The Potential of using Virtual Reality for People with Disabilities

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Abstract– Virtual Reality (VR) technologies have become a popular area of study in recent years. These technologies were found to be effective in various useful applications to support People with Disabilities (PWD). The present article explores the current trends addressing the role and applications of VR in supporting individuals with disabilities. It presents the advantages of VR, and how they can be used as assistive technologies to minimize the effects of disabilities and increase the independency of PWD. It also explores a range of successful VR applications for PWD and an example of an assistive VR application in Mada center to support people with disabilities.

Keywords- Virtual environment, accessibility, virtual reality, assistive technology.

1. Introduction

Over the past decades, VR has emerged as an innovative technology in different fields like healthcare area for rehabilitation and treatment (Bird et al., 2017). Since their emergence, various researchers have argued the advantages of applying VR to people with disabilities. Through such technology, PWD can benefit from accessible applications and services that increase their degree of independence and enhance technology for life. In this context, the use of VR technology for PWD has become essential for Information and Communication Technologies (ICT) developers (Kamieth et al., 2011). Over time, several initiatives have been conducted to use VR for a wide range of accessibility topics, targeting different disabilities like people with physical disabilities and those with cognitive disabilities.

In this article, we provide a summary of relevant studies investigating a range of applications of virtual reality for individuals with disabilities. We also present the role and advantages of VR technologies along with some assistive VR projects used in Mada center.

2. Role and Advantages of VR Technology

Virtual Reality (VR) technologies describe the process of creating a synthetic and realistic Virtual Environment (VE) using computers and other technologies (Kamieth et al., 2011). Through the experience of feeling immersed in a VE, an inexpensive and efficient means of practicing social skills and daily functioning can be provided to users (Zhang et al., 2022). Another advantage of VR is the possibility to control the type, number, and order of stimulus presented in the virtual

scenario for users. In this context, specialists can adapt their interventions by adapting the VE according to the specific conditions of each user (Kamieth et al., 2011). An additional important benefit of VR is the capability to create a realistic environment. Through the use of VR, users are allowed to experience a virtual space that is similar to reality although a controlled environment (Kamieth et al., 2011). At present, the most important areas of VR applications to PWD concerns teleoperation, learning, therapy, and training. Most of these applications are proposed to create a flexible and useful environment between users and specialists. This environment may enable specialists to set and customize scenarios, activities, and measurements to meet the needs of users and assess their progress. The next section describes some of the most significant VR applications for PWD.

3. VR as a Powerful Assistive Technology

Over the past few decades, VR has emerged as an effective technology in a range of health fields such as mental health therapy, and diagnosis (Zhang et al., 2022) (Jeffs, 2009). The widespread use of VR has encouraged many researchers to think about the potential of implementing VR technology to support the diagnosis and rehabilitation of different disabilities. Examples of these disabilities include physical, cognitive, and sensory disabilities (Jeffs, 2009).

3.1. Applications of VR for Individuals with Autism Spectrum Disorder (ASD)

The American psychiatric association defines ASD as a category of neurodevelopmental disorders characterized by a delay in the acquisition of several fundamental abilities and capacities (Frey, 2018). Previous existing research and experiments showed that the use of VR may be a useful technology in supporting and interfering with individuals with ASD (Almazaydeh et al., 2022). These benefits are related to different social aspects like social functioning, emotion processing, and speech. In terms of emotion recognition, for example, different studies have integrated VR with dynamic psychophysiological signals to enhance intervention approaches. In the study of (Modugumudi et al., 2013), an electrophysiological study was performed to test whether children with ASD could recognize effectively the basic emotions with, and without Collaborative Virtual Environment (CVE). The results indicated that CVE-based intervention significantly improved emotion recognition in children with ASD. One more study (Almazaydeh et al., 2022) was conducted to evaluate the effectiveness of a VR-based learning environment for children with ASD to safely practice and rehearse daily tasks related to the school environment. The main idea of the study was to simulate safely the real-life situations of autistic children in the world of outer school.

3.2. Applications of VR for Individuals with Cognitive Disabilities

Individuals with cognitive disabilities may often face challenges with attention, memory, and knowledge acquisition. The use of VR technology for individuals with cognitive disabilities represents an important research objective for VR researchers. It has been explored in the treatment of various cognitive disorders. Through VR, varied and motivating opportunities can be offered for the educational inclusion of people with moderate or severe cognitive disabilities. The purpose of virtual learning environments is to encourage and improve interactive learning (Jeffs, 2009). They also offer several opportunities for learners to have control over the learning process. Through VR, people with cognitive disabilities can carefully examine their strengths and preferred

methods of learning concerning the necessary learning task and desired learning outcome. In this way, virtual environments can be customized to fit different learning styles through, for example, auditory or visual information.

3.3. Applications of VR for Individuals with Sensory Disabilities

Individuals with a sensory impairment encounter problems with one or more of their senses, including hearing, vision, and touch. VR technology can play a significant role in assisting those individuals to experience what would normally be challenging or impossible for them. It transforms information from the affected sensory modality into information that can be recognized by the undamaged senses. Through VR, it is possible to create simulations for individuals with sensory impairments like blind, deaf, and hard-of-hearing people. The main purpose of these applications is to assist them in learning how to use new tools (e.g., a walking stick, and sign language) (Teófilo et al., 2018). In the study of (Ghoul & Othman, 2022), for instance, a novel approach based on VR was proposed to assist parents and teachers in learning the basics of the Qatari sign language. In another project (Torres-Gil et al., 2010), a VR application for visually impaired individuals was developed. The main goal is to propose an auditory representation of VE, making the virtual world totally across the hearing sense.

4. The use of VR as an Assistive Technology in Mada center

Recently, some projects have been proposed by Mada center to support PWD using VR technologies. For instance, a new research project called “Flight Journey Simulation Lab” had launched to support parents and children with ASD during their flight journey. The research project, proposed as part of the Mada Innovation Program, implements a simulation lab based on the best aspects of VR and augmented reality to simulate the full flight journey for children with ASD in immersive environments. One of the common features of children with ASD is the inclination to recognize unknown situations and environments as a source of anxiety. It is common for them to tend to avoid novel experiences, including traveling to new destinations, and therefore an environment like an airline trip can be overwhelming. The simulation lab provides children with ASD along with their parents the opportunity to experience air travel without the anxiety of leaving on a trip. The solution will target the key aspects of flying and all the main norms related to it. Both parents of ASD children and therapists will have control over what should be shown and heard on the VE.

5. Conclusion

The use of VR technologies for people with disabilities is as diverse as the individuals it serves. Over the years, these technologies have proven their utility and benefits for people with disabilities through various research projects and experimentations. The purpose of this article is to present a summary of relevant studies investigating a range of VR applications for people with disabilities. It describes the role and advantages of VR technologies along with a successful assistive VR application used in Mada center.

References

Almazaydeh, L., Al-Mohtadi, R., Abuhelaleh, M., & Tawil, A. A. (2022). Virtual reality technology to support the independent living of children with autism. International Journal of Electrical and Computer Engineering (IJECE), 12(4), Article 4. https://doi.org/10.11591/ijece.v12i4.pp4111-4117

Bird, M.-L., Cannell, J., Jovic, E., Rathjen, A., Lane, K., Tyson, A., Callisaya, M., & Smith, S. (2017). A Randomized Controlled Trial Investigating the Efficacy of Virtual Reality in Inpatient Stroke Rehabilitation. Archives of Physical Medicine and Rehabilitation, 98(10), e27. https://doi.org/10.1016/j.apmr.2017.08.084

Frey, B. B. (2018). Diagnostic and Statistical Manual of Mental Disorders. https://doi.org/10.4135/9781506326139.n198

Ghoul, O. E., & Othman, A. (2022). Virtual reality for educating Sign Language using signing avatar: The future of creative learning for deaf students. 2022 IEEE Global Engineering Education Conference (EDUCON), 1269–1274. https://doi.org/10.1109/EDUCON52537.2022.9766692

Jeffs, T. L. (2009). Virtual Reality and Special Needs. Themes in Science and Technology Education, 2, 253–268.

Kamieth, F., Dähne, P., Wichert, R., Villalar, J. L., Jimenez-Mixco, V., Arca, A., Arredondo, M. T., Kamieth, F., Dähne, P., Wichert, R., Villalar, J. L., Jimenez-Mixco, V., Arca, A., & Arredondo, M. T. (2011). Exploring the Potential of Virtual Reality for the Elderly and People with Disabilities. In Virtual Reality. IntechOpen. https://doi.org/10.5772/13591

Modugumudi, Y. R., Santhosh, J., & Anand, S. (2013). Efficacy of Collaborative Virtual Environment Intervention Programs in Emotion Expression of Children with Autism. Journal of Medical Imaging and Health Informatics, 3(2), 321–325. https://doi.org/10.1166/jmihi.2013.1167

Teófilo, M., Lourenço, A., Postal, J., & Lucena, V. F. (2018). Exploring Virtual Reality to Enable Deaf or Hard of Hearing Accessibility in Live Theaters: A Case Study. In M. Antona & C. Stephanidis (Eds.), Universal Access in Human-Computer Interaction. Virtual, Augmented, and Intelligent Environments (pp. 132–148). Springer International Publishing. https://doi.org/10.1007/978-3-319-92052-8_11

Torres-Gil, M. A., Casanova-Gonzalez, O., & Gonzalez-Mora, J. L. (2010). Applications of virtual reality for visually impaired people. WSEAS Transactions on Computers, 9(2), 184–193.

Virtual Reality Technology as an Educational and Intervention Tool for Children with Autism Spectrum Disorder: Current Perspectives and Future Directions—PubMed. (n.d.). Retrieved October 25, 2022, from https://pubmed.ncbi.nlm.nih.gov/35621435/

Zhang, M., Ding, H., Naumceska, M., & Zhang, Y. (2022). Virtual Reality Technology as an Educational and Intervention Tool for Children with Autism Spectrum Disorder: Current Perspectives and Future Directions. Behavioral Sciences. https://www.semanticscholar.org/paper/Virtual-Reality-Technology-as-an-Educational-and-Zhang-Ding/85bc3ad725a42f6680aec5aa86a052c77d59d109

