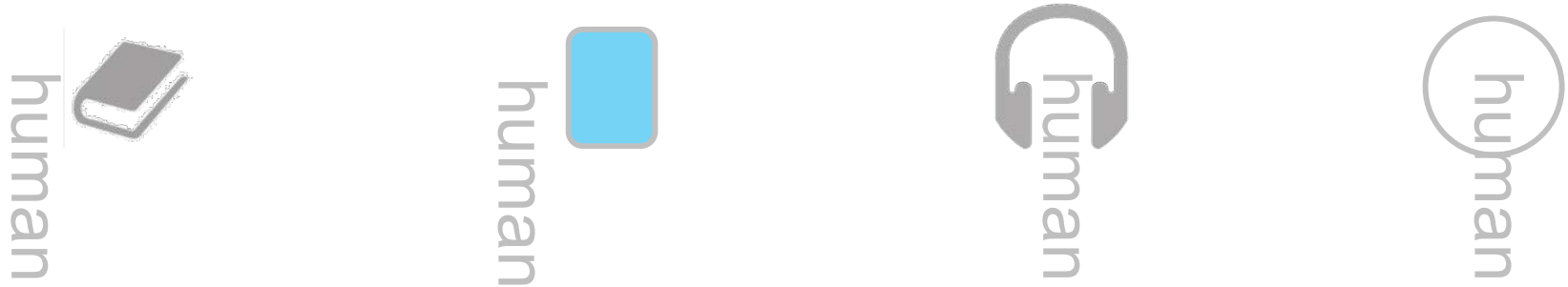
The force required to move a joystick could be computer controlled, just as the actuation force on the controls of a Link Trainer are changed to give the feel of a real airplane. With such a display, a computer model of particles in an electric field could combine manual control of the position, of a moving charge, replete with the sensation of forces on the charge, with visual presentation of the charge's position. Quite complicated "joysticks" with force feedback capability exist. For example, the controls on the General Electric "handyman" are nothing but joysticks with nearly as many degrees of freedom as the human arm. By use of such an input/output device, we can add a force display to our sight and sound capability.

Virtual Reality

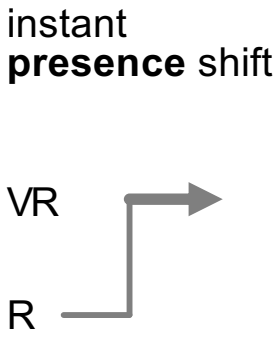
an immersion device

that makes people believe thery are in a remote world
and want to stay there.

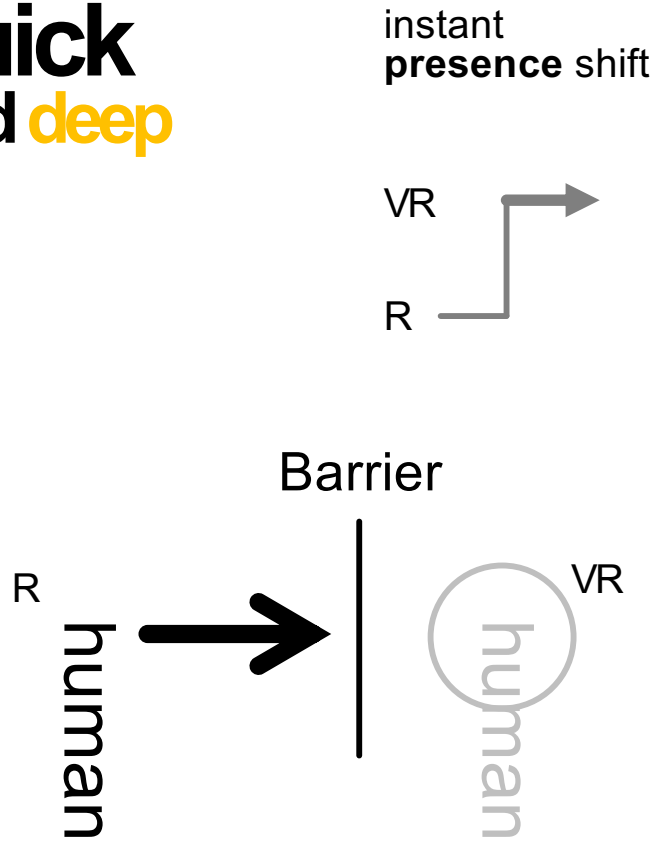
enabling
presence shift



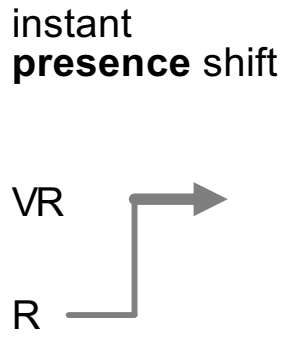
switch presence to VR **is quick**

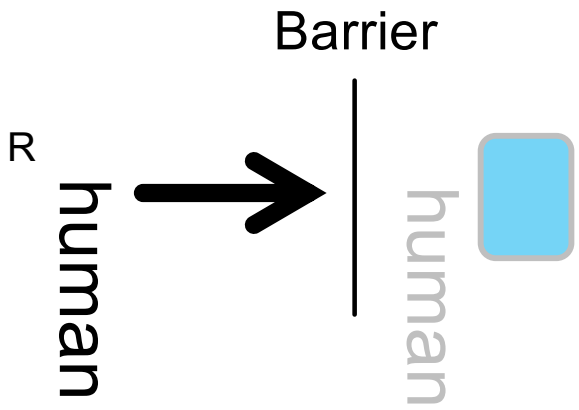


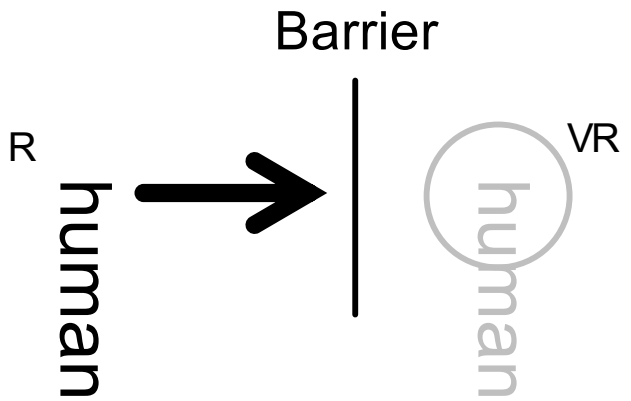
switch presence to VR **is quick** and deep



switch presence to VR **is quick** and deep

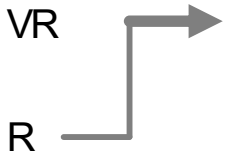


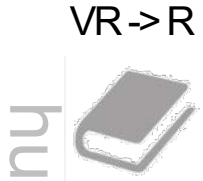


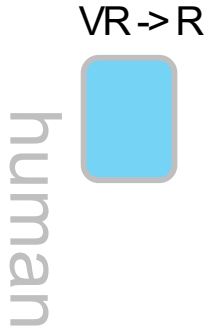


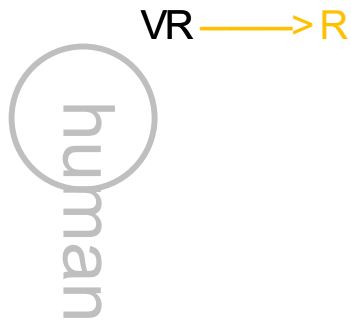
switch presence to VR **is quick** and deep returning back **is slow**

instant
presence shift





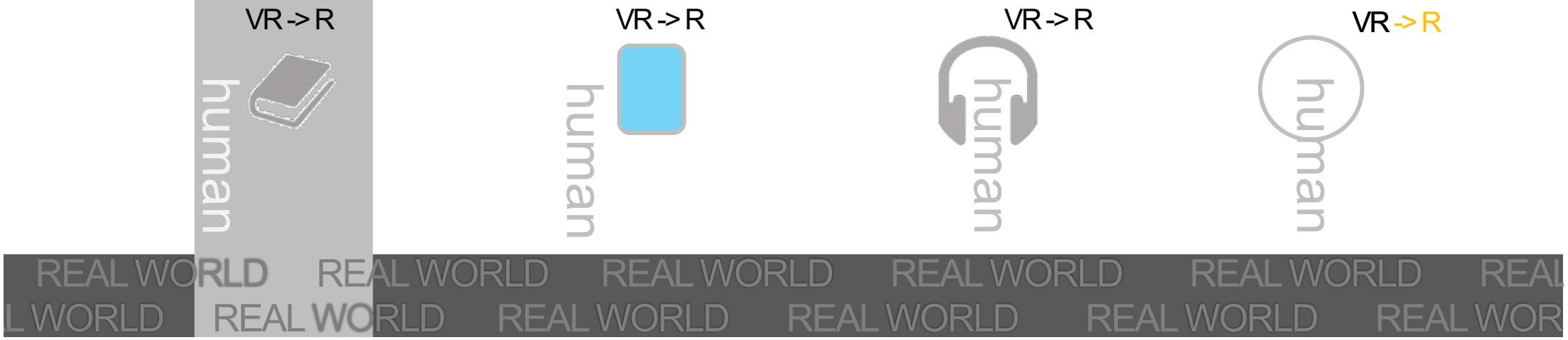




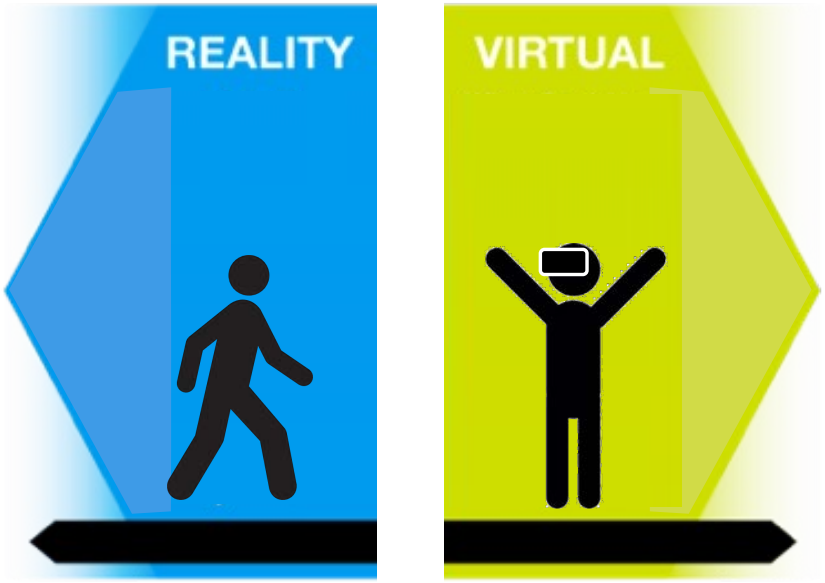
switch presence to VR **is quick**
returning back **is slow** **and deep**

Mixed-Presence Environment

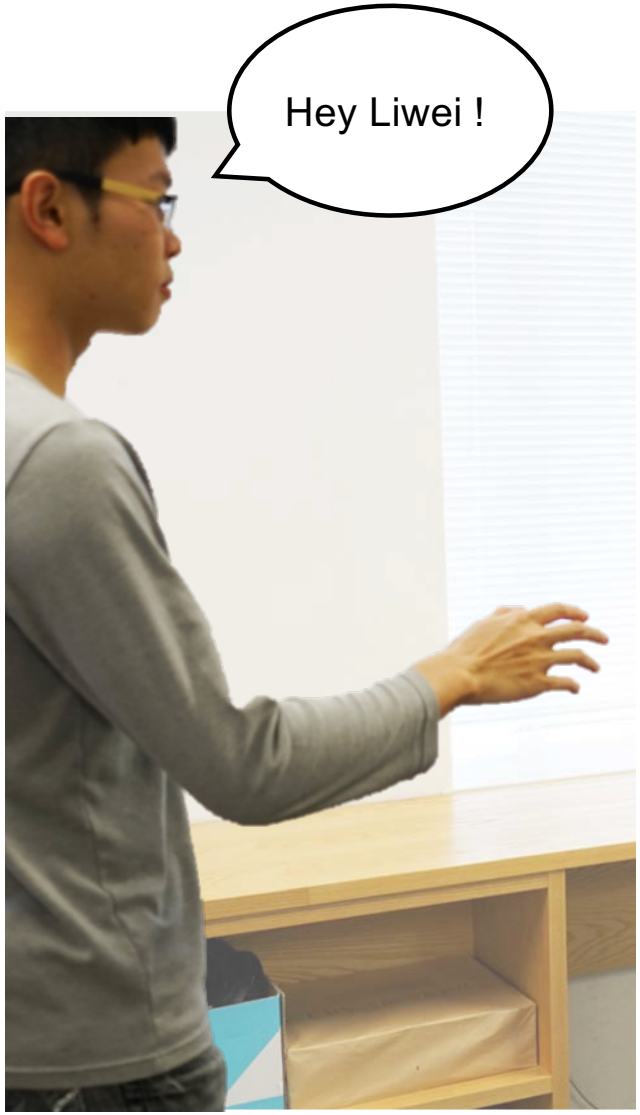
VR as an ecological device **to facilitate communication in mixed-presence environments**

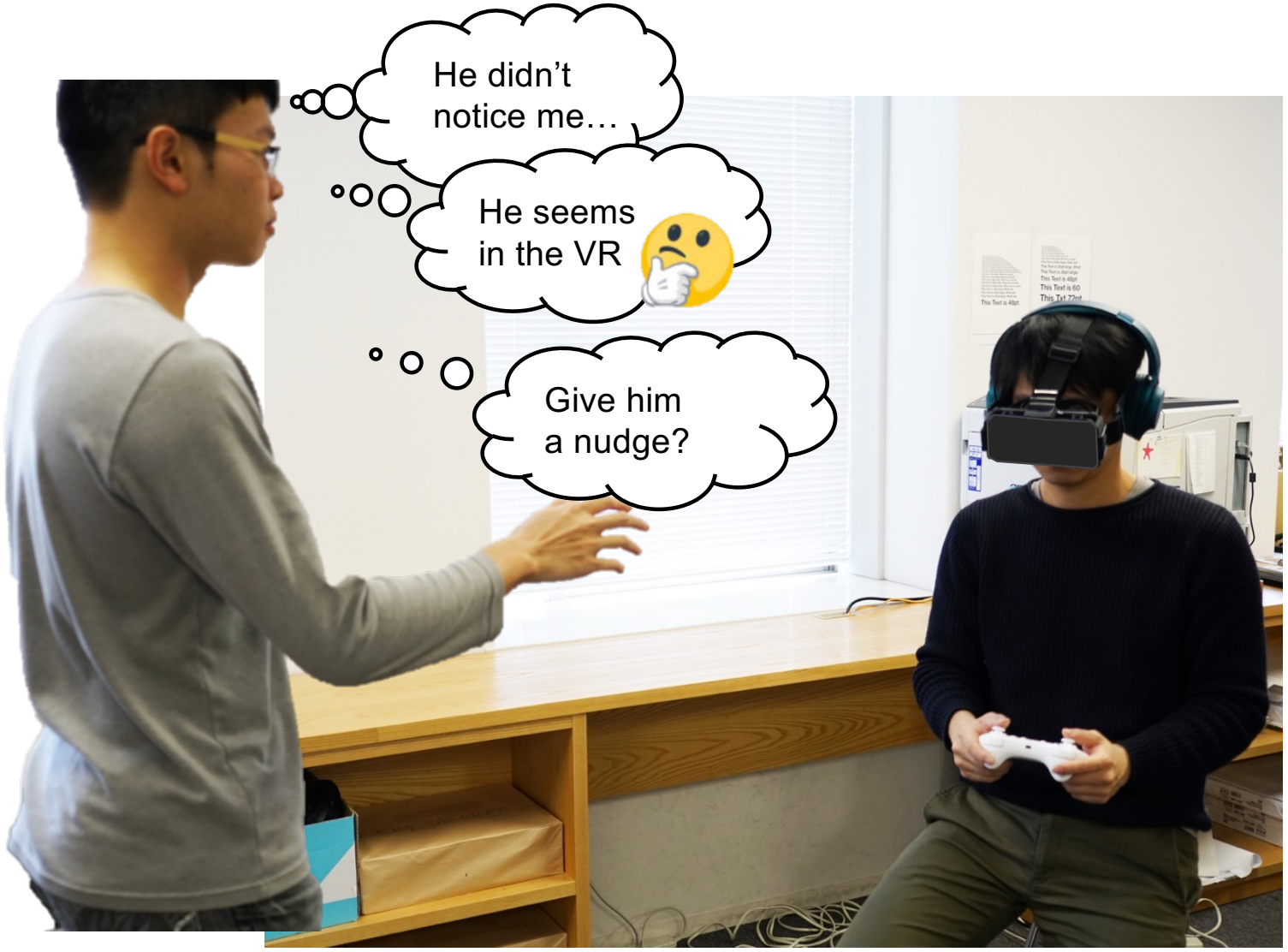


FrontFace



2017


Hey Liwei !


He didn’t
notice me…
He seems
in the VR
Give him
a nudge?


Is he really
looking at me?

FrontFace:

Facilitating Communication Between HMD Users and Outsiders Using Front-Facing-Screen HMDs

2017


Use this face screen to
communicate user state

Reality

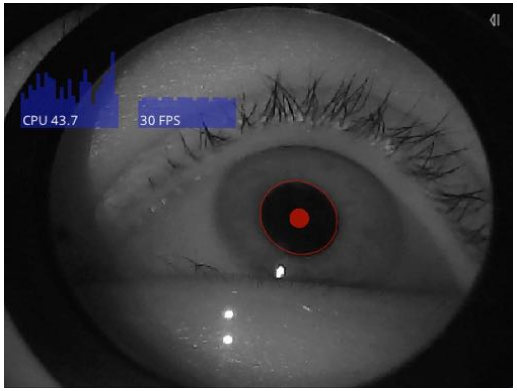
Virtual
Reality

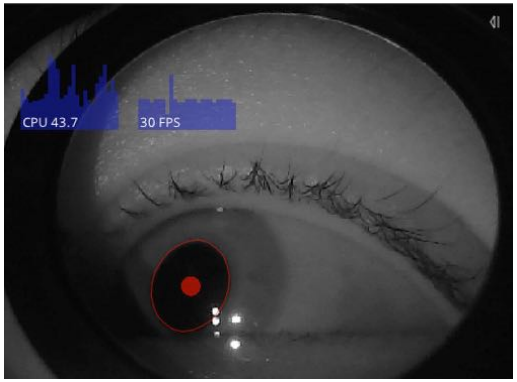

He is in VR

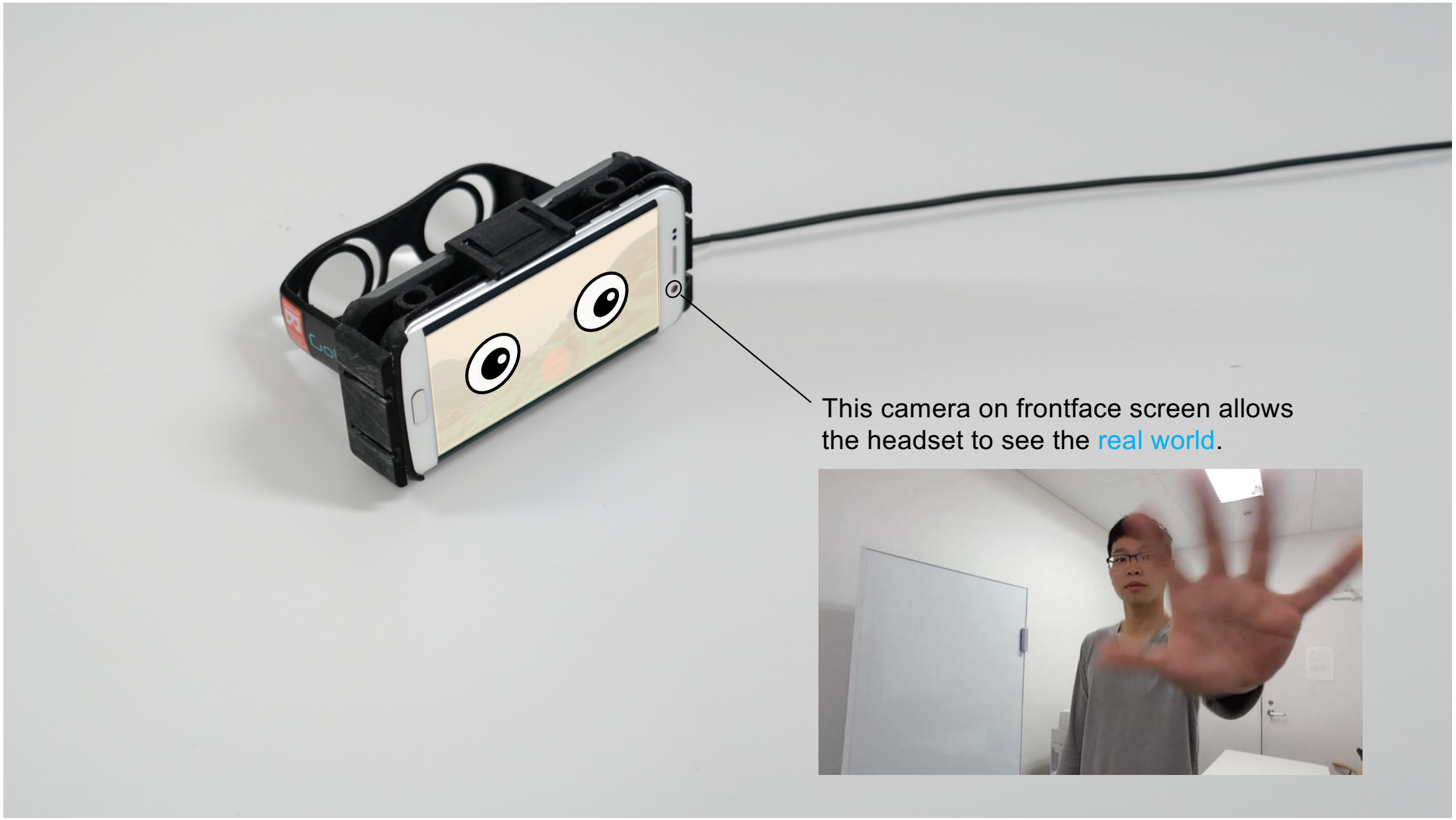

Yeah, he is
looking at me.


VR Glasses
Pupil Eye Camera
VR Screen
Case
FrontFace Screen

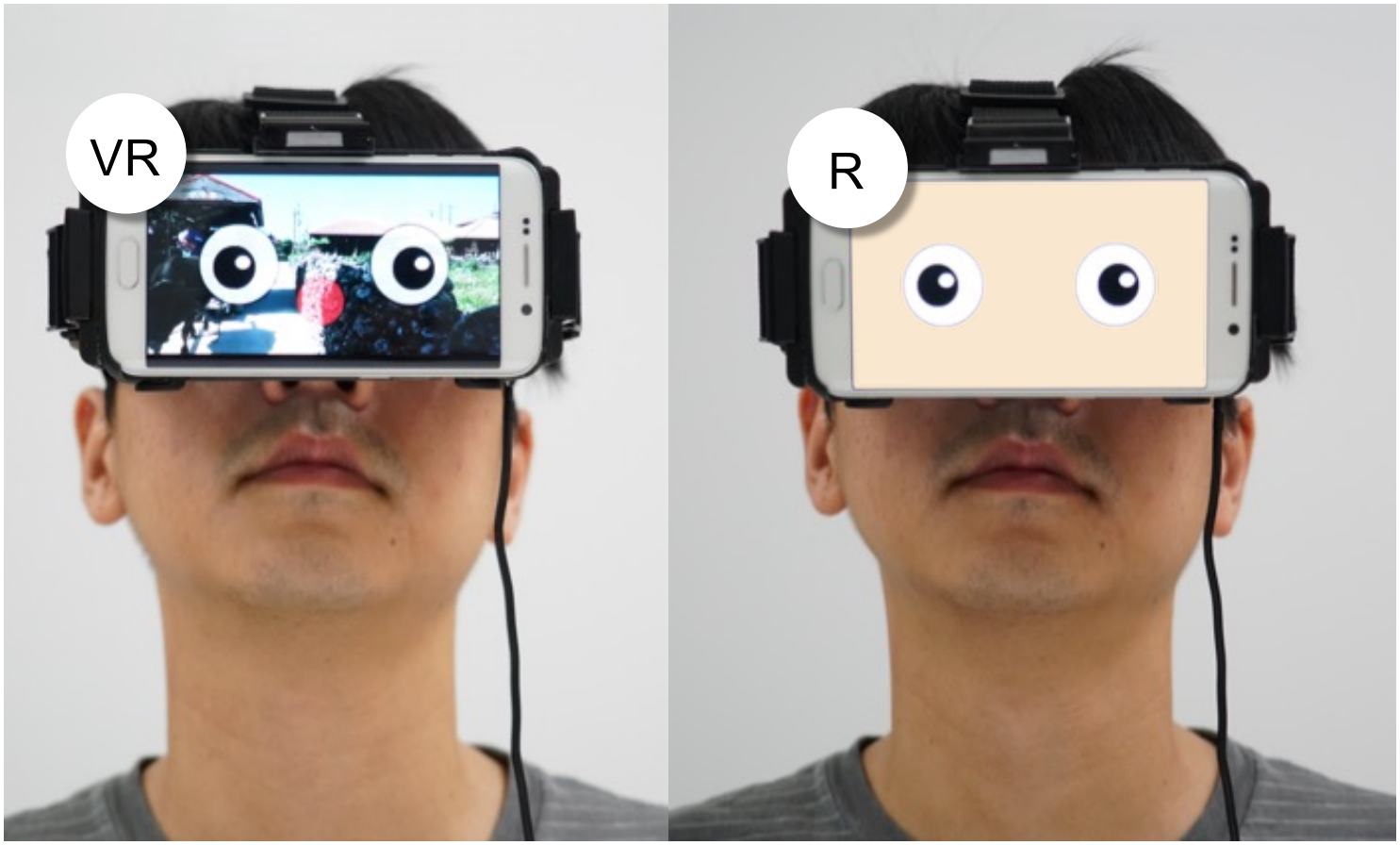
Eye camera
for eye tracking,
blinking detection






This camera on frontface screen allows
the headset to see the real world.

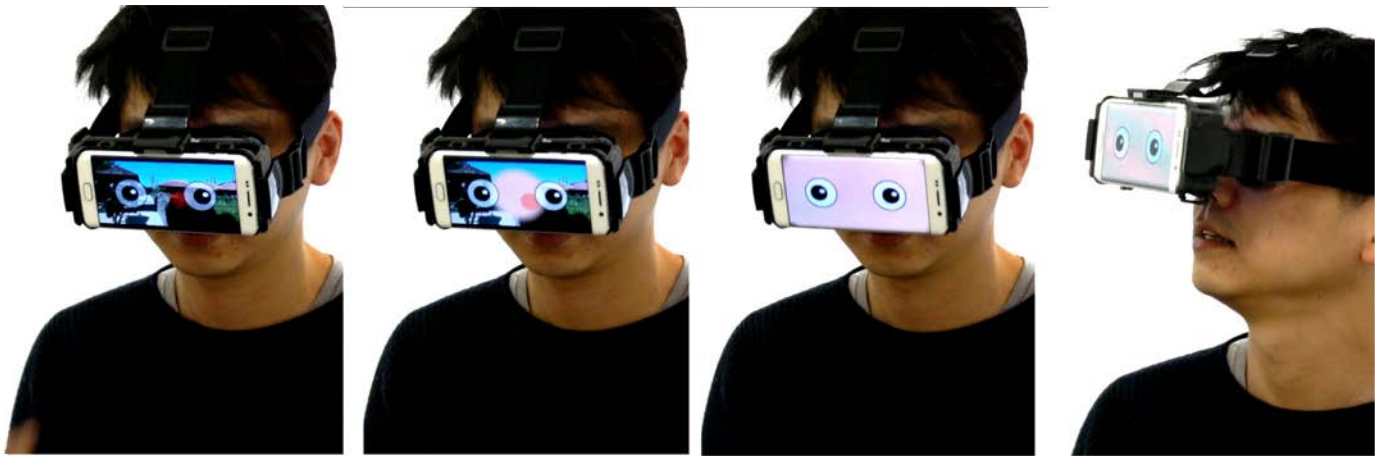
User Presence



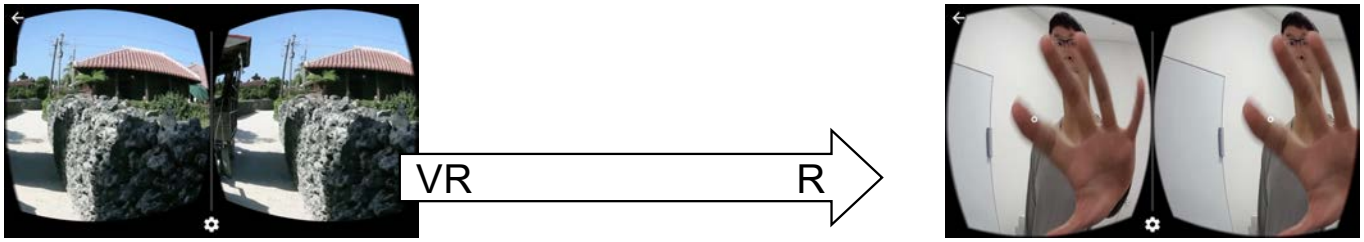
User Presence

Transition from VR to R

Front Screen

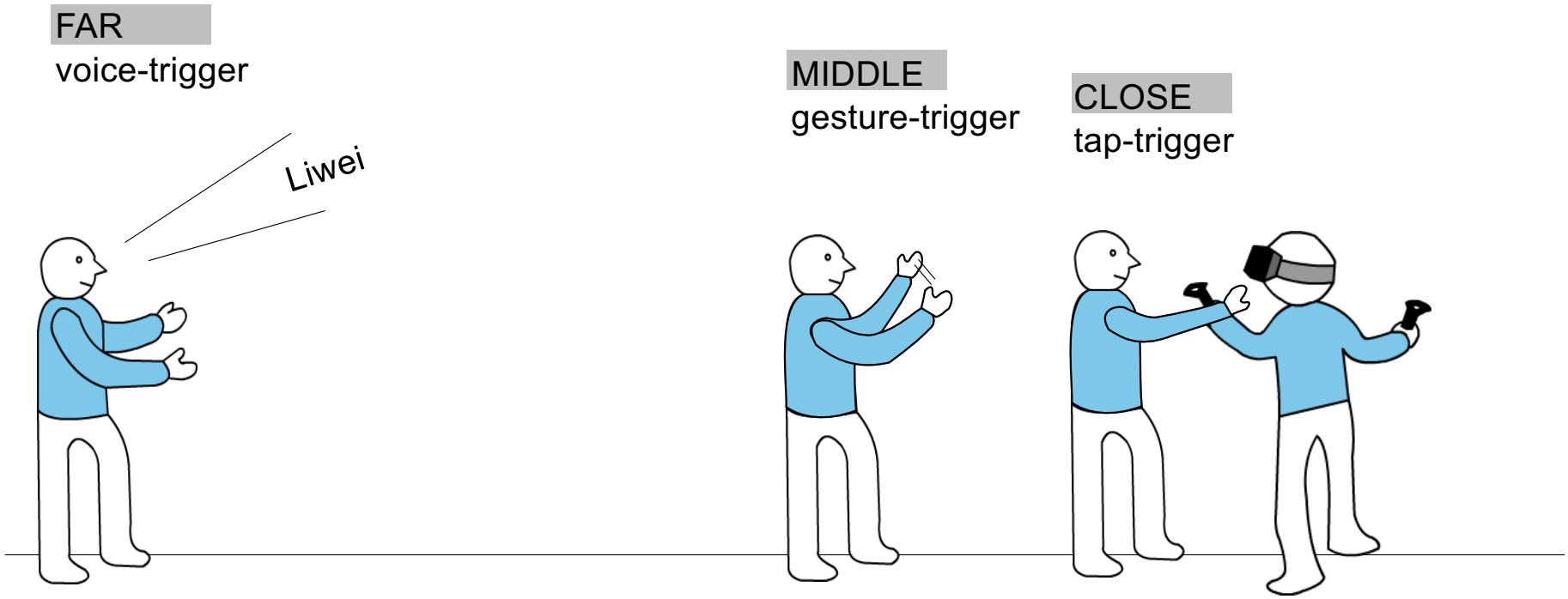


VR Screen




Apple Vision Pro

Externals-Initiated Communication

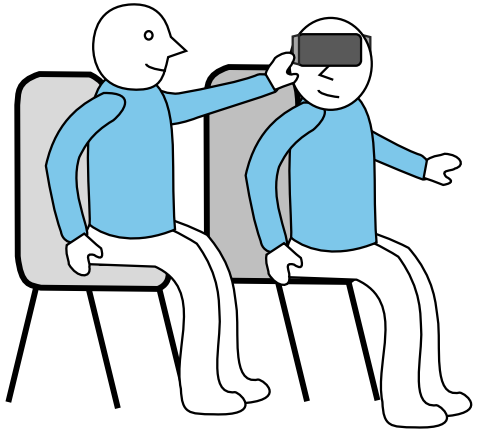


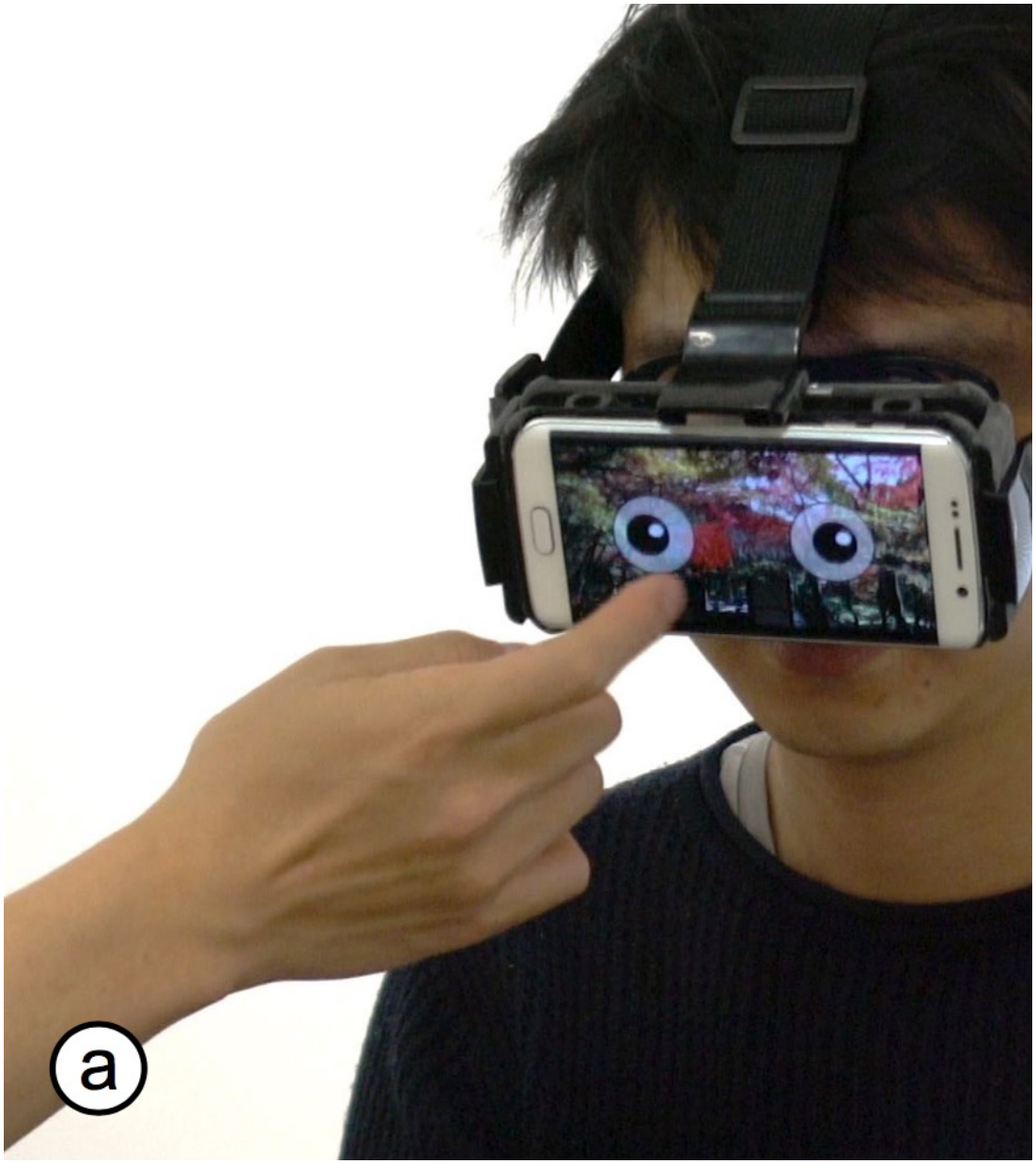
Externals-Initiated Communication

- Tap-Trigger
- Gesture-Trigger
- Voice-Trigger

CLOSE

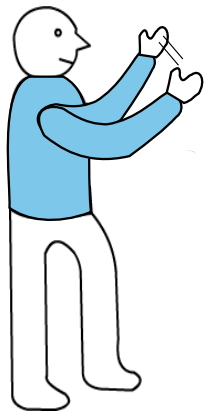
tap-trigger

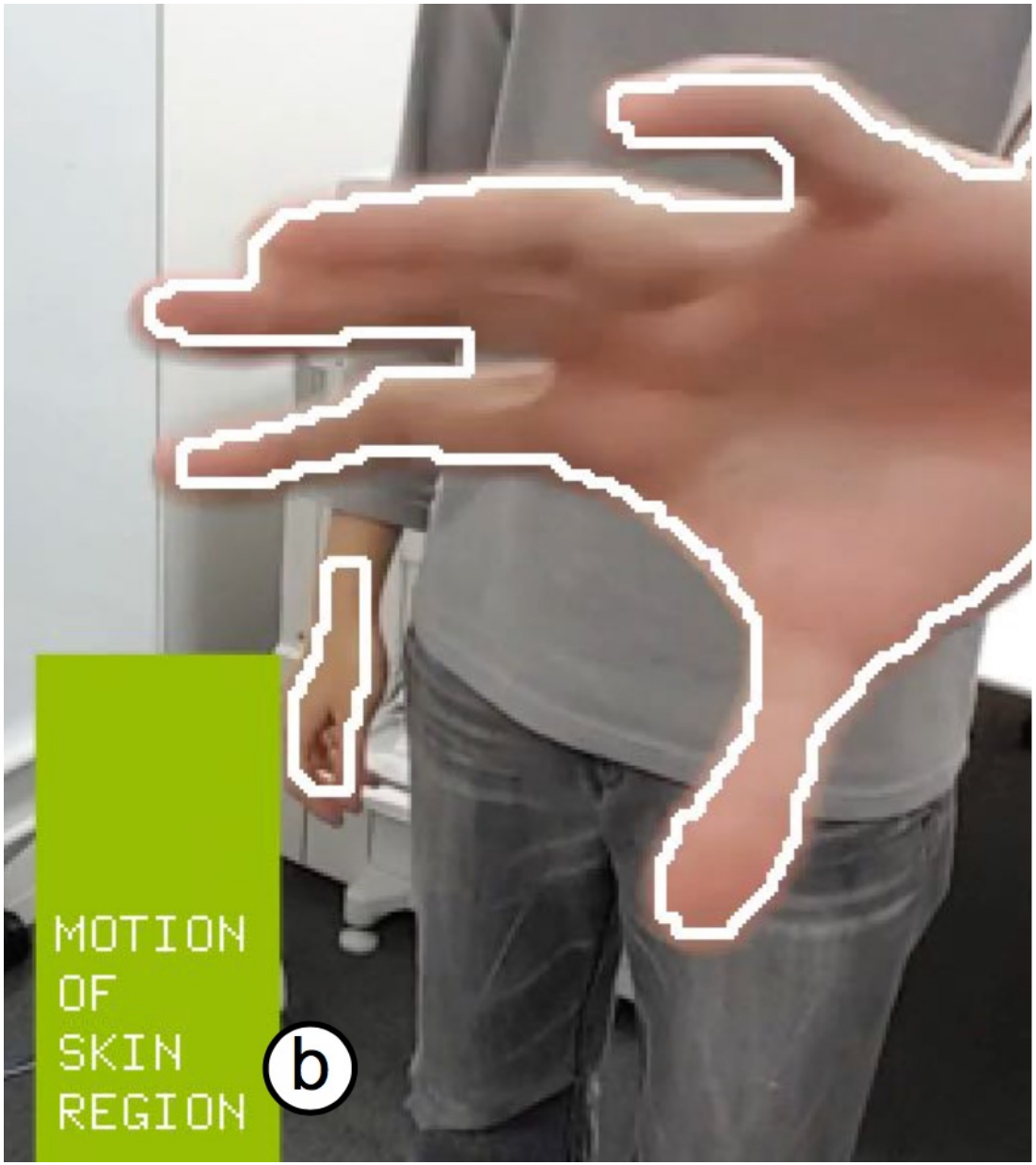




MIDDLE

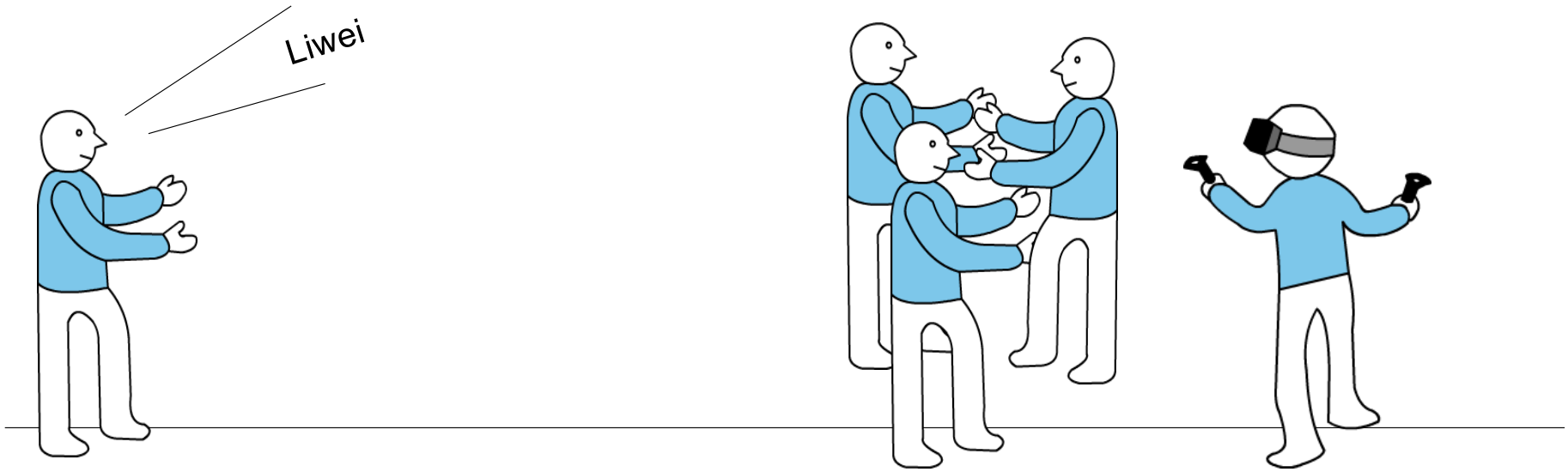
gesture-trigger



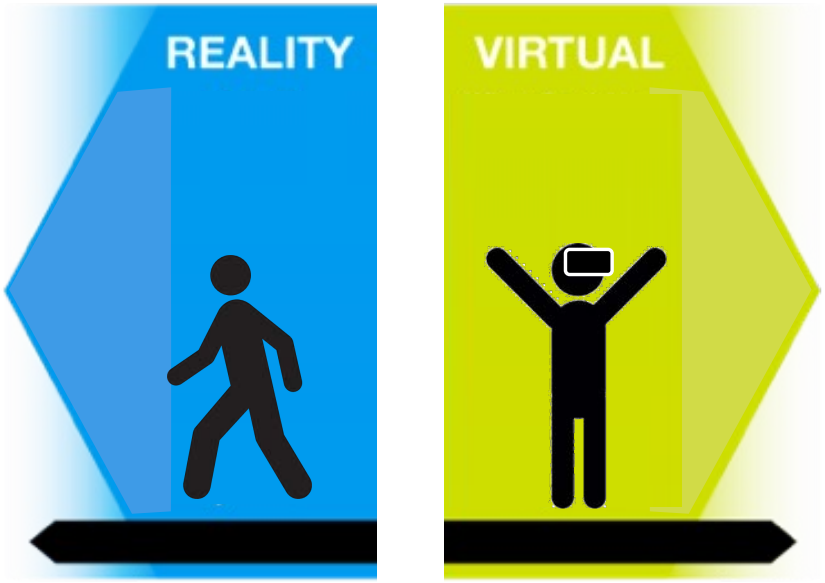


FAR

voice-trigger

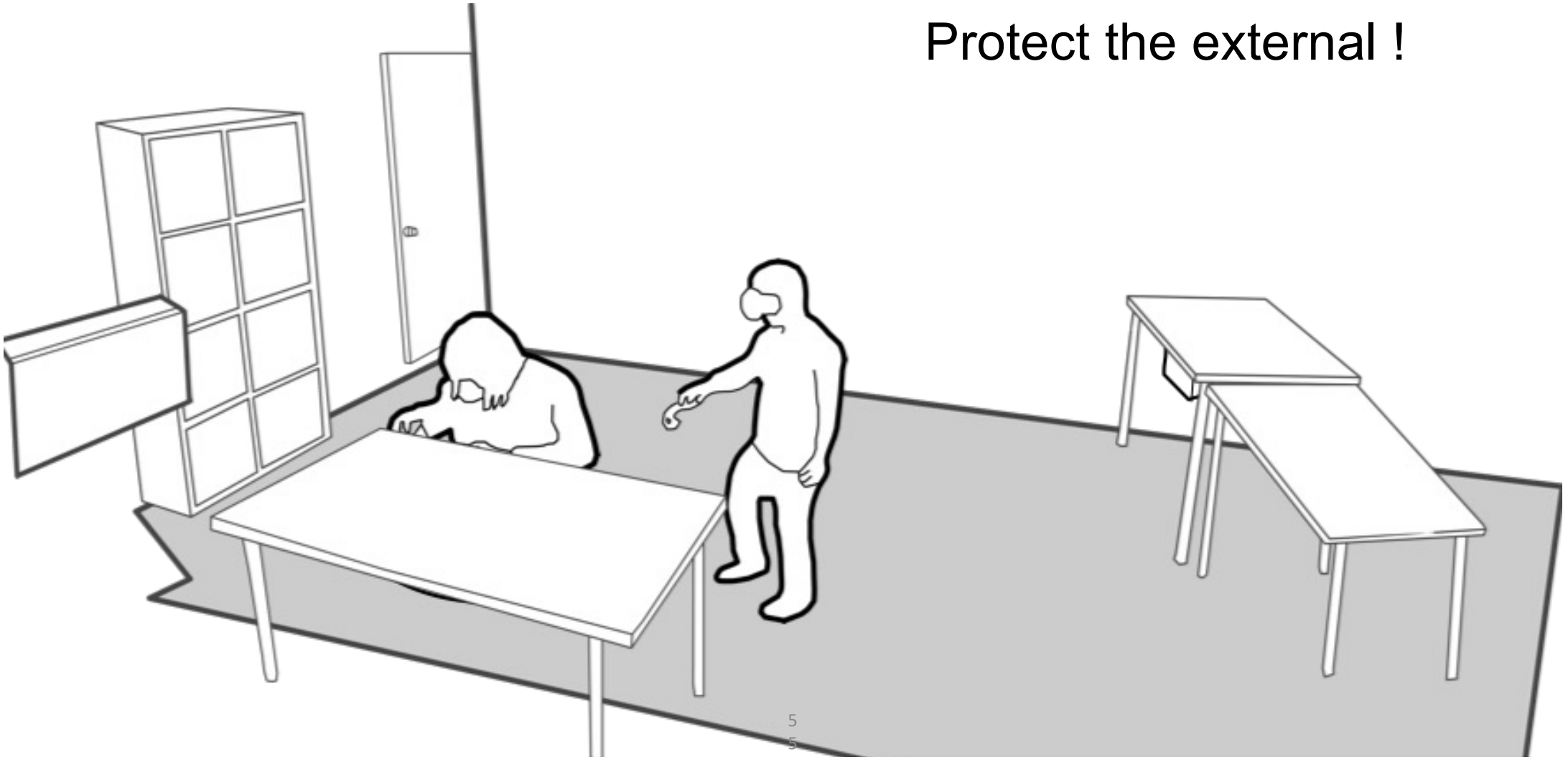


ShareSpace

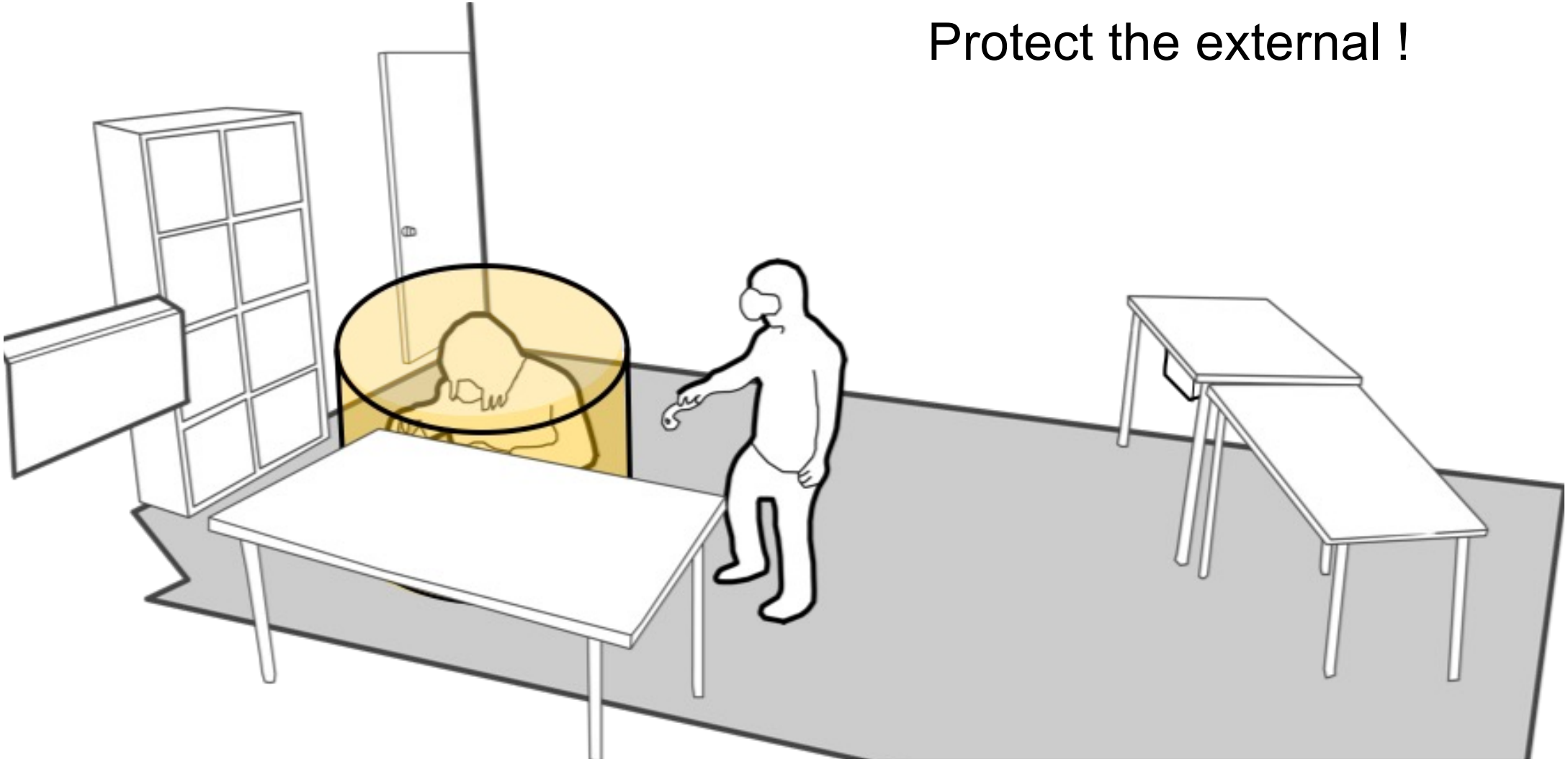


2018

Protect the external !

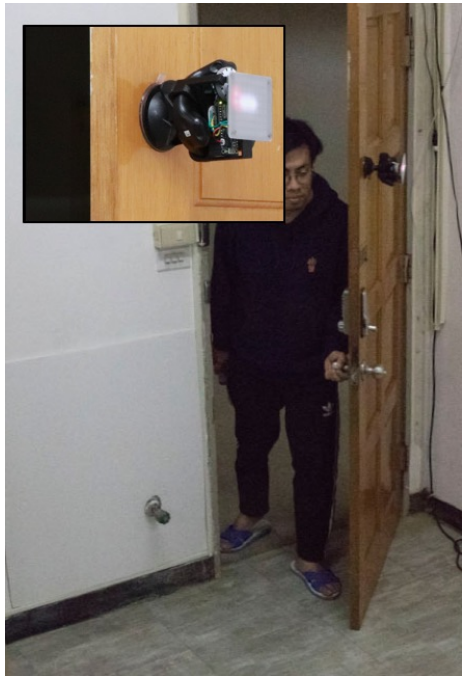


Protect the external !

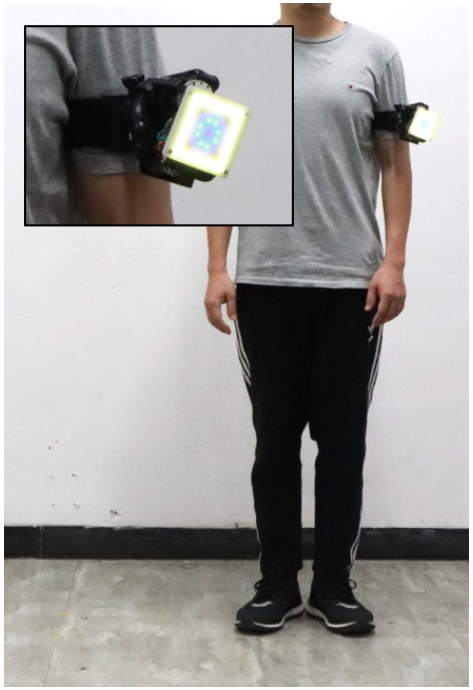


Shield Tools

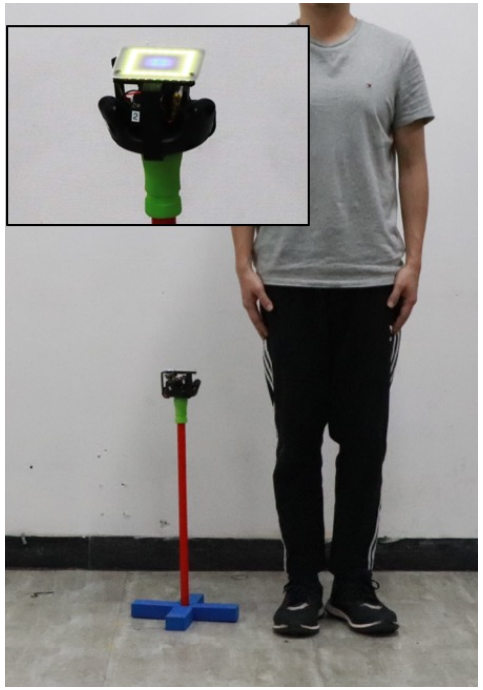
surface-sucker

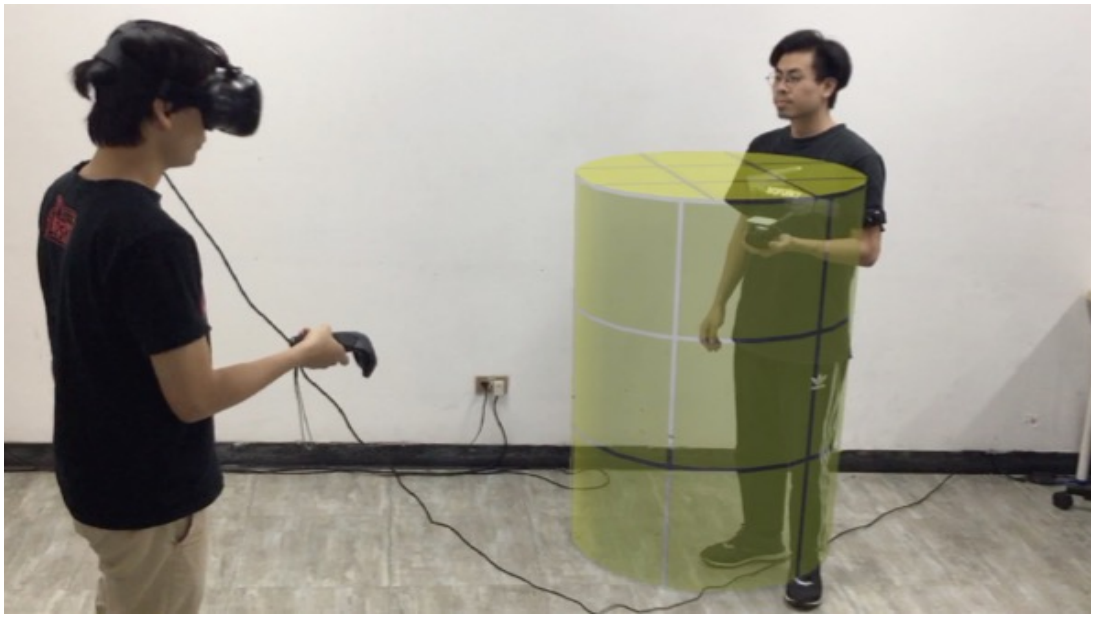


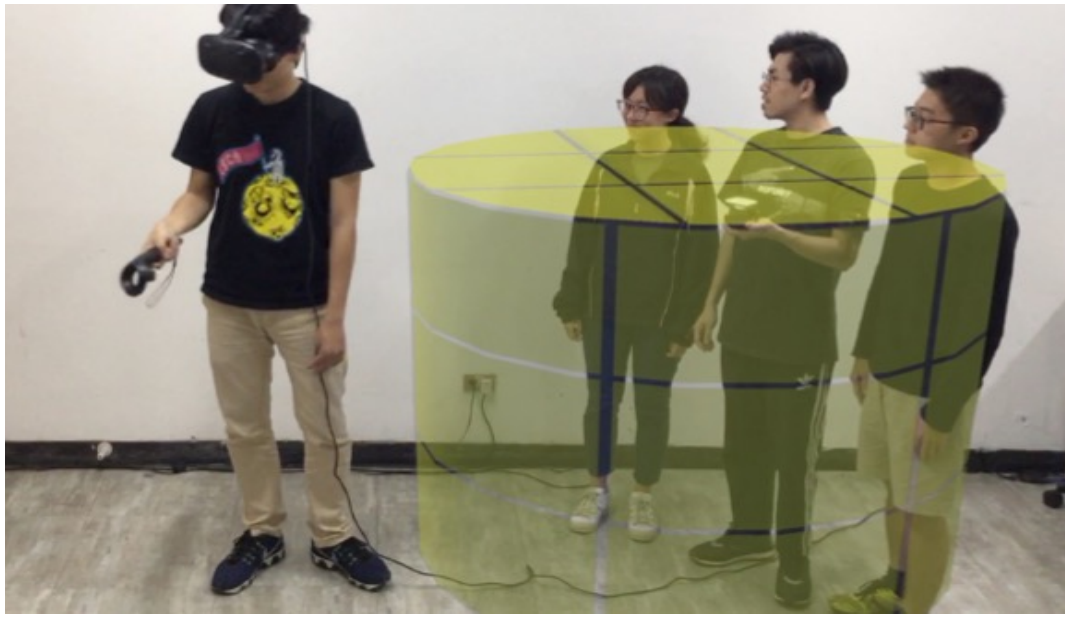
arm-belt

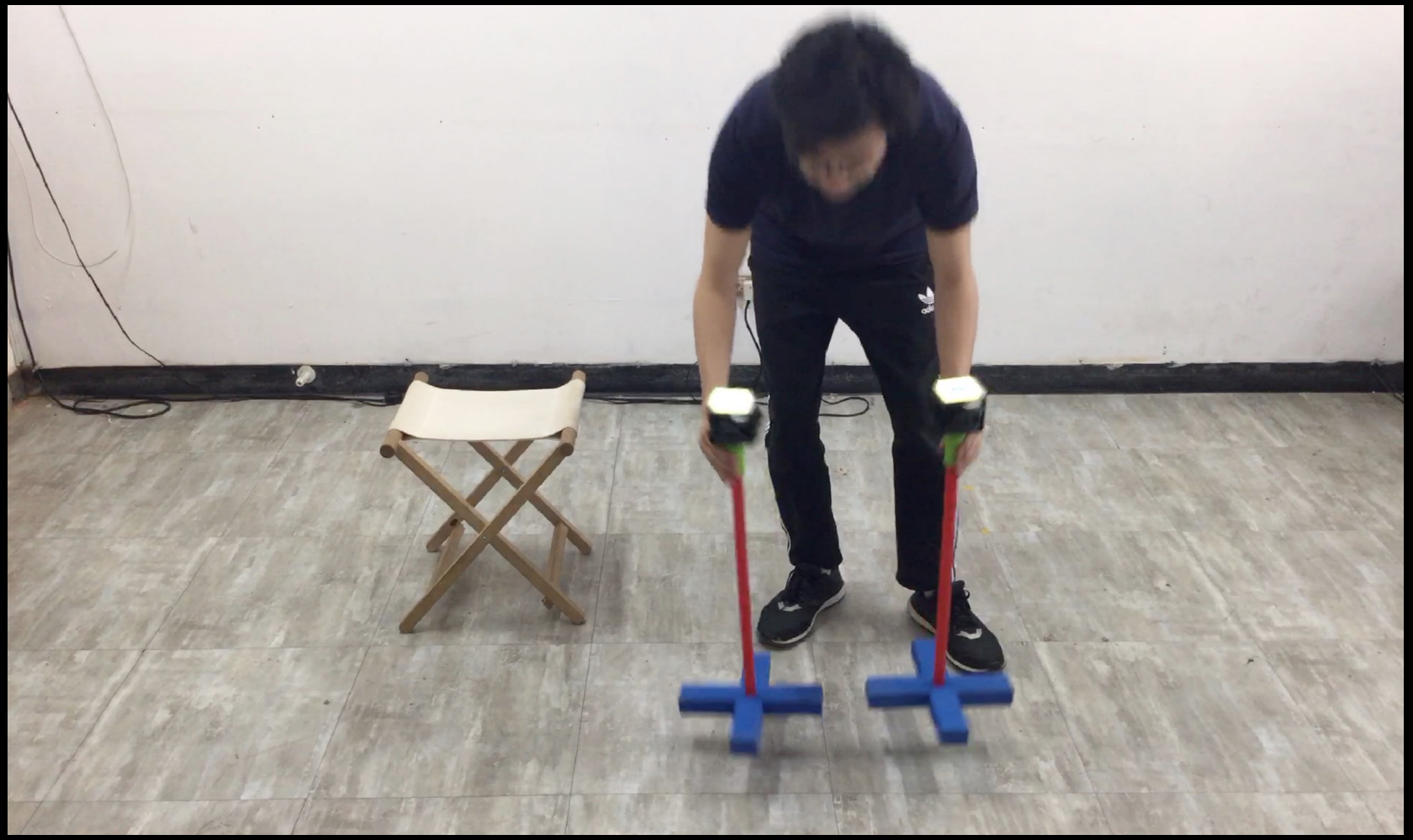


stand

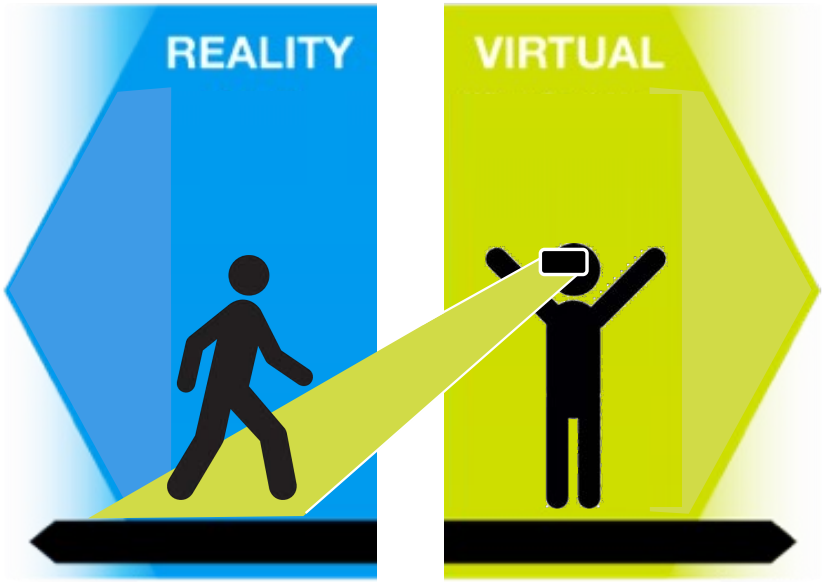








HMD Light



2020

HMD Light

Sharing In-VR Experience via Head-Mounted Projector for Asymmetric Interaction

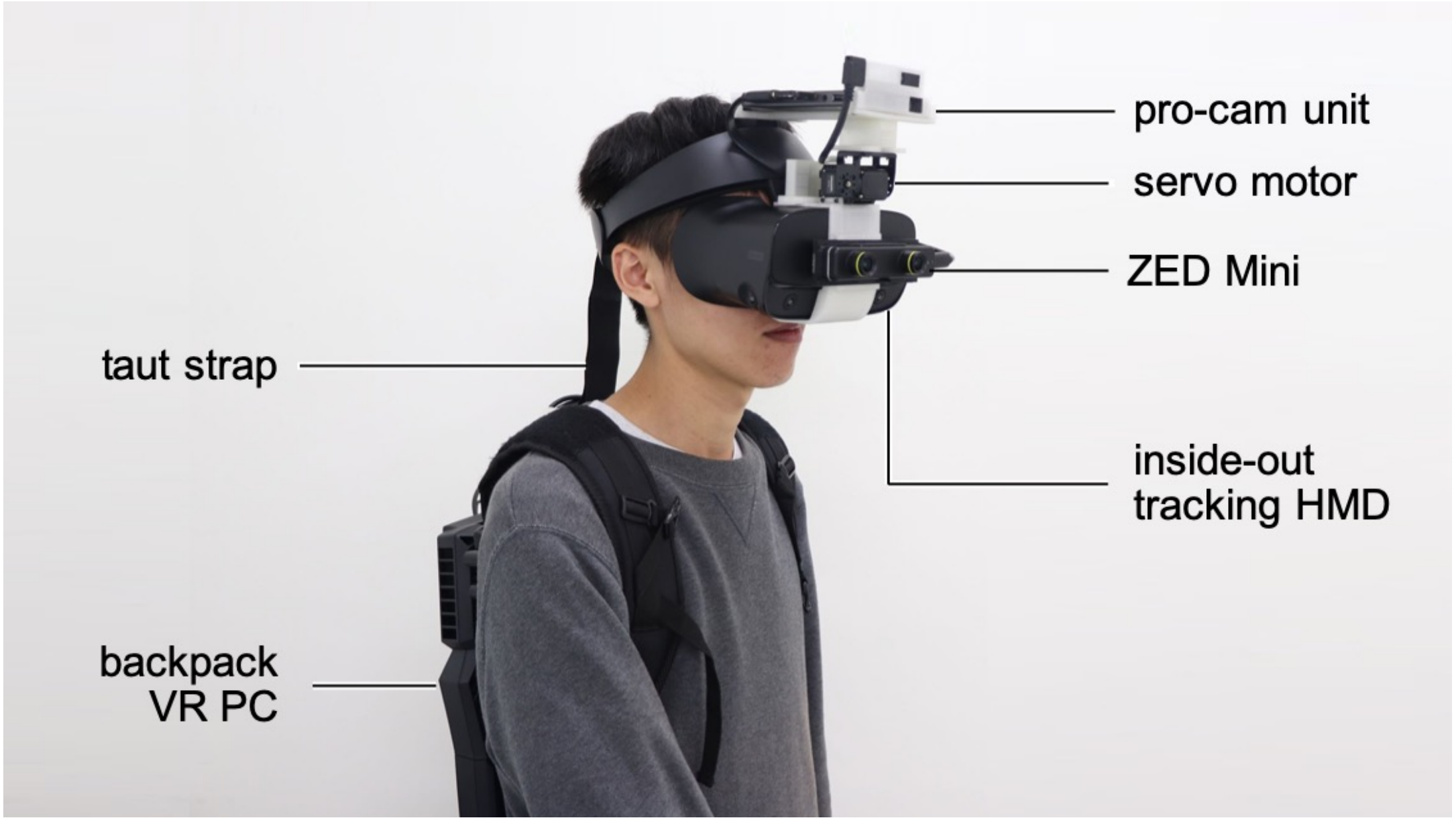
Chiu-Hsuan Wang
Seraphina Yong
Hsin-Yu Chen
Yuan-Syun Ye
Liwei Chan

National Chiao Tung University, Taiwan
NTU IoX Center, Taiwan

HMD Light

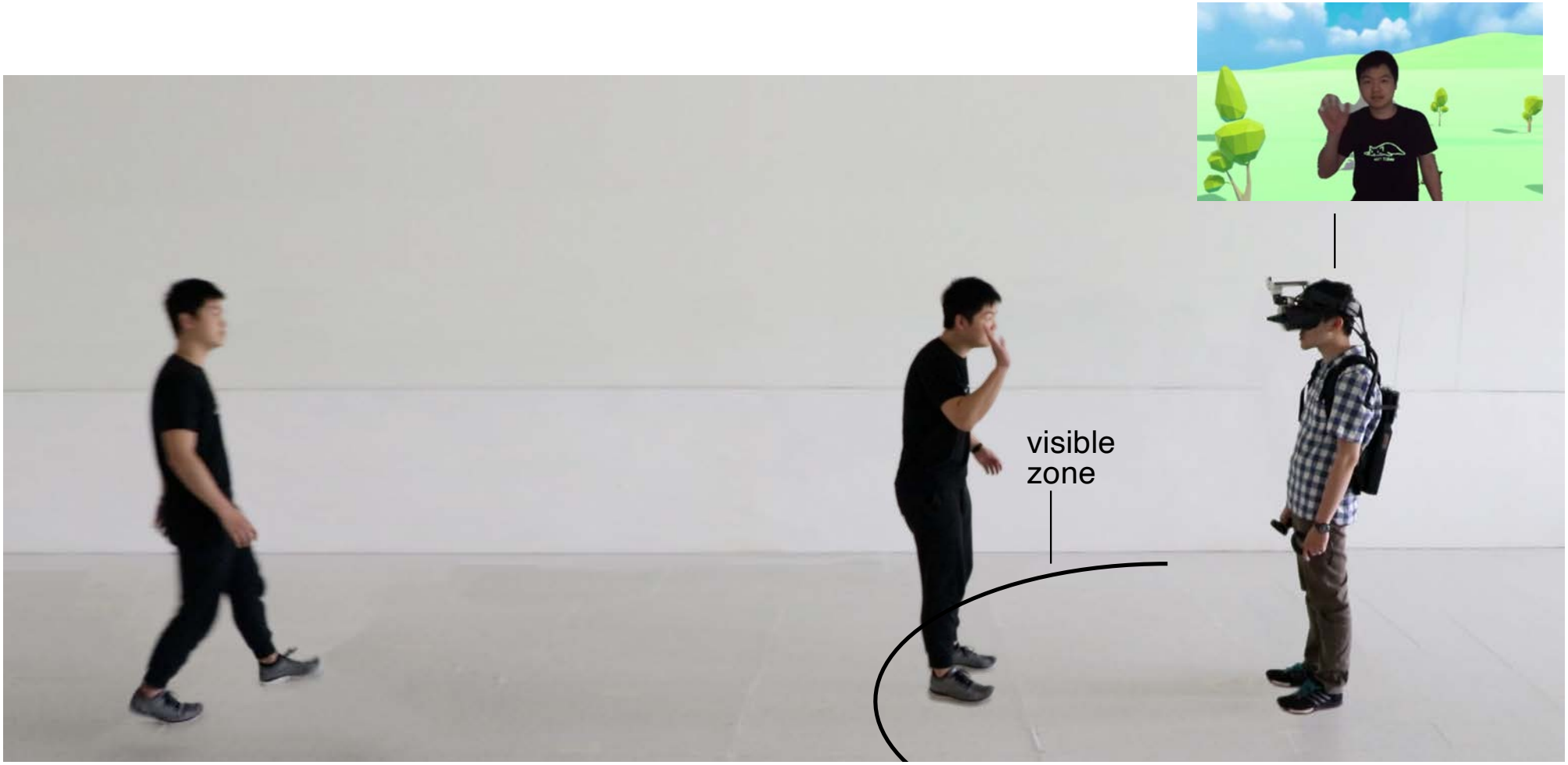
a mobile HMD integrated with a steerable head-mounted projector

allowing to anytime and anywhere reveal the VR user's experience in physical environment


pro-cam unit
servo motor
ZED Mini
taut strap
inside-out
tracking HMD
backpack
VR PC

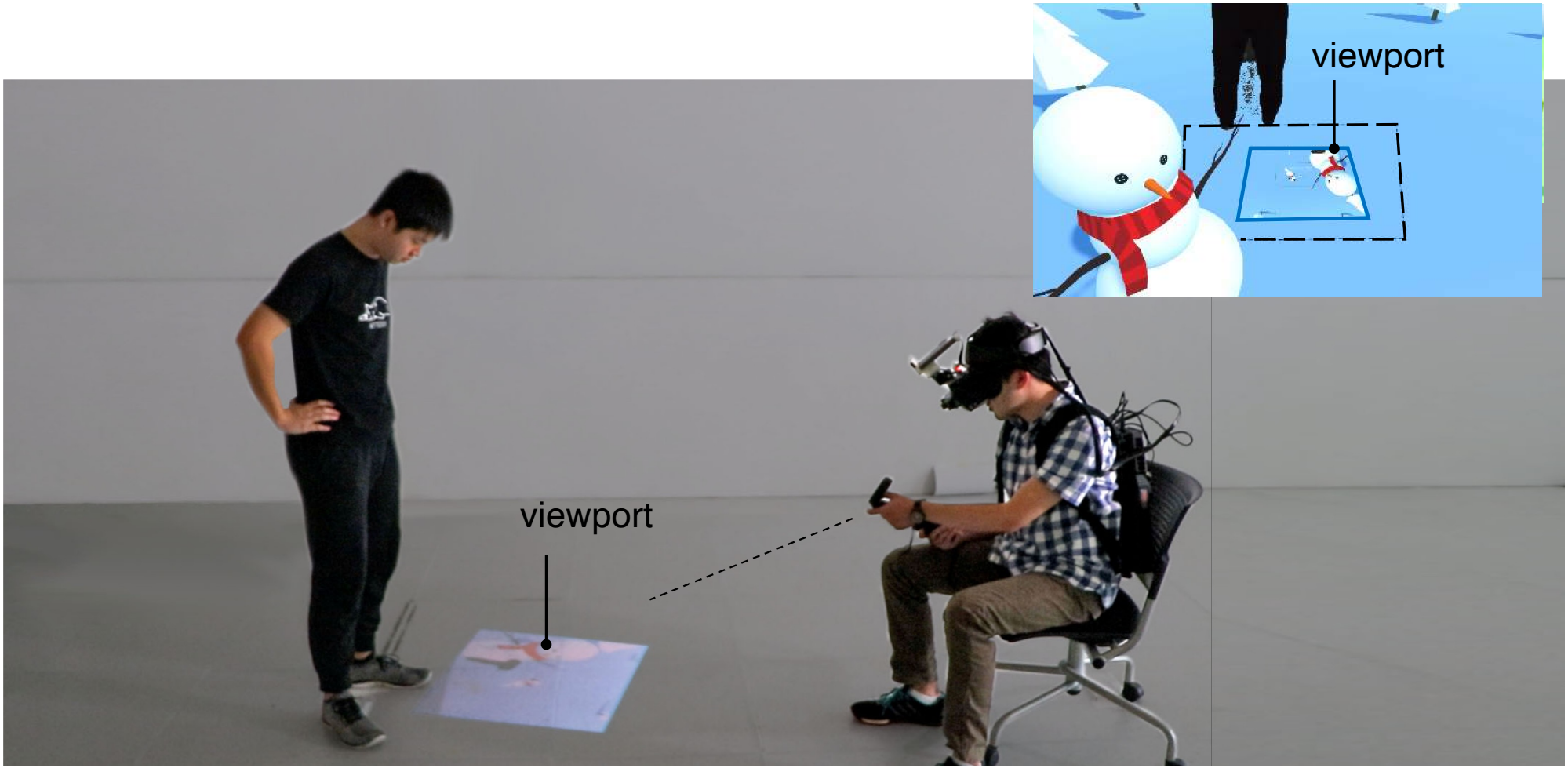
mutual communication

Visualizing **external users in VR** when they approach VR user in **visible zone**



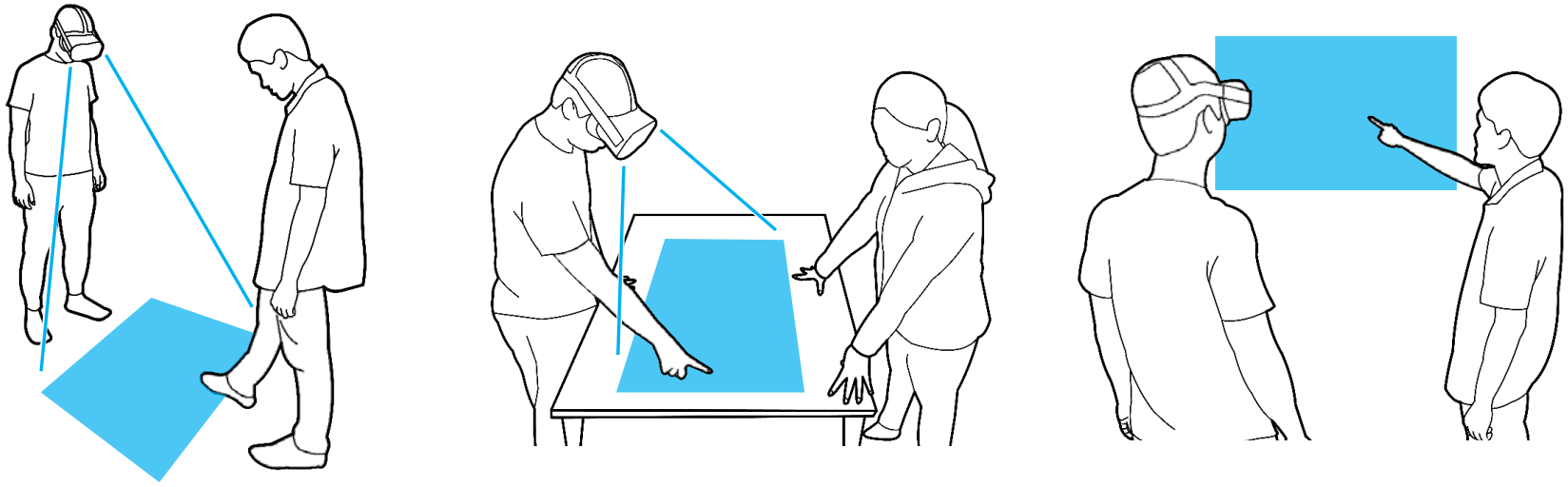
Viewport: communication reference

the VR user places a viewport to share their VR experience with external users



Free-surface Interaction

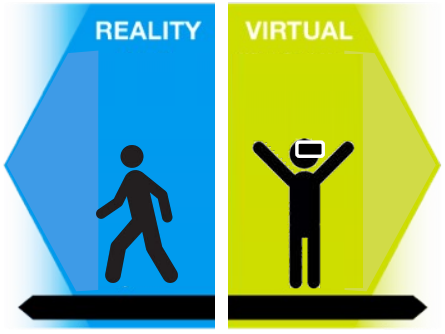
in addition to projecting on floor, HMD Light has the potential to **deploy display to any convenient surface**



FrontFace

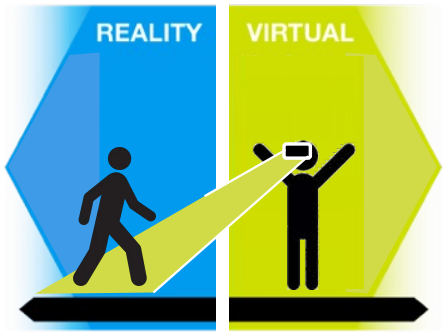
2017

ShareSpace



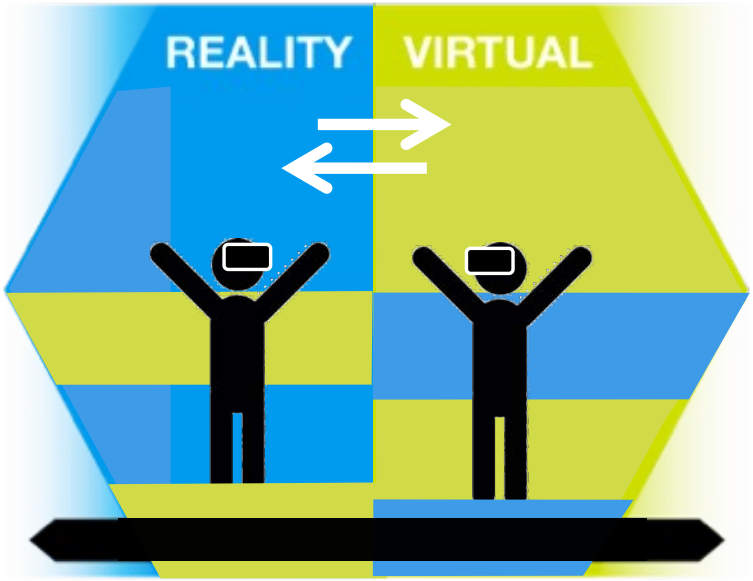
2018

HMD Light



2020

Slice of Light



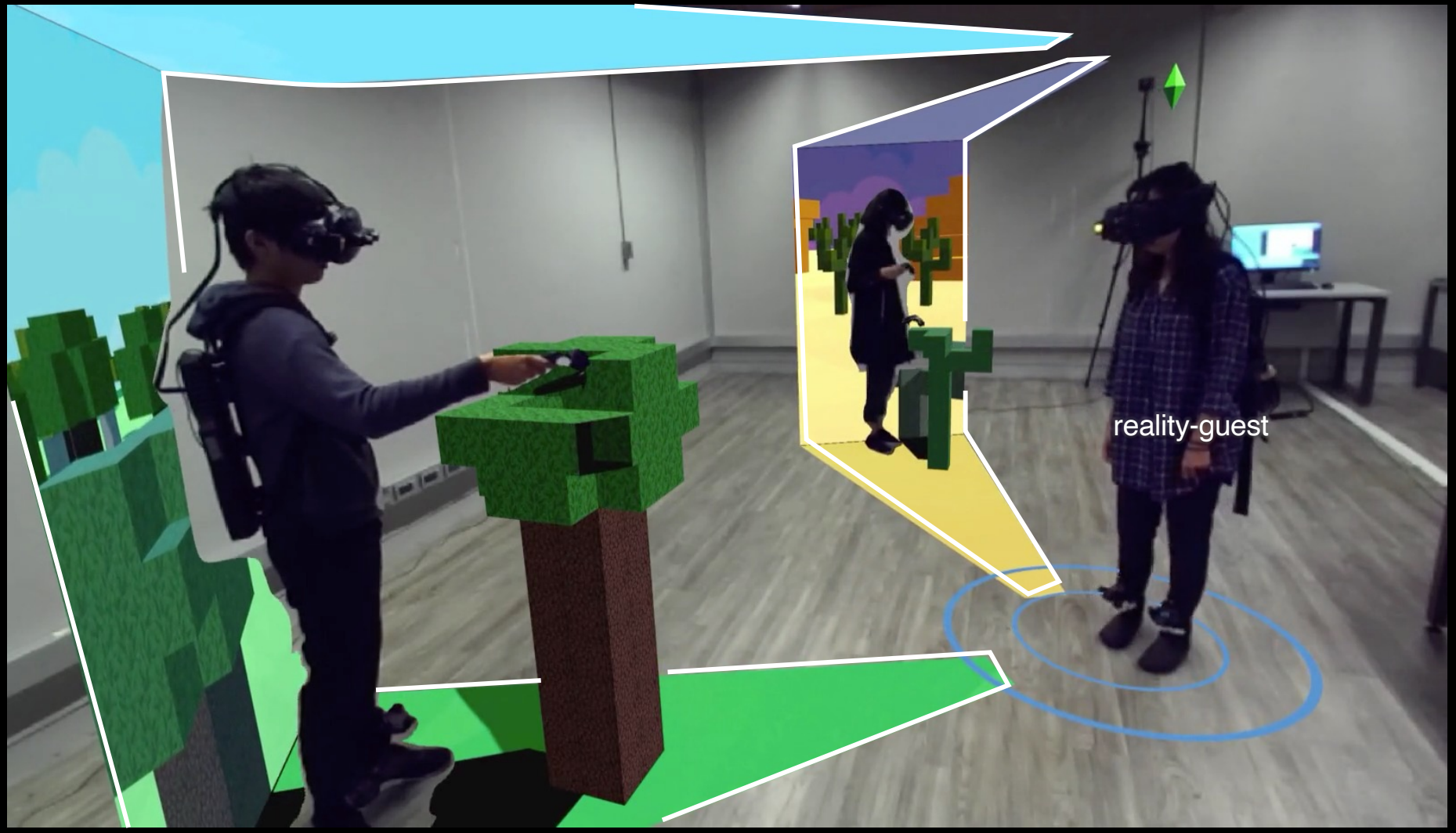
2020

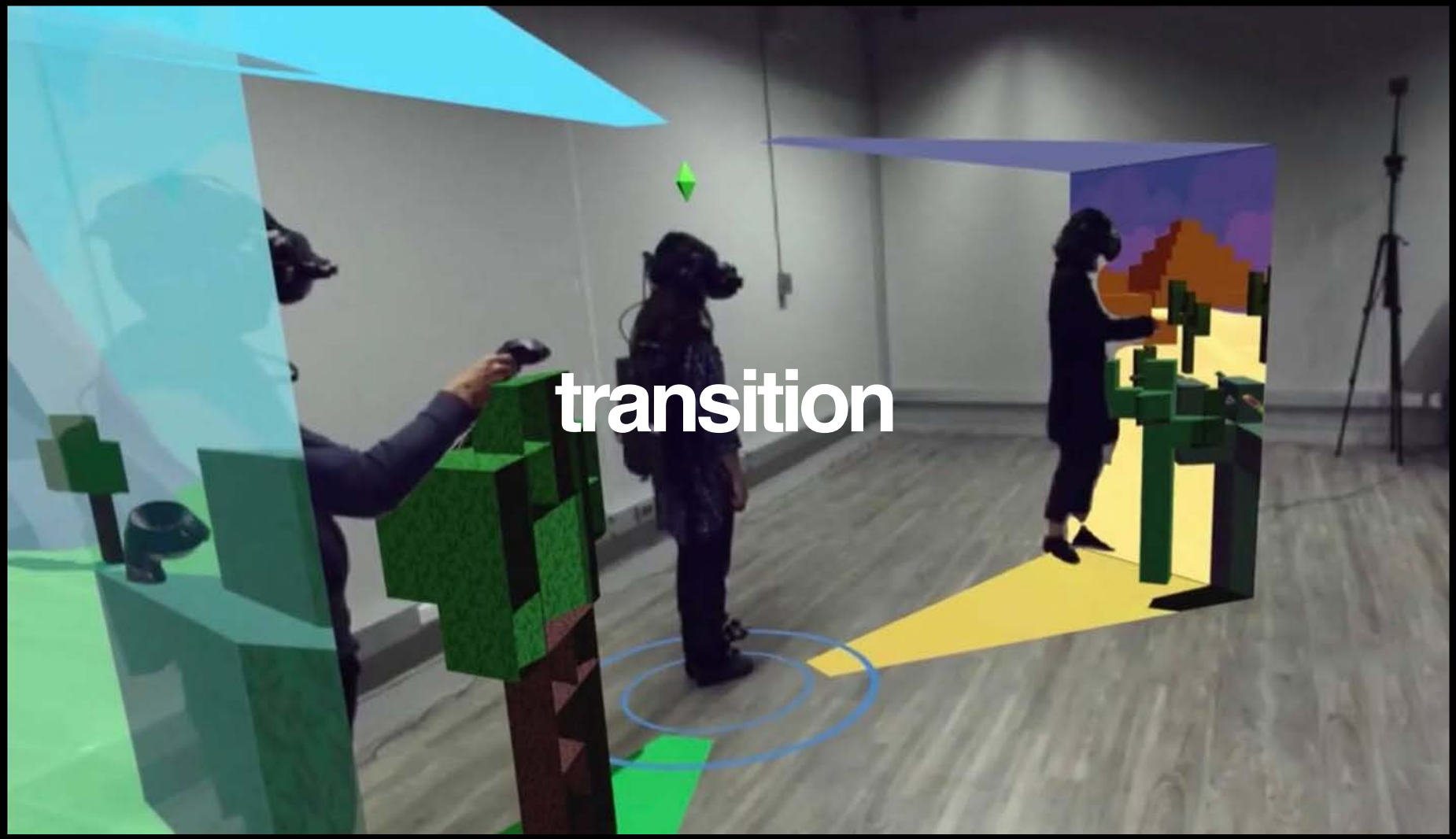
2020

Slice of Light

Transparent and Integrative Transition among Realities in a Multi-HMD-User Environment


HMD
HMD
HMD
Slice of Light
a visualization design
to enhance integrative transition
among realities of HMD users.

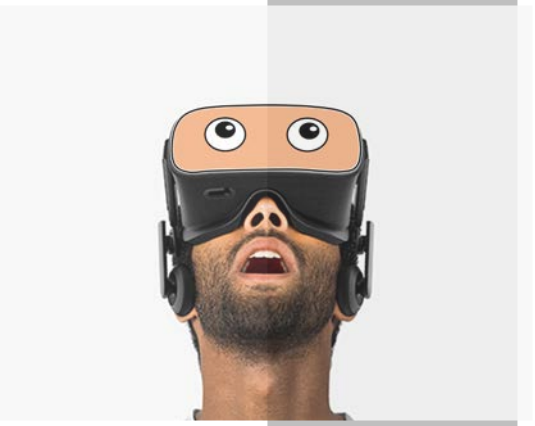

reality-guest

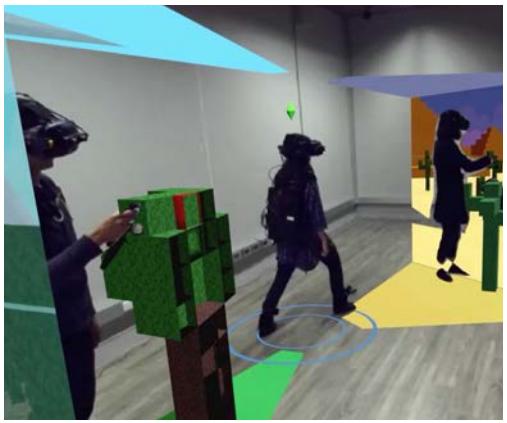

transition


reality-guest
stepping into reality-yellow

1

VR as an **ecological device**
is **accessible** to the surroundings





2

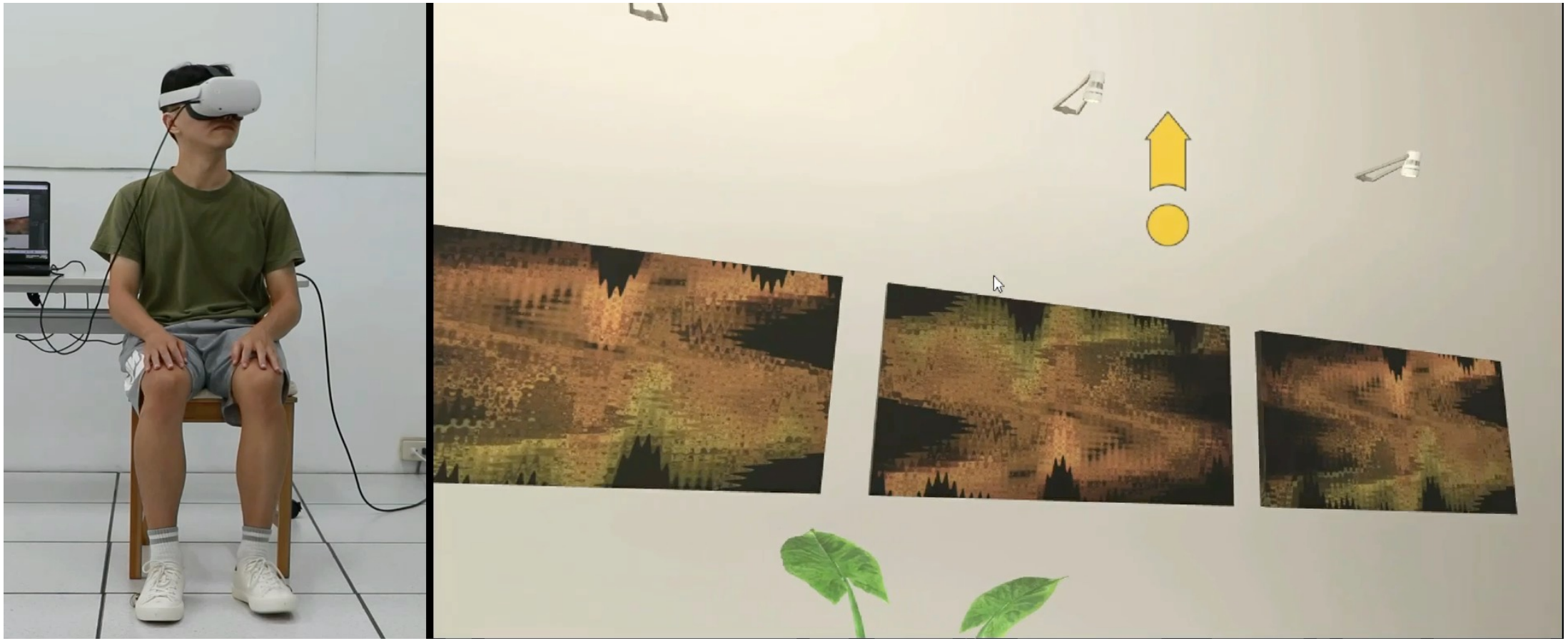
VR as an immersion device

expressive
natural
interaction

VR as an **ecological device**
can harmonize with the surroundings

Seated-Walking

A Walking-in-Place Technique for Seated Use of Virtual Reality



VR Locomotion

vs

Design Consideration

- Embodiment
- Fatigue
- Highly constrained space
- Social Acceptance

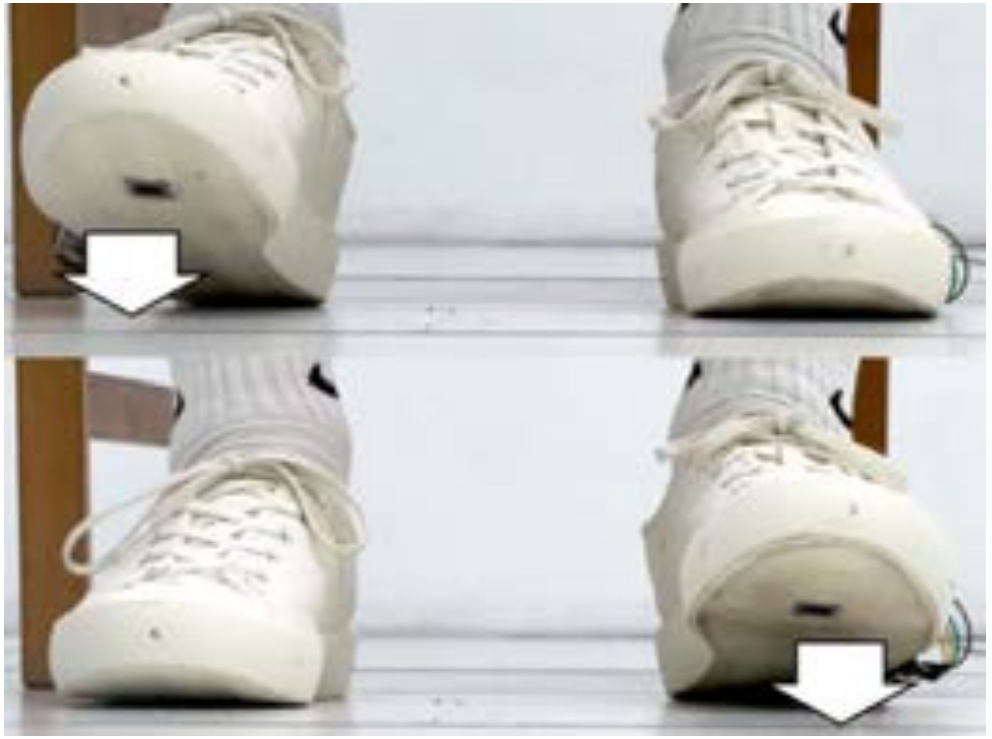
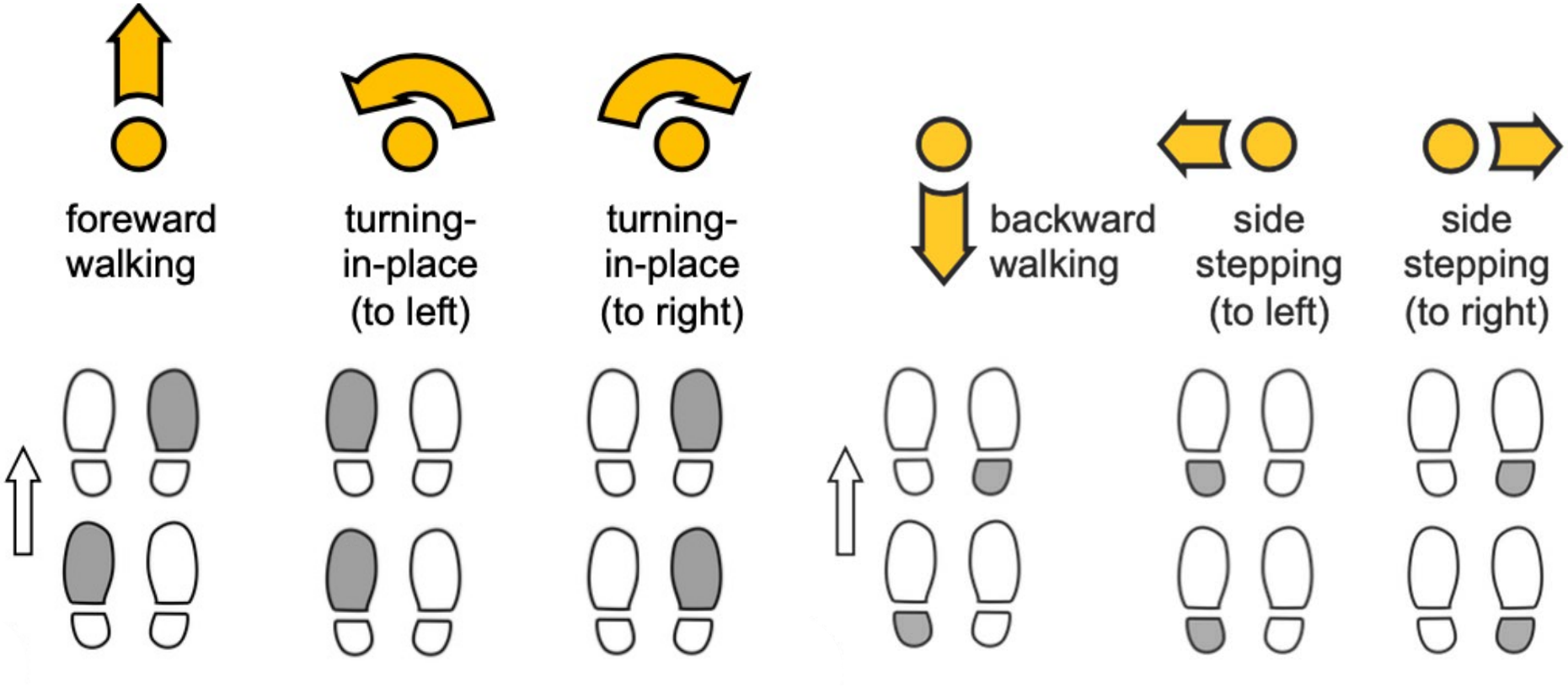
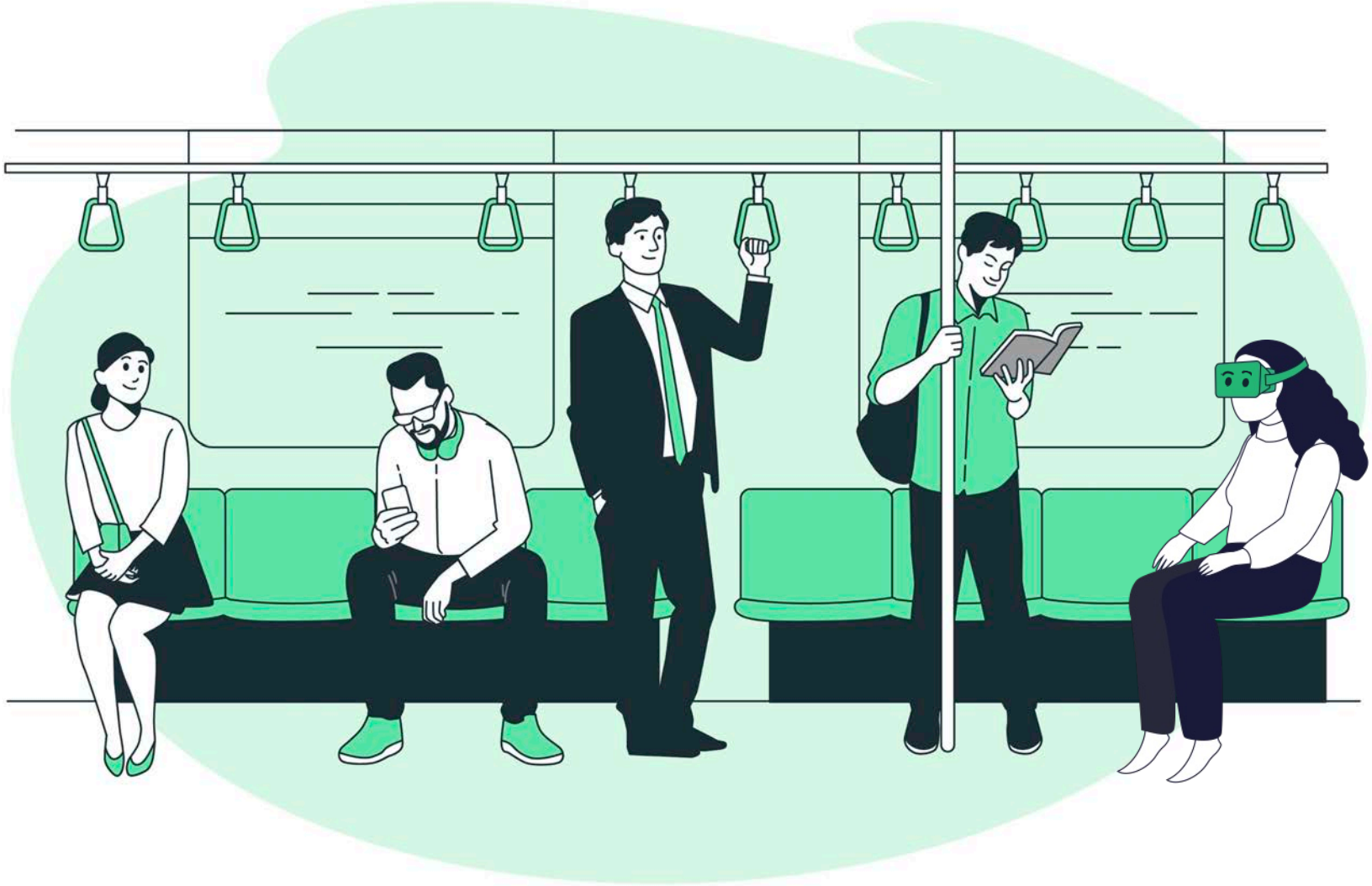


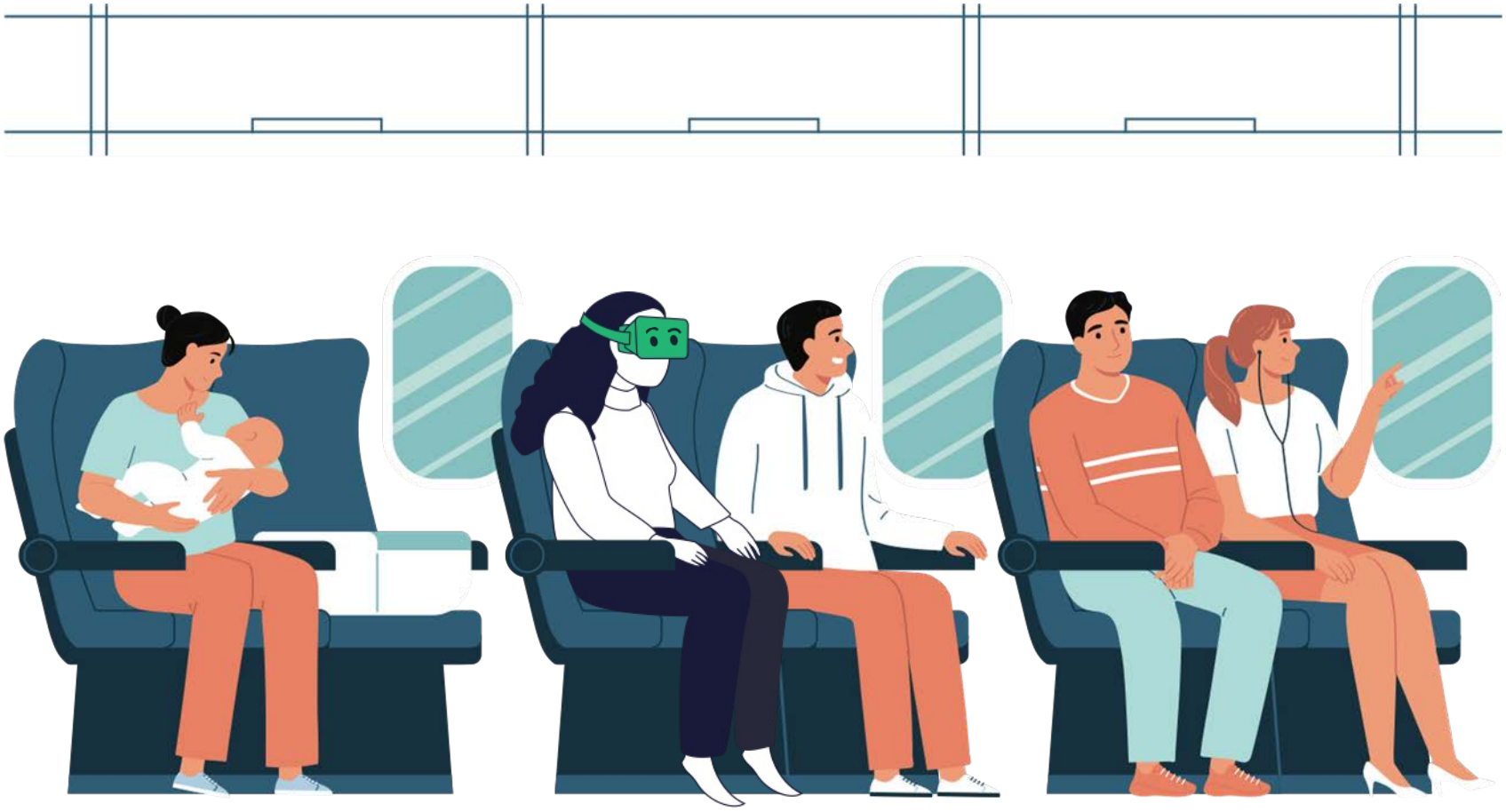

Photo-reflective sensors
Wifi Arduino (Adafruit M0) with a lithium battery

Interaction Design




SIGGRAPH 2023
Immersive Pavillion
500+ users experienced
Seated-walking

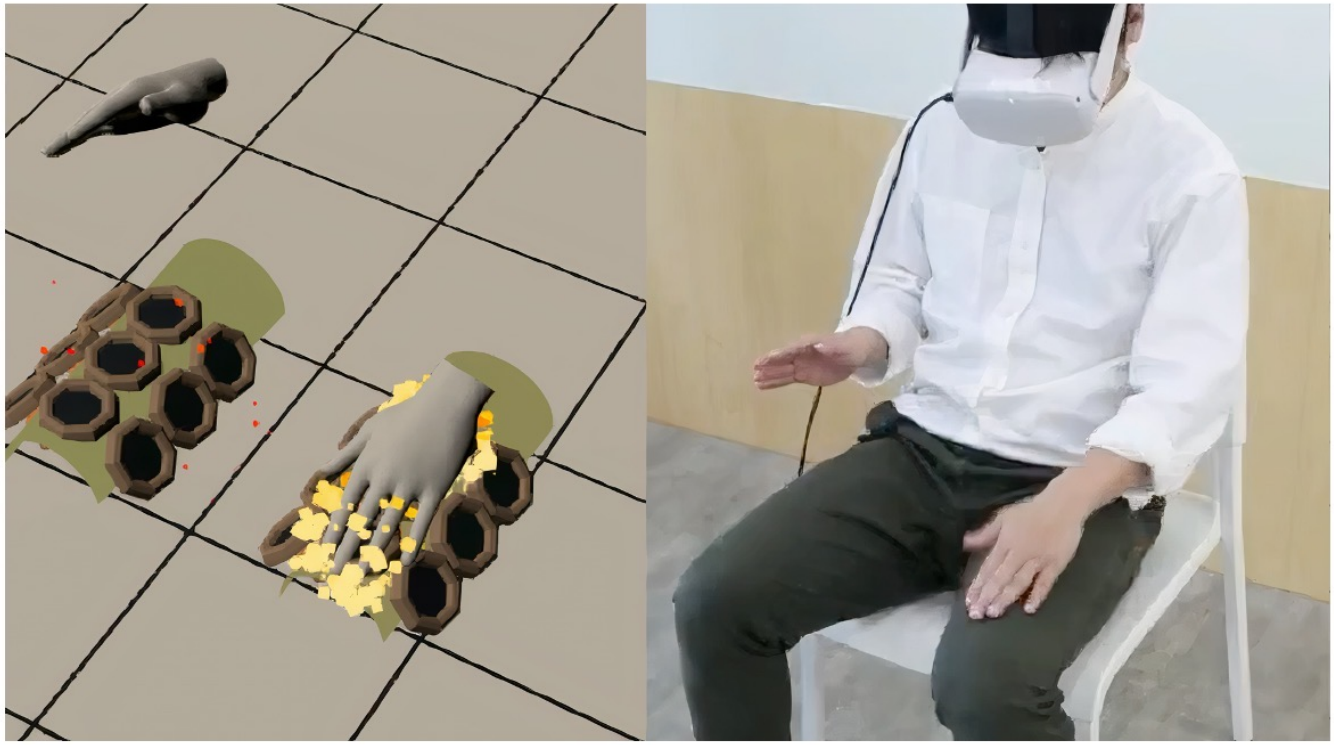





whack-a-mole

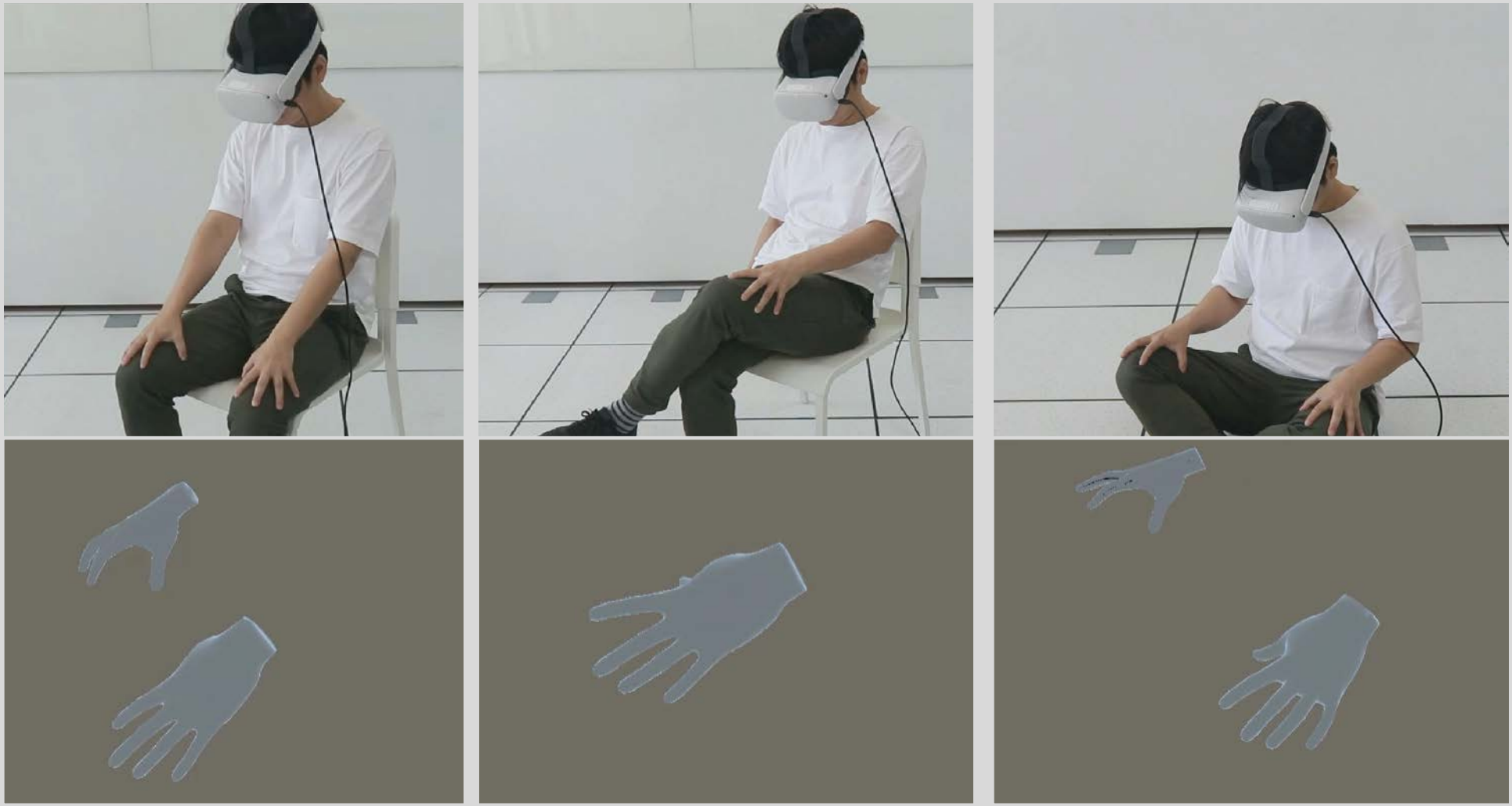
LapTouch

Using the Lap for Seated Touch Interaction with HMDs



the **lap**

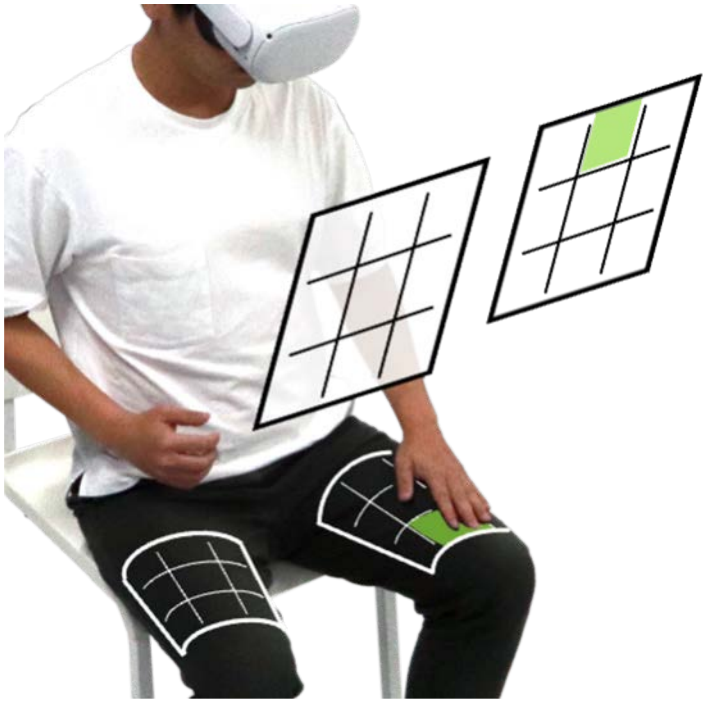
a surface, simple to access, smooth, and spacious for touch interaction.



Three ways of using the Lap interface

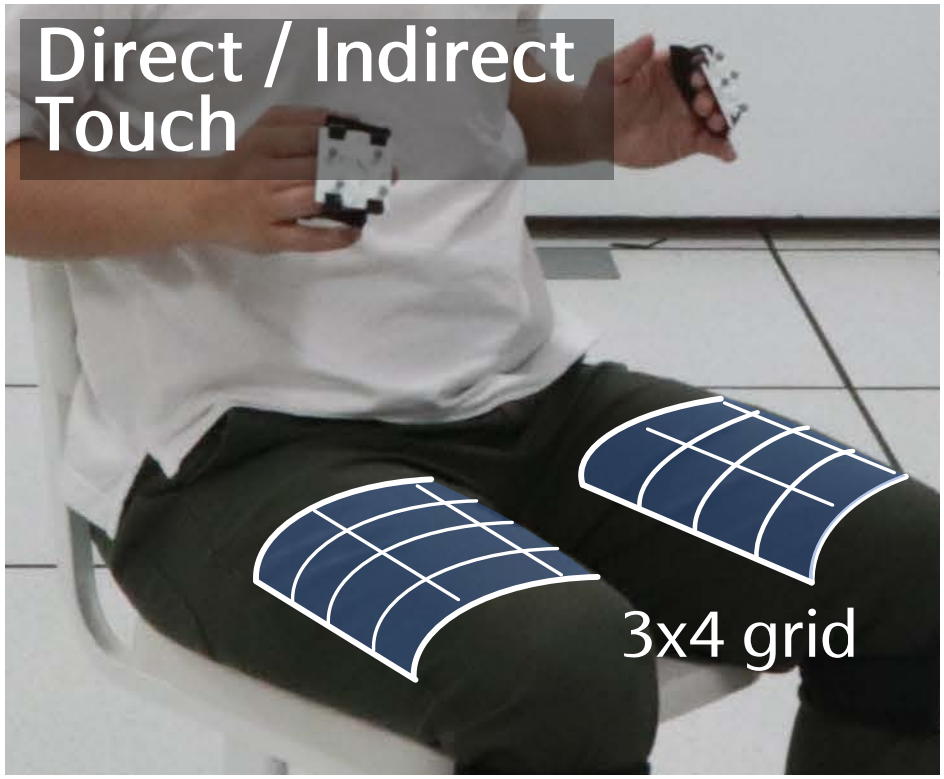
Direct Touch

Indirect Touch



Eyefree Touch

Recommended layout



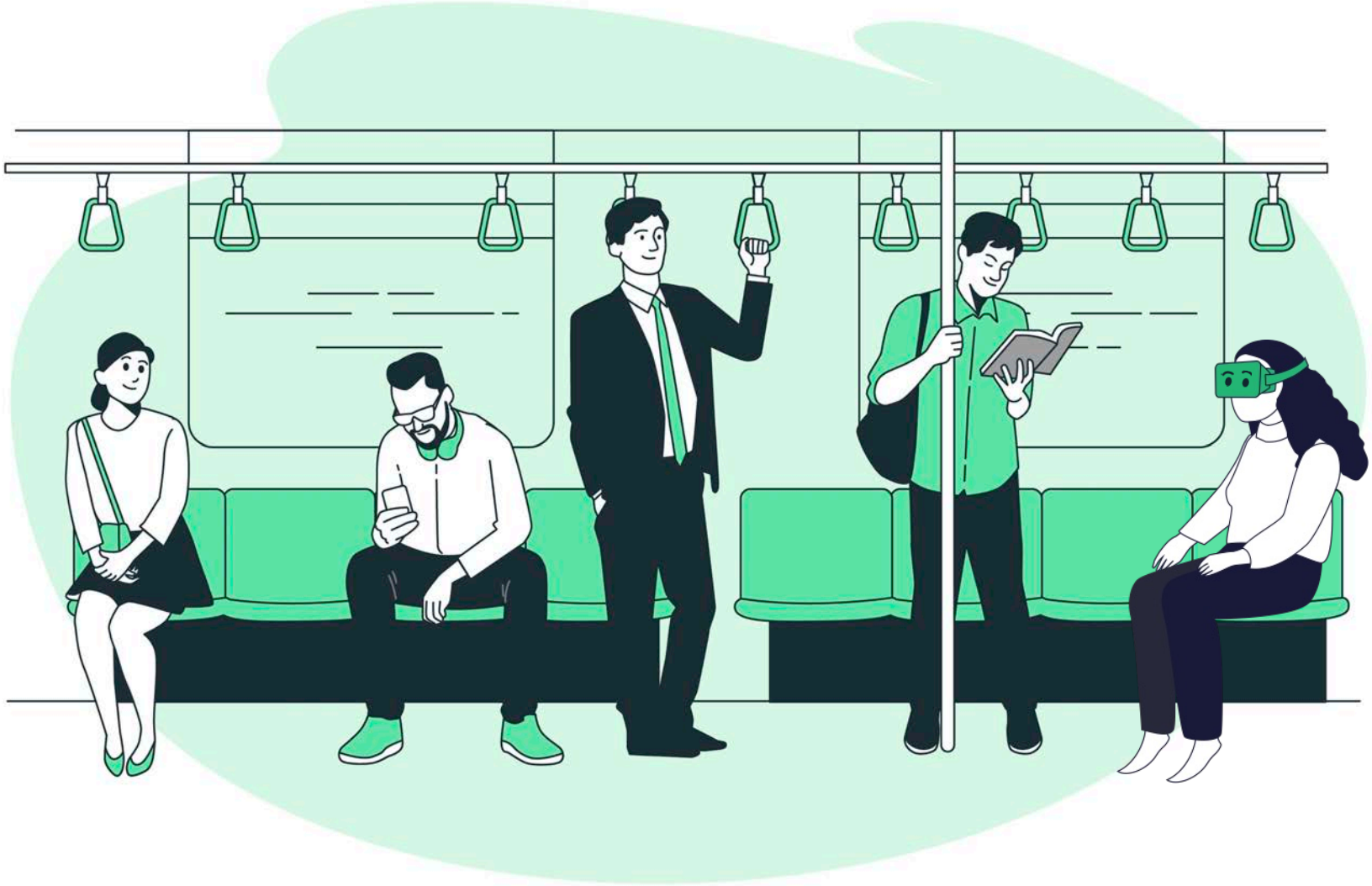
recap

make
Virtual Reality (HMD)
an ecological device.

VR as an **ecological device**

is **accessible** to the surroundings

can **harmonize** with the surroundings



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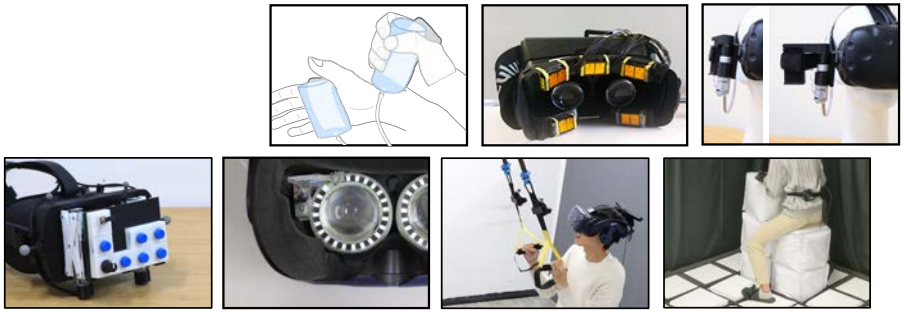

Reality ⟶ Augmented Reality (Mixed Reality) ⟶ Virtual Reality