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How Artificial Intelligence and Virtual Reality Benefit the Elderly and Individuals with Disabilities

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ARTICLE INFO	ABSTRACT
	The growing and evolving use of emerging technology including Artificial Intelligence (AI) and Virtual Reality (VR), has significantly impacted the lives of two specific groups - the elderly and the disabled. This paper investigates potential reasons for this phenomenon. Clearly, AI and VR Technology alters the everyday lives of people with disabilities and how they navigate the world. Technological developments increasingly work to address the isolation that people with disabilities as well as the elderly experience for they are often unable or limited in how they engage with their communities. This research paper outlines the way technology has improved social communication, information distribution, and day-to-day living for those with disabilities and the elderly. Undoubtedly, the internet has transformed social communication and interaction for most people. Socially isolated individuals with disabilities have gained exposure to social environments through social media. Moreover, the broad range of information available on the internet has increased access to resources such as government services, health services, and social services support. On a related point, assistive devices have enabled disabled people including many seniors to overcome motor, sensory, or cognitive difficulties that may have previously hindered them from performing daily tasks. However, although AI and VR technology has been effectively integrated in the lives of those with disabilities, many such individuals lack access to commonplace technologies, like a personal computer. This paper examines how AI and VR technology has enhanced communication, information access, and everyday activities for the disabled and aging communities despite such socio-economic limitations.

1. Introduction

Disabilities come in different forms such as vision, hearing, and color blindness (to name a few), which means different assistive technologies need to be combined to achieve compliance.

Technology has unequivocally and ubiquitously revolutionized the way we live. Automobiles and flights have transformed the speed and scope of transportation, computers have connected the population with unprecedented efficiency, and social media has overhauled the methods, pace, and transparency of human interaction.

Although historically deemed unable to live productive and independent lives, individuals with disabilities are increasingly enabled by efficient and streamlined tools that

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make life simpler. Technology has enhanced accessibility and empowered people with disabilities to participate in society more completely than ever before. Technological devices allow individuals with disabilities to overcome a multitude of physical, verbal, and mental impairments. The internet, social media in particular, has provided the ability for increased social interactions for people with disabilities and seniors, mitigating social isolation. Communication devices have the potential to improve mental health by allowing others to share experiences and provide catharsis, therefore also alleviating mental and emotional strain. Assistive devices allow people with disabilities and seniors to perform normal day-to-day activities they would be unable to do otherwise—especially with respect to sensory impairments. Technology has served as a boon for the disabled and aging population to realize more fulfilling lives in society.

2. The Use of Artificial Intelligence for Disabilities

2.1 Communication Disorders and Education

Artificial Intelligence has made technological aids more affordable, accessible, and portable to the general public. The World Health Organization has estimated that around one billion people live with a disability, and many of them experience verbal and motor-skill delays and deficits. Because of their language and motor impairment, it is difficult for them to participate in social activities and education. Primary diagnosis such as Autism Spectrum Disorder (ASD), cerebral palsy, and aphasia are the most common disorders accompanied by language and speech impairments. They often find it difficult to express their thoughts and not many people take the time to try to understand and communicate with them. To this population, adaptive applications, commonly known as Augmentative and Alternative Communication (AAC), are necessary [7].

These AAC devices synthesize speech and sound based on the user's selection of words and images. For instance, if a child wants an apple, he can press on a picture of an apple on the device, and the device says the word "apple" out loud. These AAC devices used to be expensive, heavy and bulky, and not easily accessible to the general public, but now they can be easily downloaded on smartphones and tablets. For instance, LIVOX is an Android application that not only functions as an AAC but also allows the user to change the settings to their comfort. The user can customize the number of items on the screen, adjust for repetitive touch behaviors, and change the size of the words and images, in order to meet the needs of the user. Furthermore, the application is self-adaptive and automati-

cally returns to the main page when it detects that the user is done with the sentence. A particular study has shown that when used in different contexts, such as at home, at a school, and in a restaurant, the participants with a communication disorder were able to utilize the AAC application for communication of basic needs and desires, learning letters, interacting in different social contexts, and communicate their routine at home. Indeed, technology has allowed people with language and speech challenges to become better socially integrated by allowing this population to communicate with others in different contexts [7].

2.2 Visual Disabilities

Technology has made significant changes in the lives of people with visual disabilities as well. People who are visually impaired face restrictiveness, since they need manual information about their environment, while carrying out daily tasks like eating and walking. For instance, there is an application called Object Recognition, which uses the smartphone camera to take pictures, convert the image into HSI (Hue Saturation Intensity), and detect what the object is. There are also applications that assist with speech synthesis and text recognition. It recognizes the text from a document or a pdf file and reads it out loud to the person; other applications can recognize text from images and convert it to speech [8].

Many different AI companies are working on wearable technology that can meet the needs of people who are visually impaired. For instance, a company called Navcog has recently invented a software which uses someone's smartphone camera and Bluetooth technology in order to provide live directions to the user [9]. The camera converts the images into a 3D map and provides auditory directions through earphones for the user. Similarly, a company called MyEye is working on a finger-sized device that one can attach to a pair of glasses, which can identify objects, people, and obstacles [9]. It is important to note that many companies are recognizing the impact technology can have on those with impairments and are working on ways to incorporate technology to augment people's lives and independence [8].

2.3 Smart Homes and Independent Living

Devices such as the Amazon Echo, Google Home, and Apple HomePod has reshaped the lives of many senior citizens and people with disabilities and has started promoting more independence [16]. These are voice-activated smart speakers, which can act like an "assistant" for things around the house. For instance, one can turn on household lights, turn on the heat or air conditioning,

change the TV channel, and even start the robotic vacuum cleaner by telling the device to do so. The smart devices allow people to communicate and perform tasks easily, as well as improve the safety of senior citizens and people with disabilities who live alone. When they fall or start having medical emergencies, they can easily speak out loud and tell the device to call emergency services or a family member for assistance [17]. More recently, companies have updated their artificial intelligence technologies to assist people who are blind, deaf, or who have motor impairments. They are continuing to improve their technology in computer vision and voice recognitions [16].
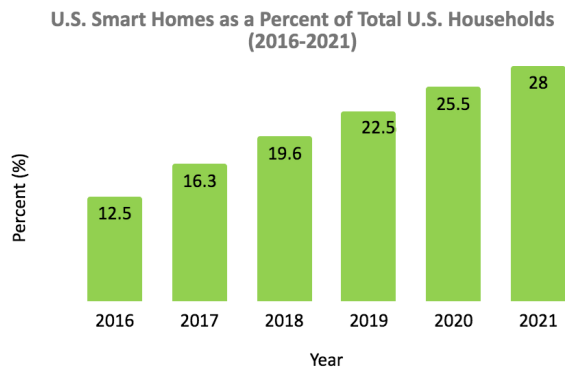

Figure 1. This graph shows the steady, projected increase of smart home usage, from 2016 to 2021 in the United States

2.4 Accessibility and Self-Driving Cars

Self-driving cars is another example of AI that can tremendously affect the lives of people with disabilities [17]. The ability to leave the house and drive yourself to a market when you need something is a basic yet overlooked skill in people with disabilities. However, technology advancements in the automobile industry shows promising hope to further assist people with disabilities. Tesla, for example, has an automated driving mode, called autopilot mode, that requires very minimal control from the driver. The automobile also has a self-park option as well as a "summon" feature, where the car moves autonomously for a few feet in the driveway or parking lot, to make it easier for passengers to get in. This new technology also has many safety features, such as automatic emergency braking, side collision warnings, and blind spot warnings [18]. The cars also utilize AI for depth perception, to interpret what objects and people are in front of the car. The development of AI technology in automobiles dissolve the barrier of transportation and accessibility for people going to work, meet friends, and

perform daily activities [17].

3. Utilization of Virtual Reality for Disabilities

3.1 Overcoming Social and Emotional Barriers with Virtual Reality

Virtual Reality Exposure Therapy (VRET) is often used for people with underlying conditions such as depression, anxiety, ASD, and social anxiety. VRET can be used as an alternative to the traditional exposure-based therapy and is more immersive to the actual environment, because it allows sensory stimulation. A meta-analysis concluded that VRET is highly effective in treating anxiety disorders, including post-traumatic stress disorder, panic disorder, and specific phobias from a simulated exposure to the stimuli [11].

Furthermore, people with underlying conditions such as ASD, mental disorders such as depression, and learning disabilities are more likely to experience discrimination, isolation, and social anxiety. Social situations can be stressful, in addition to excessive stimulation such as light, background noise, and crowds of people. These daily-life simulations may be stressful and become a huge sensory barrier on this population for independent living. Using smartphones and affordable VR headsets, it is possible to use VR as a form of exposure therapy in order to help this population better prepare for certain social situations, also known as Virtual Reality Exposure Therapy (VRET) [12]. One specific application focuses on interactions at the Aberdeen International Airport. Through the VR interaction, users can gain exposure to the entrance and check-in gates, bathrooms at the airport, a coffee shop, and the boarding gate. The user can line up at a crowded check-in gate and become more familiarized with the noise, lighting, and the layout. They can also rehearse their interactions with workers as well as adjust their expectations for the real situation [12].
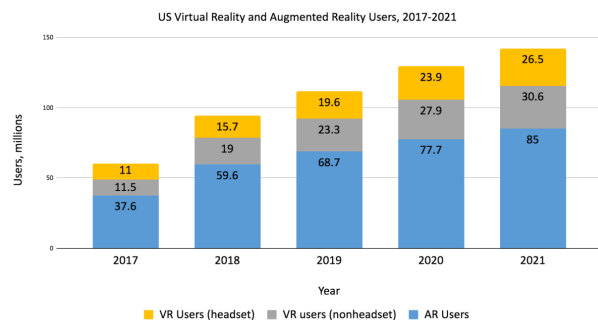

Figure 2. This graph shows the steady increase of VR and AR usage, from 2017 to 2021 in the United States

3.2 Virtual Reality for Intellectual Disabilities

The utilization of VR technologies for people with Intellectual Disability (ID) is starting to become recognized. VR training uses VR environments to explain and teach certain skills, or independent living skills, to this population. This training allows learning skills in a safe environment and generalization into real life. One study examined the effects of a VR application on a tablet, which provides information on general knowledge and family orientation, simulation of taking the right medications at the right time, practicing packing a suitcase for a trip, buying the things on a grocery list at the supermarket. Adolescents and adults with ID showed significant improvements in functional living skills. Through VR training, that was easily managed at home, the skills that they acquired were effectively generalized into the real-life situation. VR training is beneficial not only due to its easy directions but also because it may allow remote rehabilitation of people with ID, without a presence of a supervisor or a behavior therapist.

3.3 Overcoming Physical Disabilities

Cerebral Palsy (CP) is a congenital condition that causes motor function followed by paralysis and disturbances in sensation [13]. Oftentimes, a patient with CP either exhibits impaired body structure and function, such as involuntary spasms, hypertonicity, and muscle weakness. They have poor, delayed fine motor skills and have restrictions in their daily activities [13]. VR applications, such as Xbox Kinect or the Wii, can be utilized as an interactive simulation for a patient with CP to practice and perform functional activities. VR provides an ecologically accurate environment for CP patients to perform task-specific practices. It also incorporates a social play component and encourages interaction with friends and family. Studies have shown that children with CP experienced improvements in ambulation, posture control, and arm function. Although a professional, engineer-built VR system often has a better effect, commercially available VR systems can be a good alternative and have a significant effect on mobilization improvements for this population [14].

Similarly, VR therapy can be used to help patients with stroke with their balance and gait ability [15]. Stroke patients are heavily affected by motor impairment, especially in the legs. Their balance and walking ability is negatively affected, as they experience muscle weakness. Impaired gait and balance can lead to future falls and injuries, especially dangerous for older patients. In the past, rehabilitation therapy involved high-intensity, repetitive tasks. VR intervention allows clients to play games that incorporate components of physical therapy. Studies on virtual reality rehabilitation therapy reveal that VR training has a stronger effect on balance and gait improvement than conservative therapy [15]. VR allows stroke patients to repetitively train themselves without any additional equipment, which may have contributed to the improvement in outcome. Furthermore, because VR therapy is more fun and enjoyable, due to the "play" nature of the therapy, participants were more likely to be motivated to participate in the intervention [15].

4. The Role of AI in Web-based ADA Compliance

A data obtained from recent research analyzing 10 million web pages shows a very low level of Americans with Disabilities Act(ADA) compliance globally. Some of the key takeaways include:

(1) 98% of websites failed to satisfy the requirements relating to menus;

(2) 52% of websites failed to implement proper alt attributes for images (actually deemed a decent percentage);

(3) 89% of websites failed to meet the minimum compliance level of popups (considering popups break the entire compliance level of a website, this is pretty bad);

(4) 71% of websites failed to make sure forms are accessible;

(5) 83% of websites failed to have WCAG compliant buttons, largely due to missing tags;

(6) 22% of websites failed to comply with link requirements — by far the most compliant group of website elements, mainly due to default browser settings.

Those are just some of the more noticeable accessibility requirements websites must include to be compliant. The research paints a grim picture of the current state of ADA, stemming from either lack of focus or unawareness of the severity of the issue.

5. Web Content Accessibility Guidelines (WCAG) 2.2 in Development

Arguably the best way to prepare a website accessibility is to design and build with web accessibility in mind. However, in the majority of cases, that's not effective because a foundation is already set and achieving accessibility manually is near impossible due to the sheer scope of requirements.

This is where AI steps in. There are a few services that specialize in this area, powered by machine learning technologies that scan and analyze every aspect of a site's design. The Accessibility Guidelines Working Group (AGWG) has published a First Public Working Draft of

WCAG 2.2. Additional success criteria in development for 2.2 address the needs of people with cognitive or learning disabilities, users of mobile devices, and users of ebooks.

To understand how artificial intelligence can help, we first need to get a glimpse of WCAG 2.0 and WCAG technical standards. They are organized under four principles: perceivable, operable, understandable, and robust. Simplified, a website needs to be/have:

(1) Easy to navigate using keyboard-only commands besides simple mouse navigation;

(2) The information presented easy to find and process;

(3) Adjustable to evolving needs of the users;

(4) Easy to comprehend.

It's a lot of ground to cover. As expected, automated testing allows for a quicker discovery and resolution of potential interference and issues. However, an AI-powered solution differs from its more basic automated testing counterparts due to its ability to mimic a browser. It can thoroughly understand a website's structure and the role of its various elements, particularly those that are hidden and only show up upon action.

6. Digital Disparity

Developments in technology have improved the expectations of those with disabilities by enhancing their capacities and optimizing their quality of life. Technology has provided individuals with verbal disabilities a chance to communicate, with audial disabilities a chance to hear, with mobile restrictions a chance to explore. When people are more exposed to social environments, they can experience higher levels of social and personal growth, as well as the ability to make impactful contributions. Such technological advances are increasingly allowing people with physical disabilities to live a more participatory and stimulating lifestyle.

Previous data suggests a large correlation between certain socioeconomic factors and the use of technology. Unfortunately, many individuals with disabilities do not have personal computers with internet connection in their household, or lack access to resources that can provide such technology. As resources evolve and improve, this lack of accessibility creates a digital divide in societal systems. Understanding the relationship between social status and access to technology is essential in this research.

People who live in neighborhoods of above average socioeconomic status have greater access to technology. Those who live in neighborhoods of lower than average socioeconomic status may have limited access to technology. This creates a digital divide between subpopulations of people with disabilities. This research examines strategies to eliminate digital disparity and provide technology

for all individuals with disabilities.

7. The Internet and Global Connectivity

The invention of the internet has transformed modern society, changing the way people obtain information, interact with others, shop for products, and consume media. For individuals with disabilities, the internet provides an escape from isolation. Internet access has greatly improved communication for individuals with disabilities, in addition to enhancing their independence and self-sufficiency. Improved physical and mental health outcomes have also been reported as a result of internet use.

The internet encourages people with disabilities to be more visible and participate more fully in society. However, before people with disabilities can use the internet for communicating, learning, or working, they must be able to gain access to it. This often requires additional assistance by other people or by modified hardware and software. Those with disabilities are less likely to live in households with computers that are connected to the internet and are therefore less likely to be online. Even if they do have access to computers with an internet connection, they may need the assistance of adaptive hardware and software. For example, a text reader is necessary for someone who is blind, and a speech-to-text program is required for someone with mobility issues that limit typing.

Developing standard adaptive hardware and software is often difficult due to the broad range of disabilities. An individual with hearing disabilities may solely require hearing aids, while others may require a sign language interpreter. Universally, closed captions for video and audio material are key to successfully navigate and interact. Adaptive hardware and software are also necessary for individuals with vision disabilities. For those with reduced vision, a screen magnifier may suffice. However, for individuals with more significant visual loss, a screen reader that converts text to speech output may be required. In addition, braille readers that convert text to braille may be helpful.

People with physical disabilities are often unable to use a standard keyboard. In such cases, alternative keyboards with larger keys, different key arrangements, touchscreens, or speech recognition software using voice command may be warranted. Some individuals may have poor hand or voice control, such as in severe cases of stroke or multiple sclerosis. Assistive technologies exist and continue to emerge, allowing individuals to utilize their head, mouth, or eye movements as alternatives to a traditional mouse or keyboard.

For those with speech impairment, communication through discussion boards, blogs, and other social net-

working tools can be beneficial. Communication with speech output can be used when speech is necessary. For people with cognitive impairments such as learning disabilities, technology plays a large role in increasing or maintaining their independence. Tools such as a spell checker, grammar checker, word prediction, and voice recognition programs are valuable.

Many people with disabilities use the internet for social interactions and cathartic support. We increasingly use the internet to develop and sustain relationships, as exemplified by the dominance of Facebook, Twitter, and other social networks and dating sites. In addition, there are many online resources to assist individuals if they need information about their disabilities.

Given the benefits of internet use, efforts to increase access to computers with internet connection in disabled communities should be a priority. These social connection points can be a source of support, and further support can be found on informative sites relating to disabilities that assist in understanding, awareness, and even solutions to minimize the impact of disabilities.

Table 1. Percentage of all US adults and seniors over 65 who go online each year, from 2000 to 2012

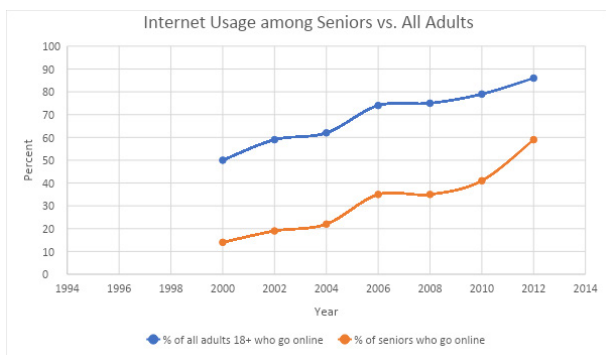| Year	% of all adults 18+ who go online	% of seniors who go online
2000	50	14
2002	59	19
2004	62	22
2006	74	35
2008	75	35
2010	79	41
2012	86	59

Figure 3. This graph shows the steady increase of adults and seniors who use the internet from 2000 to 2012

An increasing number of seniors are adapting to technology. As shown in Table 1 and 3, only 14% of seniors were internet users in 2000. In 2012, however, 59% of seniors adopted technology and became internet users.

While still significantly below the national average, internet usage among seniors is steadily rising. This shows potential for seniors to adopt technology that will assist them in their day-to-day lives.

8. Assistive Devices

Advances in technology support the independence and security of seniors and those with disabilities. Assistive devices are used to compensate for motor, sensory, or cognitive difficulties in disabled and aging populations. Some of these difficulties include the inability to make continuous motions, lack of coordination, and hindrances in visual and auditory abilities. Such physical impairments make it difficult for people with disabilities and seniors to operate within the home. Assistive devices such as powered wheelchairs and stair climbers help individuals with limited motor functions become more mobile. Cognitive orthotics, including simple reminder systems and interactive robotic assistants, serve as technological support for cognitive aging.

Cognitive orthotics provide technological support in two different dimensions. The first dimension relates to executive function, or information processing. This function controls planning, task prioritization, self-monitoring, and problem solving, as these are related to memory, attention, and orientation. The second-dimension concerns attempts to strengthen intrinsic abilities (rehabilitation technologies) or to provide extrinsic support (compensation technologies). Cognitive orthotics requires monitoring of one's environment, as tracking one's actions is the best method of assessing health and independence.

The purpose of technological aids involves maintaining independent functionality, security, autonomy, and safety, as well as to provide both synchronous and asynchronous means of connecting with distant family members and friends. Overall, technology can facilitate the security of people with disabilities and seniors to compensate for age and disease-related problems. Technology can help older adults delay and possibly avoid a decline in function while maximizing their ability to live independently. Technology related to living environments of the disabled and aging populations can provide cognitive assistance, monitoring, and social communication.

Technological advancements such as security systems, webcams, and built-in communication systems allow people with disabilities and seniors to feel protected from intruders and other safety issues. These advances also allow family members to feel more secure about leaving a senior at home alone. Moreover, in terms of home health and wellness, systems such as health management apps help ensure the elderly family member or person with dis-

abilities takes his or her medication and is self-sufficient. One example of a health management app is MHealth, which also helps the elderly and people with disabilities to track their overall wellness with other family members.

9. Discussion

Technological innovation can break traditional barriers that exist for people with disabilities while diminishing their exclusion and marginalization. Information and Communication Technology (ICT) devices and services can provide opportunities for people with disabilities to access lifelong education, skills development, and employment while facilitating communication and information distribution. According to a recent survey of 150 experts, websites and mobile devices can contribute to the social inclusion of people with disabilities. Text-to-speech, voice recognition, ability to change contrast and color schemes, touch and gesture input, and screen magnification features are already available

It is crucial to understand the disability divide as about 15 percent of the world's population lives with one or more disabilities. Discrimination exists in employing those with disabilities, which is illustrated by employment rates. The employment rate of people with disabilities are a third to half of the rate for those without disabilities. The unemployment rate among people with disabilities is as high as 80 to 90 percent in developed and developing economies. Unfortunately, lower education and lower productivity in the workplace results in a wage disparity among those with disabilities as compared to individuals without disabilities. Implementing community programs that help those with disabilities learn workplace technology will lessen the high rate of unemployment.

However, there are several barriers and challenges that people with disabilities and seniors face when using new technologies. These include physical challenges to using technology due to disability, handicap, or chronic disease, as well as skepticism about the benefits of technology and difficulties learning to use new technologies. Financial barriers can also influence the accessibility to these technologies. Individuals with disabilities and seniors should increase their engagement with technology and the digital world, so companies and innovators should focus on how to make alternative technology more affordable. It is important to overcome the difficulties and learn how to use technology as there are many benefits to their mental health, daily life, and professional life. Communication channels also allow them to connect with more people and maintain relationships with them. In addition, it allows them to find large amounts of health-related information beneficial to their health. It is imperative to address such

issues and find ways for more seniors and those with disabilities to embrace technology.

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