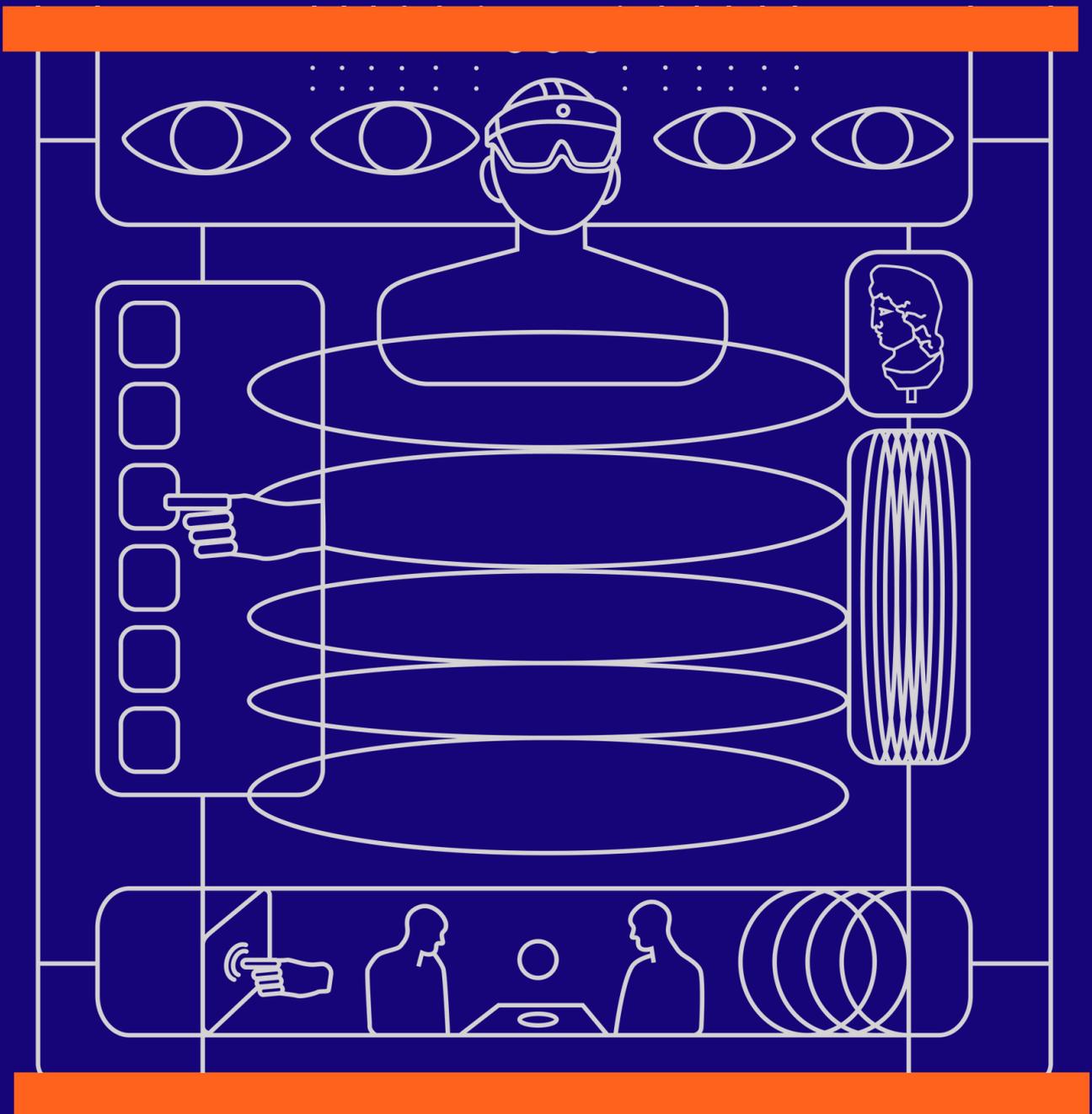


LET'S BE

**MULTISENSORY STORYTELLING IN HAPTIC-SUPPORTED
VIRTUAL REALITY FOR AN IMPROVED SENSE OF PRESENCE
AND CONNECTEDNESS**



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INTRODUCTION

The prevalence of loneliness and social isolation as an issue for well-being has been widely documented across a variety of populations (Hawkley et al., 2010). Estimates indicate that loneliness – which refers to perceived social isolation rather than objective one (Hawkley et al., 2010) – affects as many as 80% of individuals under 18 years of age and 40% of adults over 65 years of age at least occasionally (Berguno et al., 2015; Pinquart & Sorensen, 2001). The negative impacts associated with these feelings can be far-reaching, with studies showing links between feelings of loneliness and an increased risk for morbidity and mortality (Sugisawa et al., 1994; Penninx et al., 1997; Thurston & Kubzansky, 2009).

Psychosocial problems related to social isolation have become a significant public health concern in the 2010s' and was further exacerbated by the COVID-19 pandemic, which has brought the issue of loneliness into the public eye and sharper focus.

The problem is increasingly being recognized as a major public health concern and policy issue. The UN's Demographic Change and Healthy Ageing Unit targets those issues as one of the four primary action areas of its Decade of Healthy Ageing (2021–2030) (WHO, 2022).

Loneliness interventions often use mediated environments to improve the feeling of connectedness. Recent studies have shown that VR can be an effective tool for improving mental health. In particular, VR has been found to be helpful in treating conditions like, for example, anxiety and depression (Burdea & Coiffet, 2003; Riva et al., 2016). It is thought that this is due to the immersive nature of VR, which can help people to disconnect from their environment and enter into a new virtual world (Riva et al., 2016). This can provide a sense of escape for people who are struggling with mental health issues.

Video calls and (social) virtual reality (VR) are also used to improve connectedness. They aim to create an illusion that a mediated experience is not indeed mediated and create for users a strong sense of presence (Lombard & Ditton, 2006).

This project delves into the potential of haptic technologies for enhancing participants' sense of presence and connectedness in semi-scripted virtual reality-based social experiences.

THE APPROACH

Through exploration of various kinds of VR environments and interactions, the project aimed at offering a better understanding of designing haptic-technology-supported experiences and their potential for improving social connectedness.

To explore the aspects contributing to feelings of presence and connectedness, existing content and platforms were combined with newly developed (for the purpose of this exploration) prototypes, as well as a range of hardware - haptic vests, gloves, and suits.

The exploration was split into three subprojects, each exploring the impact of haptic feedback on storytelling development, user engagement, the feeling of connectedness, and presence. The results of the sub-projects 1 & 2 were used as a basis for the development collaborative VR experience - Kyle's Escape.

Sub-projects:

1

**Haptic feedback &
Cinematic Virtual Reality**

2

**Haptic feedback &
Social VR**

3

**Prototyping
Kyle's Escape**

TOWARDS SOCIAL CONNECTEDNESS

The approach of the project is based on the conceptual frameworks of social connectedness proposed by Van Bel et al. (2008) and social space by Kreijns et al. (2022).

Social connectedness is defined as a short-term experience of belonging and relatedness, based on quantitative and qualitative social appraisals, and relationship salience when using communication systems. The framework consists of five dimensions that measure: relationship salience, closeness, contact quality, knowing each other's experiences, and shared understanding (Van Bel et al., 2008). Those characteristics can be seen as corresponding with the concept of social space, which focuses on the interpersonal and emotional connections between group members as a part of social interaction in a computer-generated environment (Kreijns et al., 2022).

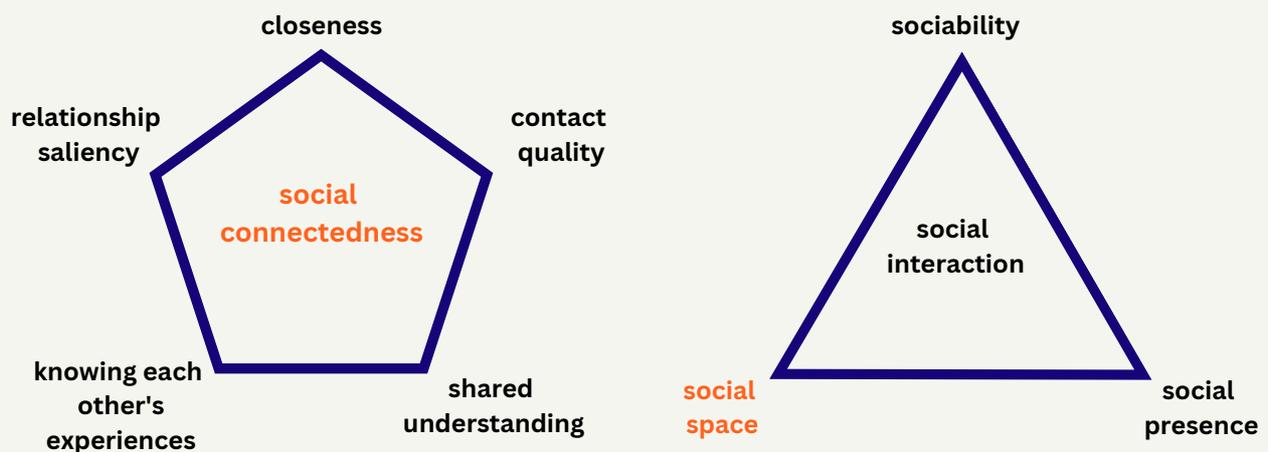


Figure 1. Project's theoretical framework as adapted from Van Bel et al. (2008) and Kreijns et al. (2022).

HAPTICS & CVR

The use of haptic feedback in Cinematic Virtual Reality movies offers the potential to enhance audience experience and engagement by improving connection, immersion, and guiding viewers' attention and helping navigate the plot within a 360-narrative.

Project setup: The study explored emotional connection, and emotional engagement with the characters and embodiment through multi-modal stimulation by integrating visual, auditory, and tactile content. To set grounds for the development of own prototype, the project utilized existing content of Cinematic Virtual Reality productions. Ten participants were invited to watch two movies: "The Party: A Virtual Experience of Autism" and "Help" using a VR headset, haptic gloves, and a haptic suit. The software of the bHaptics Designer tool was used to add haptic feedback to the movies.

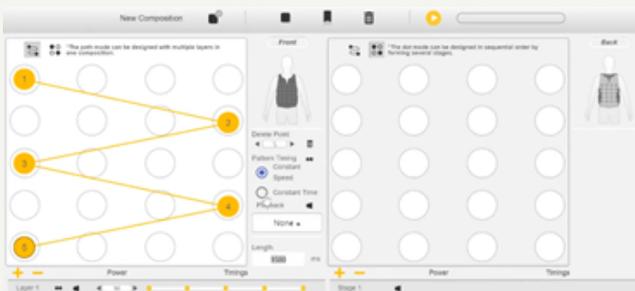


Figure 2. Bhaptics designer view for vest haptic feedback authoring

"Even though you don't have an impact on the set of events happening, you feel like you are actually being impacted by your surrounding and by the characters"

Interviewee

Connection

The greatest impact of utilizing haptic feedback was seen when used during the scenes viewed from the point of view of the protagonist (also referred to as "the Hero perspective"). The haptic sensations can correspond then directly with the experiences of the protagonists. Presenting the storyline this way allows viewers to feel more directly addressed by the characters and engage in their inner thoughts on a deeper level. This leads to increased feelings of immersion, as well as stronger social and emotional connections with the characters. Additionally, providing a more detailed narrative structure supported with relevant haptic cues create higher levels of engagement between the audience and the movie's characters.

Diegetic and global effects

Diegetic local effects can be seen as creating a more effective feeling of connection and emotional engagement between the viewer and the storyline and its characters. This is due to the fact that it provides a sense of physical presence for viewers in the virtual environment, making it easier for them to connect emotionally with what's happening on screen. In contrast, global effects are perceived as more "realistic" and immersive, but less focused on creating a connection with the audience through a sense of touch.

Haptics can act as a cue to guide the viewer's attention

Cues and Narrative Navigation

For filmmakers creating CVR experiences, haptic feedback can be used to help viewers understand the narrative and prevent them from feeling fear of missing out (FOMO). By providing a physical cue, haptics can serve as a guide for a viewer's attention, allowing them to engage with the story in a more immersive way. Haptic feedback can be also beneficial for clarifying information and enhancing understanding of the scene setup. For example, haptic cues can indicate when something important has happened in the story and in which area of the 360-degree environment. Additionally, by providing an additional layer of sensory input through the sense of touch, filmmakers are able to create a more intricate experience by being more in control of the feeling of the environment by, for example, changing the temperature through the affordances of the haptic suit.



Figure 3. *The Party: A Virtual Experience of Autism*

Problems with immersion:

In some cases, haptic feedback, in the form of vibrating sensations, interfered with the experience, resulting in a loss of immersion for the viewers. The participants discussed the perceived lack of realism of the sensations was distracting and preventing them from getting truly immersed. What stood out was the relationship between realism and unrealism, as well as the hero/witness narrative option. Even though 'local' effects more successfully supported establishing a sense of connection, four out of ten individuals thought the local haptic effects were still implausible for the abovementioned reasons.

"It was a lot of vibrations for what was happening. It made it a bit more unrealistic because normally, I don't experience any vibration or any bodily reactions"

Interviewee

HAPTICS & SOCIAL VR

Sub-Project Setup

This sub-project focused on exploring how haptic feedback affects the experience of feeling connected between people in existing social experience environments. To accomplish this, an environment chosen for the exploration was VR Chat. VR Chat is a virtual reality social platform that allows users to create and explore 3D worlds with other users. In order to introduce haptic feedback, however, it was necessary to use a hobbyist mod maker called HerpDerpinstine. This mod allowed two people to interact within the same environment using vests, gloves, and haptic face covers.

The participants were placed in an environment that resembled a café in the physical world. This included an indoor area complete with a bar, several tables, and chairs, as well as an outdoor area featuring a pool table, a couch with cushions, and a television with a remote control. The participants were then instructed to carry out simple tasks such as interacting with the various attributes within the environment, including talking to one another and exchanging items such as food or cups of coffee, looking at the mirror, or hugging each other.



Figure 4. One of the researchers as an avatar in the VR Chat

The purpose of this setup was twofold: firstly, it allowed for the investigation of whether incorporating haptic feedback into social experiences would increase feelings of connection between two people; secondly, it provided an opportunity to explore how different types of haptic feedback might affect these feelings of connection differently. For example, there may be different responses depending on whether vibrations are used or if objects are given physical weight when touched. This setup offered the chance for researchers to look into both aspects simultaneously in order to gain a better understanding of how human beings respond to physical contact in virtual worlds.

The research was designed around the social interaction model by Kreijns et al. (2022), which consists of three concepts, namely, social presence, sociability, and social space. The project explored the theory by means of a qualitative experiment with five couples participating (N=10).



Figure 5. VR Chat experiment taking place in Virtuorium, Leiden

Social presence & positional tracking

Social presence understood as a person's 'realness,' was partially recognized through technological affordances for the transmission of nonverbal and verbal cues, as well as social affordances provided by immersive VR, such as the ability to play a game.

Since the element of visual recognition plays a significant role in how users interact with and identify each other, in VR environments, participants are able to transfer and recognize cues such as gaze, gestural behavior, voice, and even height. That helps them to create a feeling of 'realness' between them. However, contribute to social interaction; through characteristics such as the height or characteristic body language of the other participant, some form of recognition takes place. The prerequisite is that an interpersonal relationship is already present before participants experience social interaction in an immersive VR environment.

this is not enough for participants to actually believe that the other person is real since their representation is still done through an animated avatar or even a computer generated character.

Apart from visual recognition, users also tend to experience social presence by taking into account various sensory parameters such as touch or force feedback

In VR, individuals adapt to the medium's constraints by seeking cues in the language they use and adjusting their emotional and social responses to the available language. Haptic feedback expands the range of coping mechanisms for the users.

The finding is in line with the previous research by Walther (1993) on how users adapt to the restrictions of the medium.

GESTURES AND HAPTICS IN COMMUNICATION

“Each hand has approximately 150 000 mechanoreceptors which are connected to the central nervous system by 30 000 primary afferent fibers. The density of these receptors is highest on the fingertips (2 500 per cm²). Each fingertip is innervated by 250–300 mechanoreceptive fibers. This large number of nerves confers fine tactual acuity to the fingertips, enabling them to read Braille and to discriminate surface texture.” (Gardner, 2010)

Hands are a primary tool for non-verbal communication. Studies have revealed that perceiving hand movements during speech modulates the distributed pattern of neural activation involved in both biological motion perception and discourse comprehension. This suggests that listeners attempt to seek meaning not only from the words spoken but also from any accompanying hand movements (Dick et al, 2009). Moreover, people can relate more deeply and personally through physical tactile contact than they can with just verbal or visual cues alone (Gardner & Gratch, 2019; Torrey, et al., 2017). Consequently, VR haptic gloves can be employed in the attempt of replicating personal gestures and interpersonal touch experiences and thus providing insight into embodied cognition and related connectedness.



Figure 6. Manus Prime X Haptic VR Gloves used for Kaly's Escape experiments (photo: Manus Press Materials)

KYLE'S ESCAPE PROTOTYPE

"Kyle's Escape" is a Virtual Reality escape room built in Unity.

The game featured two levels, both with the same initial objective: connect and collaborate to escape. The experience involved two players simultaneously to evaluate how they interacted with each other and their environment.

The first level focused on introducing players to the overall concept of cooperative play in a virtual reality environment. To create this level, we used Manus' Prime X haptic gloves and plugins for Unity, which allowed us to take advantage of full hand tracking and basic vibration feedback in addition to the use of netcode.

Players began at opposite sides of an interrogation room with a one-way mirror - a person in room 1 could not see the person in room 2, but vice versa.

The second level sought to test a different type of cooperative experience, where one player had limited sight and hearing while the other provided more tactile input via the haptics gloves. This time players worked together to overcome obstacles such as locked doors or puzzles and make it out before time ran out.



*Figure 7: Room 1 view.
Participants do not share the room.*

KYLE'S ESCAPE PROTOTYPE

The prototype developed for the project produced an environment that enabled collaboration and a challenge-based experience. This exploration examined how users can create social presence through virtual interaction, with or without direct physical contact, by making use of touch to interact with the surrounding elements as well as incorporating hand/body tracking technology which affords natural body language expression via gestures.

Selected findings:

- Through the introduction of a mirror, study participants were able to ground themselves in their virtual reality and perceive each other as actual characters,
- This heightened sense of realism was then further enhanced by touch feedback and shadowing techniques related to individual body movements,
- Interactive hand/body tracking features allowed players to effectively perform gestures, which helped them cope with communication limitations while recognizing specific characteristics among co-participants.



*Figure 8: Room 2 view.
Participant sees own avatar in the mirror*



*Figure 9: One of the researchers testing
the experience with the haptic gloves*



*Figure 10: Experience view.
Puzzle is partially solved*

ARE WE THERE YET?

Haptic feedback can enhance the feeling of presence and connection within virtual experiences and offer an increase in perceived realism and immersion. However, the (tested) technology still falls short of replicating authentic physical touch and the vibrations alone are not enough to mimic tactical sensations.

As one respondent noted:

It feels more like a computer saying: you feel something now.

This links to the overall state of development of the majority of haptic technologies, being still rudimental. However, there is a big potential in hand tracking, which was reacted to above expectations

1

2

3

Vibrations

Even though vibrations serve well as cues and environment positional tools, they fall short as touch replications.

Positional tracking

Positional tracking offered the most potential for creating the feeling of realness within the experience

Bulkiness

Hardware made some of the participants constantly conscious about the presence of the technology and was pulling them out of immersive experience

KEY TAKE AWAYS

Haptic feedback can be seen as a promising approach to improving the feelings of presence and connectedness in virtual environments. The haptics offer the potential for improving the perceived realness and liveness of the experience and, therefore, offer the potential for building social connectedness on those principles.

HIGHLIGHT 1

By serving as cues and elements of an environment, haptic feedback can contribute to storytelling. It improves the realness of the experience by giving participants the impression that they are being impacted by the surroundings.

HIGHLIGHT 2

Individuals in VR adapt to the medium's limits by looking for cues in their language and changing their emotional and social reactions to the available language. Haptic feedback broadens the spectrum of coping techniques available to users.

HIGHLIGHT 3

Replicating touch allows participants to improve the feeling of realness and immersion in the collaborative and challenge-based settings

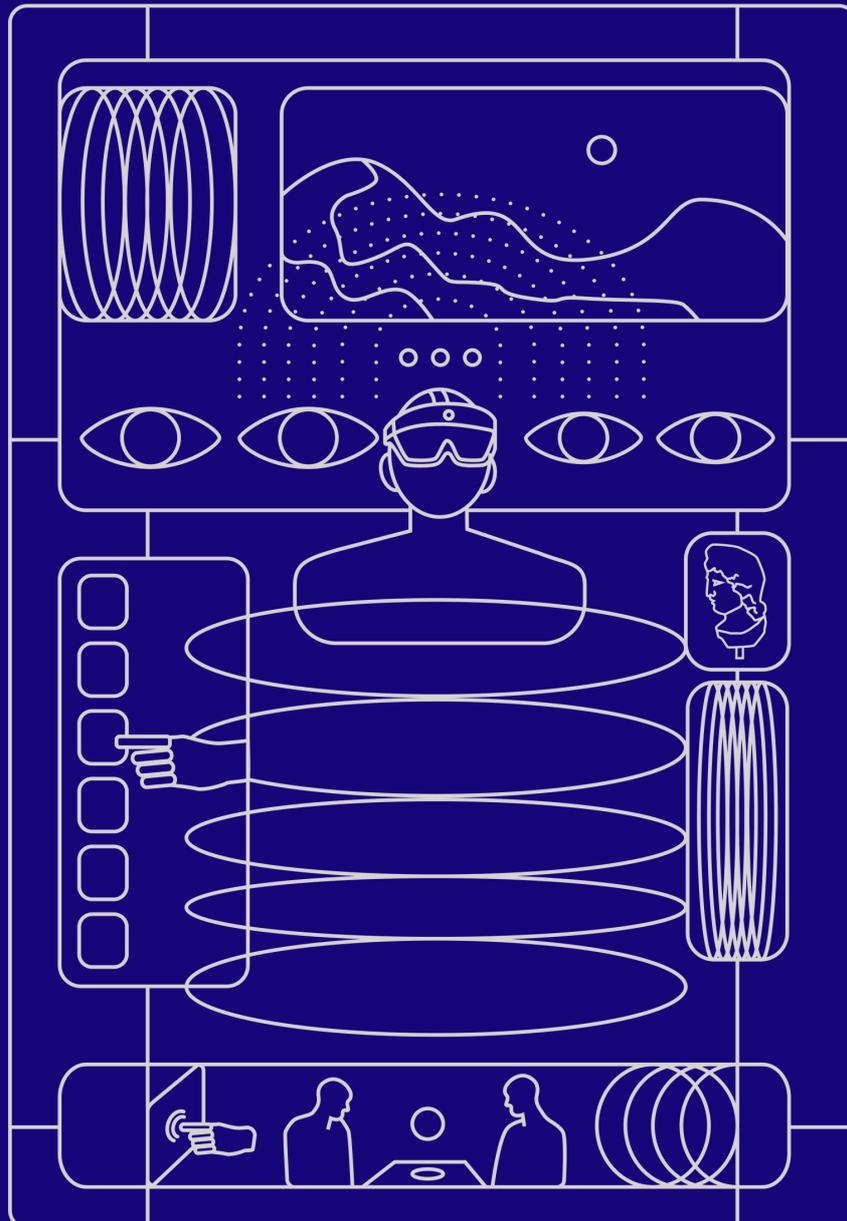
HIGHLIGHT 4

Despite its potential, there are still limitations on the technological level - the haptic feedback does not feel authentic enough to replicate the real-life touch and the "bulkiness" of the equipment has proven to be a barrier to the feeling of immersion.

We thank you for reading our report!
Visit also our website lets-be.page to follow the updates about the project.

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