VR Accessibility/Inclusivity

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Introduction VR technology

Virtual Reality (VR) technology immerses users in a simulated environment, often through headsets and motion-tracking systems. It creates an interactive, 3D experience that can simulate real or fictional worlds.

The first technical developments of VR started in the 1960s when Cinematographer Morton Heilig created Sensorama, the first VR machine. It was capable of simulating a lot of senses such as a 3D video, audio, vibrations. (*History of Virtual Reality - Virtual Reality Society*, 2020)

Modern advancements, driven by companies like Meta, Sony, and HTC, have made VR more accessible and realistic, with applications in gaming, training, healthcare, and social interaction. Current trends focus on improving immersion through haptic feedback, AI integration, and wireless capabilities.

VR for people with a disability

Almost every VR system requires the use of a hand-held controller to navigate and interact with the virtual environment. Most of us don't really think about this, but for people with a disability, such as people who have difficulty using their hands, it is a common problem as they are not able to use it at all .

To solve this issue, developers have been working on new forms of input to improve accessibility, for example eye-tracking and brain-computer interfaces, that allow users to control VR systems using their eyes or thoughts.

Another method that they are developing for input is voice recognition technology**.** With this technology users can navigate and interact with the virtual environment hands-free. This is especially beneficial for users with mobility problems.

Hardware

For our topic, VR Accessibility and Inclusivity, many VR headsets incorporate features that enhance accessibility. For example, Meta produces the Quest VR headsets and, in 2020, introduced Virtual Reality Checks (VRCs)—a set of technical recommendations designed to help developers create more accessible VR software. These Accessibility VRCs focus on aspects like audio, visuals, interactions, locomotion/movement, and overall accessible design.

Besides Meta's Quest headsets, other major companies like HTC, Pico, Sony, and Apple also develop VR headsets, each contributing to accessibility in different ways.

The future of VR focuses on greater accessibility and inclusivity. Developments such as lighter and more comfortable headsets, AI integration for personalized experiences, and advanced haptic feedback make VR more realistic and user-friendly. Additionally, companies like Meta are working on smart AR glasses with neural interfaces, making technology even more accessible.

Hardware list

https://www.meta.com/nl/quest/quest-3s/

https://www.meta.com/nl/quest/quest-3/

https://www.picoxr.com/global/products/pico4

https://www.vive.com/us/product/vive-focus-vision/overview/

https://www.apple.com/apple-vision-pro/

Most interesting examples:

Meta quest 3:

The Meta Quest 3 is Meta's latest VR headset, offering a balance between performance and affordability. It features improved lenses for clearer visuals and reduced glare, enhancing the immersive experience. The device also boasts advanced mixed reality capabilities, allowing users to seamlessly blend virtual and real-world elements. Its ergonomic design ensures comfort during extended use. The Quest 3 is particularly relevant for its robust software support and a vast library of VR content, making it a versatile choice for both gaming and productivity.

Pico 4:

The Pico 4 is a standalone VR headset known for its lightweight and balanced design, providing users with comfort during prolonged sessions. It features a 4K+ super-vision display with a 105° ultra-wide field of view, delivering vivid and lifelike images. The device supports motorized interpupillary distance adjustment, ensuring a customized fit for various users. Its advanced haptic feedback enhances interaction within virtual environments. The Pico 4's focus on accessibility and user comfort makes it a significant player in the VR market.

Link to further explanation and comparison between the two headsets:

https://youtu.be/XtBDMiQ4j-M?si=flz3l6OJvFpdntZu

Software to make VR more accessible

Eye-tracking:
Eye-tracking is a technology that uses specialized cameras and infrared sensors to detect and follow eye movements. This allows VR systems to determine precisely where a user is looking, enabling more intuitive interactions. It is particularly beneficial for individuals with mobility impairments who cannot use traditional controllers. So instead of pressing buttons on the controller, users can navigate and interact with VR environments using their eyes. They can for example select a button by looking at it and confirming the action with a blink or a voice command.

Voice recognition:
Also known as “speech recognition”, is a technology that enables computers to understand languages like English. Nowadays voice recognition technologies are all around us. AI models like Siri, Gemini and Alexa all use this technology to understand and execute commands given by the user. In VR it can be used to navigate, a user can say for example: “exit to menu” to close the game/app and return to the main menu.

Hand-tracking:
Just like eye-tracking, hand-tracking allows you to interact and navigate without using VR controllers. Sensors capture the position, orientation, and velocity of your hand. It then uses this data to create a real-time virtual embodiment of them. One example of how hand-tracking can be used in VR is virtual sculpting. In applications like Adobe Medium or Gravity Sketch, users can manipulate virtual clay using just their hands. They can pinch, stretch, and carve 3D objects naturally, just as they would in real life, without needing a controller. This enhances immersion and makes the experience more intuitive, especially for artists and designers.

Captioning systems (subtitles):
Subtitles in VR help break down accessibility barriers, making virtual experiences more inclusive for users who are deaf, hard of hearing or speak a different language. Captioning systems provide text for spoken dialogue, allowing users to follow conversations in games, training simulations and social VR experiences. Not only does it caption dialogue but also sound effects(e.g [Footsteps approaching], [Explosion]), which helps the user understand the environment and events.

Text-to-speech:
Text-to-speech technology allows a computer to read text aloud, making VR experiences more accessible for users who are blind, visually impaired or have reading difficulties. With this technology computers can for example help a user navigate through a menu by reading aloud all the menu options.

Software list

- Hand-tracking
- Eye tracking
- Voice recognition
- Captioning systems (subtitles)

- Text-to-speech

Relevant applications

Application list:

- https://equalreality.com/everydayinclusion/
- https://en.wikipedia.org/wiki/VRChat
- https://virtualspeech.com/
- https://www.xr.health/virtual-reality-physical-therapy/

Most relevant applications:

Everyday Inclusion by Equal Reality:

This VR application immerses users in scenarios that highlight unconscious bias and microaggressions, promoting empathy and understanding. It's relevant for its focus on diversity and inclusion training, providing a safe space to explore sensitive topics.

https://equalreality.com/everydayinclusion/

VR chat:

VRChat is a social VR platform that allows users to interact in virtual environments. It has been working on enhancing accessibility features, including content gating and moderation tools, to create a safer and more inclusive space for all users.

https://en.wikipedia.org/wiki/VRChat

VirtualSpeech:

VirtualSpeech offers VR training courses that include accessibility features such as voice commands and customizable environments. These features aim to make learning experiences more inclusive for users with varying abilities.

https://virtualspeech.com/

Future vision

We believe accessibility in VR technology is going to improve a lot in the coming years due to advancements in hardware, AI and software. Future VR headsets will become lighter, more ergonomic, and include features like eye-tracking and hand-tracking, reducing the need for traditional controllers and making them more accessible to users with disabilities.

AI solutions will also play a crucial role in making VR more inclusive. Real-time language interpretation, AI-generated captions and audio descriptions will improve communication for users who are deaf or visually impaired. Additionally, haptic feedback through gloves or suits will provide sensory information, enabling users to “feel” virtual objects, while auditory and haptic cues will help with navigation in digital environments.

For people with mobility impairments, VR spaces will become more adaptable, allowing for different movement methods and ensuring that users in wheelchairs have the same immersive experience as standing players. Standardized accessibility guidelines, created by organizations like the XR Access Initiative and WebXR, will push for universal design standards that ensure VR experiences are always inclusive.

The development of these features will be driven by multiple factors, including market demand, AI advancements and a growing awareness of the need for inclusivity in VR technology. Companies must be motivated to make VR more accessible to reach a wider audience, comply with accessibility laws, and meet ethical standards. As a result, the future of VR will be one where more people, regardless of their physical abilities, can fully engage with and benefit from immersive digital experiences.

Relevant tutorials:

Tutorial quest 3:
https://youtu.be/LI5ywZZFM0A?si=hLPHG7jQZOMswZNg

Tutorial for virtual speech:
https://youtu.be/rBIOO7JHyJA?si=YbzOWFBRJGIAR3ZJ

Tutorial for VR chat:
https://youtu.be/Bm8quWg_wig?si=mlakeJgGTxIFfs-U

Tutorial for VR captions:
https://equalentry.com/accessibility-virtual-reality-captions-open-source/

Sources

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