xCoAx 2024
12th Conference on Computation, Communication, Aesthetics & X
Fabrica, Treviso, Italy
2024.xCoAx.org

Crip Sensorama: Re-Imagining XR with People with Sensorimotor Disabilities through Criptastic Hacking

Puneet Jain
puneet.jain@zhdk.ch
Zurich University of Arts, Zurich, Switzerland

Crip Sensorama is an interactive and multisensory XR artwork that enacts as an investigation, exploring how the ableist technologies of XR (eXtended Reality) could be hacked, modified, and made accessible in collaboration with disabled artists – opening XR as a platform of storytelling for (and by) people with disabilities. Hence, enabling the disabled communities to shape their own future imaginaries through 'assistive' XR artistic interventions. *Crip Sensorama*, thus, is a multisensory 10–15-minute interactive VR/AR experience inviting the audience (disabled and non-disabled) to enter the world of disabled artists and activists Eric Desrosiers (Montreal, Canada) and Christian Bayerlein (Koblenz, Germany), accessible through the developed assistive XR technologies. As a part of the VR/AR experience the audience navigates, moves, and interacts in an immersive virtual world using a sequence of mouth gestures customized, trained, and parameterized on Eric and Christian while a narrative around disability culture and living unfolds itself.

Keywords eXtended Reality (XR), Assistive Technology, Disability Studies, Human-Computer Interaction, Virtual/Augmented Reality, Machine Learning.
DOI 10.34626/2024_xcoax_031

Introduction: Motivation and Background

Crip Sensorama is a research-creation artwork that situates itself at the intersection of Human-Computer Interaction (HCI), Disability studies, Critical Design-based research and XR (eXtended Reality). XR is an umbrella term for computer-generated environments (Virtual/Augmented Reality (VR/AR)), comprising a set of body-worn in-

terfaces (head-mounted VR displays, hand-held controllers, wearable haptics etc.) that bridge the physical body within a continuum of real and virtual space. To give a recent context, with the proposal of building a futuristic XR social media platform called the "Metaverse" by Meta (formerly Facebook) for its 3.2 billion users, the discipline of HCI has expanded its focus on XR as an 'assistive' technology, aiming for broader inclusivity (Siu et al. 2020; Wedoff et al. 2019; Aldas et al. 2020; Biswas et al. 2021; Sidarto et al. 2022).

However, the current generation of XR technologies still demand an intricate coordination between the head (e.g. 360-degree head movements), hands, and dexterity of body-based gestures (e.g. rapid finger movements on hand-held controllers) to navigate and interact inside the virtual environments – a gestural landscape that my close friends and collaborators Eric Desrosiers and Christian Bayerlein cannot afford. Eric (based in Montreal, Canada) and Christian (based in Koblenz, Germany) are artists and disability activists living with quadriplegia and regularly work with technologies such as robotic arms for painting, facial recognition algorithms for music generation, and brain-controlled interfaces for flying drones (Bayerlein 2023). Even with such a technological expertise, unfortunately, they cannot access the world of Virtual and Augmented reality – revealing that these technologies are still designed with implicit assumptions about human bodies, what HCI researchers Gerling and Spiel have also described as a "corporeal standard" (2021) (i.e. an ideal able-bodied user). Therefore, the minor adjustments incorporated for inclusion of people with disabilities (such as content accessibility through increased font size in AR devices (Zhao et al. 2017)) reifies what disability studies scholars' critique as the "*common sense idea of accessibility*" (Ellcessor 2016) – proliferating an imaginary of a future where disability is not desired and welcomed but "fixed" – through technology (Fleet 2019).

Fig. 1. An audience member experiencing *Crip Sensorama*.

Crip Sensorama, thus, critiquing the use of technology to "cure" disability (what disability scholar Ashley Shew (2023) also describes as technoableism) aims to flip these power dynamics. Firstly, by making these XR technologies assistive and accessible for Christian and Eric, enabling them to interact and navigate in VR/AR environments using a set of mouth gestures parametrized and mapped on the movement of their facial muscles. Furthermore, *Crip Sensorama* extends the limited goals of HCI of just making the technology 'accessible' to re-imagining the use of such assistive XR to act as platforms of storytelling for, about, and with people with disabilities.

As a part of the installation among other art works at xCoAx 2024 conference, *Crip Sensorama* is a 10-15 minute interactive XR experience where the audience goes through a timeline of narrative trajectories revolving around the lives of Eric and Christian and their experience of living with disabilities – by adjusting to a sequence of mouth gestures (mapped and parametrized on Eric and Christian). The overall experience will comprise a combination of 360-degree immersive videos, continuous shifts between virtual and augmented reality activated using mouth gestures, and spatialized audio supporting the narrative experience.

Technology Apparatus: Making VR/AR Accessible through Criptastic Hacking

The VR/AR technology used for the creation of this work is Quest 3 headset, one of the few head-mounted displays that are less heavy and accessible for Eric and Christian who have limited motor control on their head-movements and thus cannot keep their head upright with heavy headsets such as Apple Vision Pro and Meta Quest Pro. In addition, these headsets provide a feature called "passthrough" that enables the same headset to be used for both VR (i.e. block the real-world and immerse in a computer-generated world) and an AR (i.e. overlay computer generated information onto the real world) experiences. While the headsets provide accessibility features such as increase of font size, configuration of audio balance, the default input methods to navigate and interact in virtual worlds are restricted to the use of hand-held controllers – restraining people from using such technologies who have sensorimotor disabilities. Moreover, this version of headset does not provide an internal eye-tracking or face-tracking technology for user interaction (a feature that could be used to make VR/AR accessible for people with quadriplegia).

Criptastic Hacking

Hence, in-order to hack these devices and make them accessible for Christian and Eric, we adopted the methodology of "criptastic hacking" (Yergeau 2014) from disability studies. Criptastic-hacking as a methodological approach critiques technoableism (Shew 2023) and instead harnesses and draws on the long history of hacking and tinkering performed by disabled people to navigate in an inaccessible world. Moreover, unlike HCI, in the framework of criptastic hacking, technologies are

not pushed onto disabled bodies but rather disabled bodies bend and twist the technologies from their embodied knowledge.

Fig. 2. Mapping and Parameterizing mouth gestures with Eric Desrosiers to navigate and interact in VR/AR systems.

Hence, with Christian and Eric's decade long practice of using mouth operated joysticks to control their wheelchairs and computers, we adapted a mouth and lip-tracker from another VR/AR company, HTC Vive, often sold and advertised for immersive online VR chatrooms (where avatars could replicate the mouth movements of the users while talking). However, we hacked the device for our own purposes and utilized the internal 34 categories of mouth gestures recognized by an in-built machine learning classification algorithm. Some examples of these classes of gestures include "mouth open", "jaw left", jaw right", "tongue out" etc. Overall, according to preferences of Eric and Christian we finally optimized a final set of gestures and adapted the algorithms to enable Eric and Christian navigate and interact in VR. For example, while Eric preferred "mouth open" gesture to rotate 360-degree clockwise (see Figure 2) and "tongue out" gesture to move forward in the virtual scene, the "tongue out" gesture could not work for Christian due to the malocclusion of his teeth.

Fig. 3. An audience member using their tongue to interact with a face avatar in *Crip Sensorama*.

Crip Sensorama: A Proprioceptive Sensory Experience of Disability

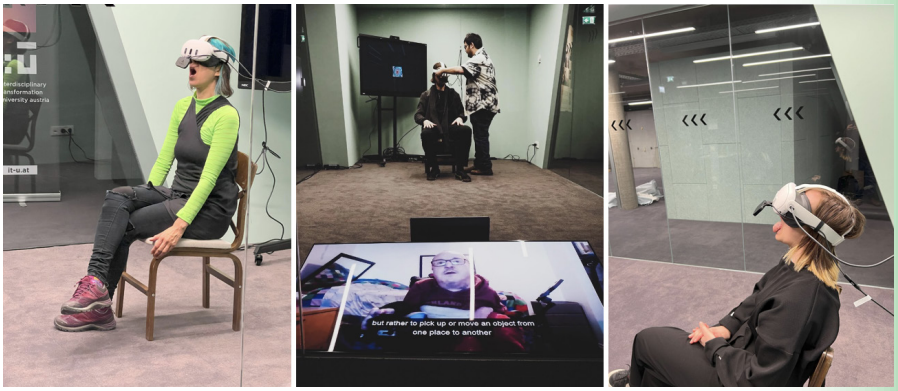

Fig. 4. The set-up of *Crip Sensorama* at IT:U and Ars Electronica, Linz, Austria (Jan. 2024).

To give a brief context, the name *Crip Sensorama* is a remodified naming of *Sensorama*, a physical device (often framed as the earliest VR technology) built in 1962 by filmmaker Morton Heilig. Sensorama as a machine invited the audience to immerse themselves in a multisensory (but limited to five Aristotelian senses) with stereoscopic colour display, fans, odour emitters, stereo-sound system, and a motional chair. However, the device was not responsive, interactive, or considered the perspectives of disabled bodies. *Crip Sensorama* on the other hand addresses the reclamation of the word 'Crip' from "Cripple" as a marker of proud and defiant identification of disabled bodies (McRuer 2020) to create another kind of multisensory interactive XR experience that integrates the proprioception (often termed as the "sixth sense") such as mouth gestures of close friends and collaborators Eric Desrosiers and Christian Bayerlein (who identify themselves as disabled artists and are living with quadriplegia) as an invitation to activate an experience situated around disability cultures and living.

The 10-15 XR *Crip Sensorama* experience is staged as follows: the audience (one person at a time) is invited to sit on a chair and is instructed about the overall piece. Secondly, the artist, as an instructor, starts the experience (by playing the UNITY scene from their laptop) which runs for minimum 10 minutes and can go till maximum 15 minutes depending on how the audience interacts inside the virtual world. The experience comprises of first-person face avatar (that mimics facial expressions, see Figure 3), 360-degree videos (shot with Christian and Eric), spatialized virtual sound sources (to support the narrative), interactive navigation using a sequence of mouth gestures (see Figure 4) – that slowly immerses the audience introducing them to lives and artmaking of Eric and Christian through gestures of mouth trained and parameterized on Christian and Eric's facial muscles.

Conclusion

Crip Sensorama aims to challenge the current generation of XR technologies and the implicit ableist biases embedded in the design of these technologies (e.g. heavy headsets, mandatory hand-held controllers). Working in close collaboration with disabled artists and activists Eric Desrosiers and Christian Bayerlein (who are living with quadriplegia) this project showcases how technologies of XR could be hacked, modified, and made accessible by drawing on long history of hacking and tinkering

performed by people living disabilities (e.g. the developed dexterity of mouth by using mouth-operated joysticks by quadriplegic people).

The result of this work is a set of mouth gestures mapped and parameterized on Eric and Christian that enables them to navigate (move up, down, left, right and 360 clock and anti-clockwise in VR) and interact (e.g. grab objects using opening of their mouth) in XR. Moreover, we push the developed XR technologies to build narratives around disability culture and living using 360-degree videos, spatialized sound, and interactable immersive experiences activated using an uncommon means of input method such as gestures of the mouth. Overall, the exhibit is a 10–15-minute VR/AR installation (experienced one at a time) where the audience will be immersed into the world and art making of Christian and Eric, activated using a set of mouth gestures trained, mapped, and parameterized on Eric and Christian's jaw, chin, and tongue movements.

Acknowledgements: This work is a research-creation project developed and exhibited as a part of the FOUNDING LAB program at IT:U and Ars Electronica in Linz, Austria (September 2023 – January 2024). The FOUNDING LAB is realized as a Public Partnership between Ars Electronica GmbH and Co KG and the Institute of Digital Sciences (IT:U), Austria and financed through funds from the Austrian Federal Ministry of Education. Science and Research.

References

Aldas, Nelson D. Troncoso, Sooyeon Lee, Chonghan Lee, Mary Beth Rosson, John M. Carroll, and Vijaykrishnan Narayanan. 2020. "AIGuide: An augmented reality hand guidance application for people with visual impairments." In *Proceedings of the 22nd International ACM SIGACCESS Conference on Computers and Accessibility*, Article No.: 2, pp. 1-13. 2020. https://doi.org/10.1145/3373625.3417028

Bayerlein, Christian. 2023. *A powerful new neurotech tool for augmenting your mind*. TED Talk. [Accessed 14 February 2024]. https://www.ted.com/talks/conor_russomanno_a_powerful_new_neurotech_tool_for_augmenting_your_mind?language=en

Biswas, Pradipta, Pilar Orero, Manohar Swaminathan, Kavita Krishnaswamy, and Peter Robinson. ."Adaptive accessible AR/VR systems." In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*, Article No.: 92, pp. 1-7. https://dl.acm.org/doi/10.1145/3411763.3441324

Ellcessor, Elizabeth. 2016. *Restricted access: Media, disability, and the politics of participation*. Vol. 6. NYU Press.

Fleet, Chancey. 2019. *Accessibility, Augmented. Digital Frictions*. Urban Omnibus. [Accessed 14 February 2024] https://urbanomnibus.net/2019/11/accessibility-augmented/

Gerling, Kathrin, and Katta Spiel. 2021."A critical examination of virtual reality technology in the context of the minority body." In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*, Article No.: 599, pp. 1-14. . https://doi.org/10.1145/3411764.3445196

McRuer, Robert.
2020. "Disability Studies." In *Oxford Research Encyclopedia of Literature*. https://doi.org/10.1093/acrefore/9780190201098.013.1120

Sidarto, Lauren, Kayla A Monnette, Cheuk Wah Chim.
2022. *Accessibility in extended reality*. [Accessed 14 February 2024] Available at: https://static1.squarespace.com/static/607a470e3441db508dff2991/t/62fd4d8e1c06ea379c1b28aa/1660767634215/ACM_MONNETTE_Accessibility_in_XR_.pdf

Siu, Alexa F., Mike Sinclair, Robert Kovacs, Eyal Ofek, Christian Holz, and Edward Cutrell.
2020. "Virtual reality without vision: A haptic and auditory white cane to navigate complex virtual worlds." In *Proceedings of the 2020 CHI conference on human factors in computing systems*, pp. 1-13. https://doi.org/10.1145/3313831.3376353

Wedoff, Ryan, Lindsay Ball, Amelia Wang, Yi Xuan Khoo, Lauren Lieberman, and Kyle Rector.
2019. "Virtual showdown: An accessible virtual reality game with scaffolds for youth with visual impairments." In *Proceedings of the 2019 CHI conference on human factors in computing systems*, Paper No.: 141, pp. 1-15. https://doi.org/10.1145/3290605.3300371

Yergeau, Melanie.
2014. . "Disability hacktivism." Hacking the Classroom: Eight Perspectives. Computers and Composition Online. [Accessed 14 February 2024]. http://cconlinejournal.org/hacking/#yergeau

Zhao, Yuhang, Michele Hu, Shafeka Hashash, and Shiri Azenkot.
2017. "Understanding low vision people's visual perception on commercial augmented reality glasses." In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, pp. 4170-4181. https://doi.org/10.1145/3025453.3025949