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Design for All in Metaverse

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"The people are pieces of software called avatars. They are the audio-visual bodies that people use to communicate with each other in the metaverse." (Stephenson 1992).

And the fiction comes true... The users of the internet are no longer just a cursor in a digital world where they spend hours. Being able to manifest would definitely change the interaction and experience. So, what can "being piece of software" bring to the lives of the users?

Metaverse started to be heard almost one year ago, by the users who are interested in crypto coins and technology especially after Facebook announced the new name of the company, "Meta"(Meta,2021). The pandemic and digitalization had enormous changes in our lives. The business life and also education has moved to the internet through video conference platforms. Metaverse is a new saying in our lives although we experience the intense use of internet in our daily life with online meetings, online shopping, augmented reality filters, social media, virtual concerts, virtual exhibitions, etc.The term "Metaverse" represents a digital world which is accepted as the future of the internet (Web 3.0) that provides users to interact with each other and software applications by letting user to be embodied in avatar form. The greatest benefits

of the platform are cited as the democratization and universal approach (Duan e. al, 2021). The meta-universe aims to benefit society by explicit and direct interactions that even race, gender, physical disability cannot prevent and weaken (Duan e. al, 2021). In this article, the predicted nature of the metaverse would be evaluated from the universal design perspective.

Universal Design and the Metaverse

Digital twins are accepted as the building block of the metaverse that makes the physical world accessible from the digital realm (Rijmenam, 2022). Technological requirements are wider for web 3.0 than web 2.0. Metaverse comprises the use of different technologies which are VR (virtual reality), AR(augmented reality), AI(artificial intelligence). Also IoT(Internet of Things), spatial technologies, HMDs(head-mounted displays and controllers), machine learning, blockchain are among technological developments that came into our lives recently. Metaverse also provides an area for users to generate contents through 3D models, softwares. Today it is possible to interact with the popular metaverse platforms such as Fortnite, Roblox, etc. by using Smartphone, PC or tablet applications and augmented reality technology without using VR headsets. However the holistic use of these technologie support the feel of presence. As it is stated six factors of the Metaverse in user focus which are "Avatar, Content Creation, Virtual Economy, Social Acceptability, Security and Privacy, and Trust and Accountability" (Lee et al, 2021).

The experience of the users is aimed to be realistic in the digital world through the similar aspects with the real world such as

environments, objects, events and eventually feelings. The Metaverse's analogy with the real world through digital twins strengthens the bond and sense of presence. Being able to embody, move and react in the form of an avatar that imitates human bodies in the digital environment strengthens the user's experience. Presence of avatars increases intuitiveness and makes interaction familiar and simple for users.

“Presence” is the sensation of ‘being there’ while surrounded with an environment (IJsselsteijn et al., 2000). In another saying, presence is a misconception that the medium disappears and is no longer separated from reality (Lombard & Ditton,1997) which provides the sense of ‘a place visited’ rather than ‘a place seen’(Slater et al. 1999). The similarity of the behavioral and psychological reactions between the physical environment and the digital environment designates the sense of “presence” (Ayiter,2000). The sense of presence cannot be achieved only with objective elements, it is aimed for users to connect with each other on a socio-cultural plane through interactions between objects and people, not as placed to somewhere, which draws attention to the importance of avatars (Riva& Mantovani,,1999)

The metaverse, which promises a socially active environment, is expected to prevent discrimination in the real world and to minimize differences (Rijmenam, 2022). In order to ensure democratization in the digital universe, the technology providing access to the metaverse is expected to be accessible to different users in the real world, and the universal design principles are expected to be taken into account. Also as Eid (2022) indicates this new platform, which

is currently being built, has the opportunity to be shaped around the principles of diversity, equality and inclusion (DEI) from the very beginning of the process by prioritizing inclusion and starting from grassroots innovation.

Principles are guides for the design process which are useful to shape the expectations and requirements of designers and also consumers about the usable products and environments. Universal design principles aim the products and technologies to be suitable for use by the greatest population of the users without the need for adjustments and design regulations. There are seven principles of universal design which are "Equitable use, Flexibility in use, Simplicity and intuitiveness in use, Perceptible Information, Tolerance for Error, Low Physical Effort, Size and Space for Approach and Use" (Connell et al., 1997). Equality and accessibility are among humanity's greatest desires. In the digital world; unlike the physical world, it is an inclusive scenario to be able to access the services provided regardless of race, language, religion, economic disability, physical disability and socialize without being judged. Below the potential and the opportunities of the metaverse is discussed under headings of universal design principles.

Equitable Use

Almost 15% of the world's population, approximately 1 billion individuals, are disabled (WHO, 2021). While VR is touted as an empathy machine, it is stated that healthy people can experience being disabled individuals (simulations of macular degeneration, dementia and conditions affecting mobility), however disabled individuals are not included in the use of VR (Philips, 2000). On the

other hand, the metaverse is seen as a democratic platform for people who suffer from disabilities (Brehuescu, 2022). As Duan et.al. (2021) indicates, the differentiating features of the metaverse that separates from the real world can be explained under the terms accessibility, diversity, equality and humanity. The economical conditions that effect the access to the technology or the preparation of the required infrastructure such as speed of the internet could change the accessibility. One of the goals of Metaverse is giving a realistic experience with the immersive environments it offers. A realistic experience is aimed for more than one billion disabled individuals who cannot interact digitally (Alexiou, 2022). As Tariq et al(2018) indicates VR technology is suitable to use with disabled people for five main purposes which shapes the use and content of the metaverse. These aims are for the rehabilitation of the disabled, for improving the learning skills, for e-learning, for training for the real environment and for entertainment. The metaverse can be a very accurate tool to overcome physical obstacles. A number of obstacles such as hearing impairment, visual impairment, color blindness, etc. can be overcome with different technological possibilities and software. In this way, it is ensured that disabled people can continue their virtual experiences and get their work done without feeling different from other users. Tariq et. al. (2018) also emphasizes the systems serves for the independence of the disabled people from other people in their normal routines, learning skills in order to financially support themselves through the virtual economy, contributing to their country by overcoming their disability, and having a chance to rehabilitate by exploring, feeling nature.

The physical interface of the technologies also gain importance at this point. Although Metaverse can be used directly without the need for a headset, these technologies differentiate the interface, offer the chance to eliminate obstacles and even give a sense of body integrity or presence in an indiscriminate environment (Alexiou, 2022).

Simple and Intuitive Use - Low Physical Effort

Simple and Intuitive Use and Low Physical Effort are highly interrelated principles for people with disabilities. It was found appropriate to evaluate these two principles together, which affect both software and hardware decisions. Many disabled users cannot experience VR without support, even if they can wear the headset, they do not have the necessary head or body movements for a full VR experience (Philips, 2020). In 2017, disabled activist Alice Wong Lucas faced accessibility barriers in a project run with an immersive entertainment studio. As a result of the conducted survey after the project, it was understood that users with different types of disabilities, such as blindness to cerebral palsy to autism, experienced problems because they could not move the necessary body parts and customize the applications according to their disability (Wong, 2017). Difficulties in motor skills limit the use of VR controllers for individuals with disabilities because of requiring two working hands or arms (Philips, 2020). The disabilities like cerebral palsy require making small movements into a more comprehensive effect and also it has been stated that it can be difficult or even harmful to use not only for physical disability but also for disorders such as autism or anxiety (Wong, 2017). Although limited applications are available for users with physical disabilities

to experience VR, there are different approaches that companies try to strengthen the feel of presence from the perspectives of different types of users with different needs. The game industry has a determinative role in the development of the metaverse and lays the groundwork with technological developments and approaches. Studies are ongoing for different types of disabilities such as vision, hearing impairment and autism.

Perceptible Information

Playground Games, one of the developers of the racing game Forza Horizon 5, has collaborated with disabled communities in the areas of sign language support and color blindness mode (Williams, 2022). This can be attributed to Meta's offering 3 color correction filters in Horizon Workroom so that colorblind people can distinguish virtual objects. In accordance with the principles of accessibility and equality, there is a need to present the locations in the metaverse with subtitles or with translation to sign language for hearing impaired visitors. For blind individuals, it is especially important that VR is compatible with existing assistive technologies, and that the voice guidance transmitted by VR content is presented with equal effectiveness to the experiences of sighted users. Visually impaired or low vision users can benefit from this technology with the help of voice narrations (Alexiou, 2022)

Flexibility in Use

To create a fair and sustainable society with the appearances and social identities depending on the user's request seems possible, with avatars. This way discrimination that may occur due to physical appearance, and physical abilities can be prevented at least in digital

world. The avatars can be designed similarly to the appearance of the user and can differentiate between platforms. In avatar representations, arrangements are planned according to the preferences of the disabled people depending on how they want to be represented (Brehuescu,2022). At this point, working with the disabled makes the process easier.

Since the height of the avatar in Horizon changes depending on sitting and standing, a comfortable experience cannot be provided for wheelchair users or users who use the device while lying down. However, an upgrade feature is being worked on for meta users to keep it in line with other avatars. Lens adjustment features make the technology accessible and usable for different body types (Brehuescu,2022). Oculus's The Climb is one of apps that doesn't require moving the arms overhead for the game (Philips,2020).

Size and Space for Approach and Use

On the other hand the long duration use of these headsets can be problematic for all types of users in the means of flexibility of use and low physical effort criteria. The experiment that was conducted by Wall Street Journal shows the difficulties of spending 24 hours in Metaverse (Wall Street Journal, 2021). It has been seen that there is a necessity to provide a safe zone while using the device. The users need to spend high physical effort while using the technology with the precaution they take or for the adjustment of the headset devices to daily life. The battery problems of headsets is another problem that might affect the flexibility of use.

Discussion and Conclusion

The metaverse has a great potential for democratization with the help of technological developments that are used to enhance the experience of disadvantaged groups. In this article, metaverse and technological developments are examined through the principles of Equitable Use, Flexibility in Use, Simple and Intuitive Use, Perceptible Information, Low Physical Effort, Size and Space for Approach and Use. The principle of Tolerance for Error requires that the contents to be created for the metaverse be developed in a wise manner to prevent misleadings.

The strong sense of presence could bring so many advantages to the lives of the whole community. Designing for all does not only comprehend the disabled but also the technology would reach a wider age range by applying the required principles. The communication between the individuals would be strengthened by eliminating the requirement of learning Braille alphabet or sign language or even displacement. The digital equality would change the worlds of the disabled together with the whole society who had a chance to know people that manage to live though restrictions. The economical opportunities that metaverse and crypto provides also presents new areas to work together or socialize for disabled. If the economical requirements to obtain this technology can be balanced through virtual economy the scenario of democratization would be more realistic.

References

Alexiou, G. (2022, April 4). Is the metaverse likely to be accessible and inclusive of people with disabilities? Forbes. Retrieved October 6, 2022, from <https://www.forbes.com/sites/gusalexiou/2022/03/31/is-the-metaverse-likely-to-be-accessible-and-inclusive-of-people-with-disabilities/?sh=76a6bd04d20d>

Ayiter, E. (2010). Embodied in a metaverse: Anatomia and body parts. *Technoetic Arts*, 8(2), 181–188. https://doi.org/10.1386/tear.8.2.181_1

Brehuescu, I. (2022, April 14). How the metaverse is making experiences more accessible for disabled and impaired people. *The Drum*. Retrieved October 6, 2022, from <https://www.thedrum.com/opinion/2022/04/13/how-the-metaverse-widening-accessibility-digital-experiences>

Connell, B. R., Jones, M., Mace, R., Mueller, J., Mullick, A., Ostroff, E., et al. (1997). *The principles of universal design*. Retrieved February 24, 2006, from http://design.ncsu.edu/cud/univ_design/principles/udprinciples.htm

Duan, H., Li, J., Fan, S., Lin, Z., Wu, X., Cai, W., (2021). Metaverse for Social Good: A University Campus Prototype, *MM '21: Proceedings of the 29th ACM International Conference on Multimedia*, p.153-161 <https://doi.org/10.48550/arXiv.2108.08985>

Eid,N. (2022), Making the Metaverse Accessible to Diversity, Equity, and Inclusion <https://www.ruhglobal.com/making-the-metaverse-accessible-to-diversity-equity-and-inclusion/>

Lee, L., Zhou,P., Braud,T. (2021). All One Needs to Know about Metaverse: A Complete Survey on Technological Singularity, Virtual Ecosystem, and Research Agenda.Technical Report ·

Lombard, M. and Ditton, T. (1997). At the heart of it all: The concept of pre-sence', Journal of Computer-Mediated Communication, 3, <http://jcmc.indiana.edu/vol3/issue2/lombard.html>. Accessed 12 March 2009.

Meta (2021).Introducing Meta.[Video File].YouTube.https://www.youtube.com/watch?v=pjNI9K1D_xo

Phillips, K. U. (2020, January 29). Virtual reality has an accessibility problem. Scientific American Blog Network. Retrieved October 13, 2022, from <https://blogs.scientificamerican.com/voices/virtual-reality-has-an-accessibility-problem/>

Rijmenam,M.,(2022).Why Digital Twins Are One of the Building Blocks of the Metaverse <https://www.thedigitalspeaker.com/digital-twins-building-block-metaverse/>

Riva, G., Mantovani, G., (1999). The ergonomics of virtual reality: Human factors in developing clinical-oriented virtual environments.Studies in Health Technology and Informatics 62:278-84

Slater, M., Pertaub, D. and Steed, A. (1999). 'Public speaking in virtual reality: Facing an audience of avatars', IEEE Computer Graphics and Applications, 19 (2), pp. 6–9.

Stanford Online (2022, May 16). Stanford Seminar - Accessible Extended Reality (XR). YouTube. <https://www.youtube.com/watch?v=DGVEeNRAXYo>

Stephenson, N. (1992). Snow Crash. Bantam Books (US)

Tariq, A., Rana, T., & Nawaz, M. (2018). Virtual reality for disabled people: A survey. 2018 12th International Conference on Open Source Systems and Technologies (ICOSST). <https://doi.org/10.1109/icosst.2018.8632182>

Wall Street Journal (2021, December 11). Trapped in the Metaverse: Here's What 24 Hours in VR Feels Like | WSJ [Video File]. YouTube. <https://www.youtube.com/watch?v=rtLTZUaMSDQ&t=10s>

IJsselsteijn, W. A., de Ridder, H., Freeman, J., & Avons, S. E. (2000). Presence: Concept, determinants, and measurement. SPIE Proceedings. <https://doi.org/10.1117/12.387188>

WHO, (2021). Disability and Health. Retrieved October 6, 2022 from <https://www.who.int/news-room/fact-sheets/detail/disability-and-health#:~:text=Over%201%20billion%20people%20are,often%20requiring%20health%20care%20services>.

Williams, L. J. (2022, June 15). Forza Horizon 5 adds sign language support. GamesHub. Retrieved October 16, 2022, from

<https://www.gameshub.com/news/news/forza-horizon-5-sign-language-13997/>

Wong, L. A. (2017). DVP Interviews A-Z.
<https://disabilityvisibilityproject.com/dvp-interviews/>