Review of Augmented Reality Glasses that Benefits those who have Impaired Eyesight

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Abstract

With the ability to improve their perspective of the environment and give useful information and support, augmented reality (AR) has the ability to be extremely helpful for people with disabilities. It is an interactive experience that uses perceptual data produced by computers to enrich the actual environment. Augmented reality uses software, applications, and hardware like AR glasses to superimpose digital material on actual settings and objects. This study article explains how augmented reality benefits persons who are blind or visually impaired, as well as the tools and materials that are utilised for them. This study also discusses a few technologies that will be combined with augmented reality to reach higher levels in the future.

Keywords: Augmented Reality (AR), Smart Glasses, 2D & 3D Technology, Virtual Reality (VR), Artificial Intelligence (AI)

1. Introduction

Using digital visual components, sounds, or other sensory cues, augmented reality (AR) creates an improved representation of the actual world that is transmitted through technology. It is a developing trend among businesses that deal with mobile computing, especially commercial apps [11]. Users of augmented reality can get additional data or have the aesthetics of natural environments changed. The primary benefit of augmented reality (AR) is that it seamlessly integrates virtual and three-dimensional (3D) aspects with how people really view

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the world. There are several uses for augmented reality, including entertainment and decision-support.

Thomas Caudell, a researcher at Boeing Computer Services Research, first used the phrase "augmented reality" in 1990 to describe how electricians used head-mounted displays to assemble intricate wiring connections. The yellow first down marker, which started to show up in broadcast football games probably in 1998, was one of the first commercial uses of augmented reality technology. At the moment, Google Glass, smartphone games, and heads-up displays (HUDs) in car windscreens are the most well-known consumer augmented reality (AR) products. However, many other industries are now utilising this technology, including those in the fields of healthcare, public safety, energy and petroleum, transport, and marketing. [12].

In contrast to virtual reality (VR), augmented reality (AR) only adds layers of virtual items to the actual world. This is how AR differs from VR. Conversely, the world in virtual reality is entirely artificial and computer-created. Augmented reality games provide a visual example of how things are layered onto the actual environment. For example, WallaMe is an augmented reality gaming application that enables users to conceal messages in actual locations. It accomplishes this by making use of geolocation technology, which enables users to hide messages anywhere in the world. Applications for these kinds of systems are numerous, ranging from artistic expression to activism. [13].

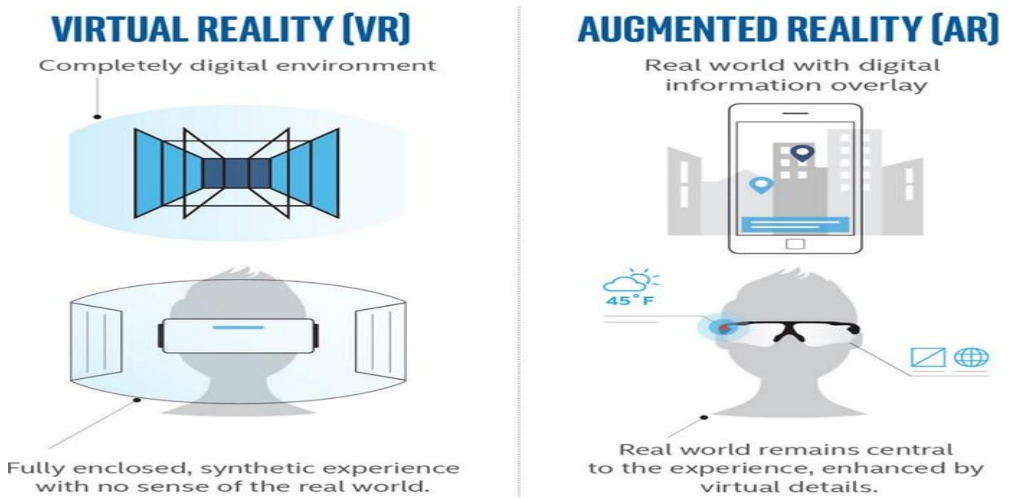

Figure 1. Difference between Augmented Reality (AR) vs Virtual Reality (VR) [14]

The AR glasses will be thoroughly discussed in this study paper. The 'Sword of Damocles', the first augmented reality head-mounted display (HMD) and tracking device, created in 1968 by Sutherland and Sproull. After a period of rapid growth, the first immersive augmented reality system was introduced in 1992 as a way to enhance the immersive experience. The AR smart glasses are taken to the next level by incorporating various technologies such as AI, iOS devices, ML, IoT, sensors, and so on. This study will describe about the smart vision glasses for persons with visual impairments, as well as the components, various technologies, and applications of augmented reality.

2. Related Works

This section explains the negative impacts on eyesight that can be mitigated by using smart glasses with augmented reality applications.

Yuhang Zhao et.al [1] proposed research that conducted an experiment with 20 participants with poor vision and 18 people with normal vision to recognise the virtual forms of objects and sentences in various colours, sizes, and thicknesses. Additionally, the research assessed their capacity to recognise the virtual features while moving. As a result, the low-vision participants had the capacity to sit and walk while recognising the basic structures and reading the brief sentences on the glass. This study provided proof that common AR glasses may be effective accessibility tools. The research study develops recommendations for poor vision users' visual output and discusses the accessibility application possibilities on this platform.

Alice Lo Valvo et. al. [2] presented an ARIANNA+, a modified version of ARIANNA, a system for interior and outdoor localization and navigation for persons with vision impairments. There is no need for any physical help because of ARIANNA+. It increases the potential for people to engage with their surroundings more effectively. The suggested method makes it simple for those who are blind to traverse both indoor and outdoor environments by loading a recorded virtual course and automatically guiding them along the way using haptic, voice, and audio feedback.

Benoît Froissard et. al. [3] suggested research that is devoted to examining the potential uses of augmented reality glasses for those with visual issues. Here, 58 individuals with various visual diseases were carefully selected for this suggested effort by vision care specialists. One of the key goals is to demonstrate the value and significance of including all participants in order to get the information necessary for the development and design of new visual tools that improve poor-vision individuals' mobility. The initial findings are positive and show a desire to employ integrated augmented reality systems to create beneficial solutions that are easily adaptable to the requirements of the many visual issues that hinder mobility.

Xuetong Wang et. al. [4] aimed to compare modifications to visual fatigue and ocular surface characteristics following an hour of viewing in 2D and 3D using optical waveguide AR glasses. 30 young, healthy individuals viewed the same movie in 2D and 3D independently wearing AR glasses over the course of a week in this experiment. Pre-watching, post-2D, and post-3D visual tasks for one hour each were used as the time points for evaluating subjective visual fatigue and ocular exams. Using the Lipview interferometer, Lipid Layer Thickness (LLT) and Total Blink (TB) were assessed. In contrast to the symptoms of pain and dullness, watching 2D and 3D films for an hour while wearing AR glasses showed moderate visual discomfort. Future AR design and application must take into account ocular characteristics.

Ola Younis et. al [5] discusses one of the primary visual field abnormalities that can be upsetting, undermine patient confidence, and interfere with daily activities: is peripheral vision loss, often known as tunnel vision. In this article, the proposed review two possible treatments for this condition. In the first, moving objects in the peripheral vision region are alerted to the user using optical visible glasses that are enhanced by computer-generated images. The second option is to design a full augmented reality scenario and show it in an eye that is in good condition. A system of ubiquitous computing is suggested for both situations in order to process and show the acquired photos in a way that is specific to the demands of the patients. The suggested solution's technical needs and psychological components are also examined.

3. Methodology

By giving visually impaired people more sensory information and enhancing their spatial awareness, augmented reality (AR) has an opportunity to improve their quality of life. While augmented reality cannot cure blindness, it can provide useful resources and aid in navigation for visually impaired.

Following are a few methods of augmented reality that can be used by the visually challenged.

3.1 Object & Text Recognition

Objects, text, and signage in the surroundings may be identified and described using augmented reality (AR) technology. Visually challenged people who use AR-enabled glasses or a smartphone camera can get audio or tactile input that will assist them in understanding the surroundings. For example, Imene Ouali et. al. [6] proposed a work in text recognition-based AR with deep learning technology. Both augmented reality and deep learning are utilised to improve the efficiency, clarity, and safety of reading. The system's main goal is to assist those who are visually impaired in reading text from typical visuals. The creation of a mobile application utilising augmented reality and deep learning will enable the visually impaired to connect natural photographs taken with smartphones to understandable text that is easy to read.

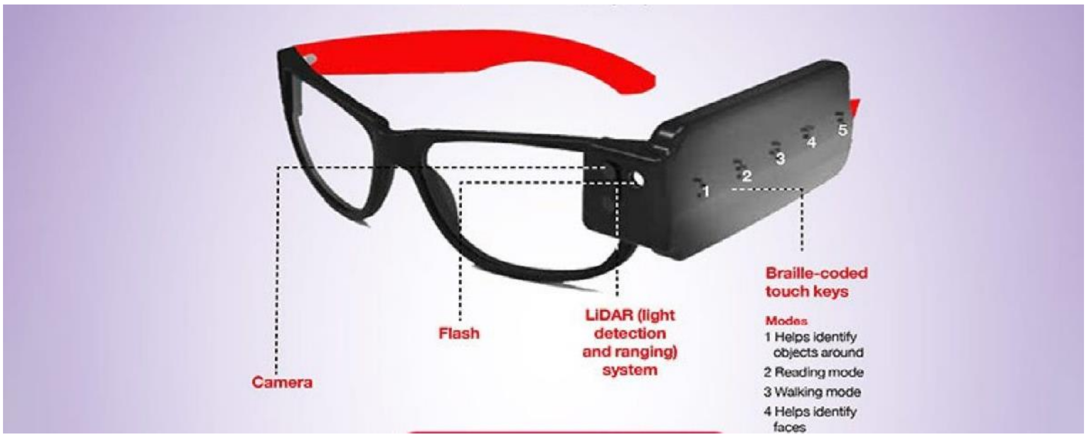

Figure 2. Smart AR Glass for Object Detection [15]

3.2 Navigation Assistant

Through the use of augmented reality (AR), real-time audio instructions can be used to guide visually handicapped individuals in new environments. AR may add directional signals, such as arrows or audio reminders, to the live camera image by using GPS and mapping data, making it easier for users to move around streets, buildings, or transport systems. For example, the proposed work [7] is especially helpful for people who aren't used to handling modern technologies (e.g., elderly people), people who are experiencing disorientation, and, more broadly, individuals with a mild cognitive deficit. This navigational thought better matches the requirements of users than do conventional navigation systems. The system also has a feature that enables the user's family members to set up chores that must be completed in a certain area and to keep an eye on the user's actions in order to spot potentially dangerous circumstances.

Figure 3. AR glasses with Navigation System [16]

3.3 Face Recognition

By identifying faces and displaying details about that individual in view of the visually impaired person, AR can help with social interactions. It can help in recognising people, expressing feelings, and giving context for earlier interactions. In this study [8], face detection, identification, and motion tracking are used to deploy augmented reality on a mobile device. Using the Viola-Jones algorithm, the front camera's photos are used to recognise faces. For face identification and tracking facial movements, the Eigenface algorithm is used. By superimposing a 3D graphic object that corresponds to a recognised face over the back camera picture, GPS, and accelerator sensor data, augmented reality is accomplished. Algorithms and techniques are constrained by mobile device specifications, including processor power and main memory size.

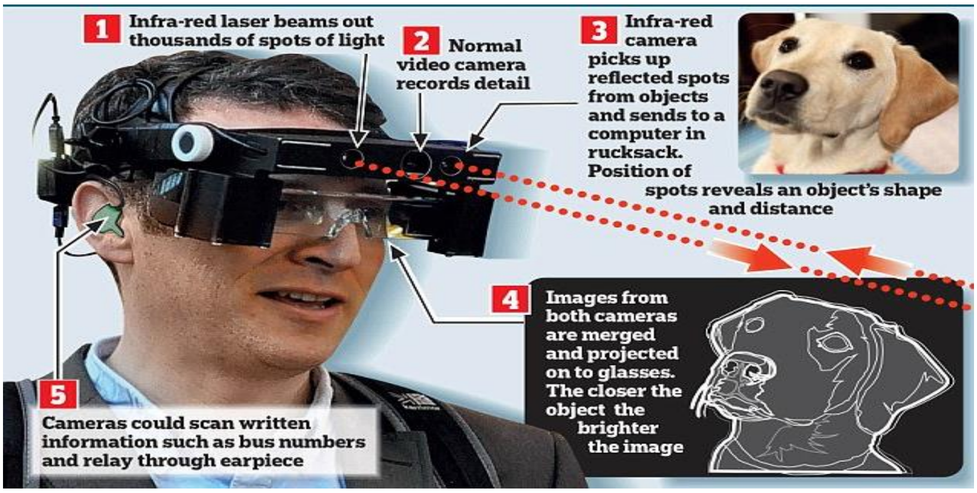

Figure 4. Smart Glass Working Diagram for Face Recognition [10]

3.4 Virtual Assistance

Figure 5. Virtual Assistant using AR glasses [17]

AR can act as a virtual assistant for those who are blind by combining speech recognition and natural language processing technology. Their capacity to ask questions, gather data, and get auditory feedback allows them to become more independent and increases their access to knowledge. For example, this research study [9] seeks to understand how undergraduates who are blind or have poor vision (BLV) interact with the augmented reality app Aira in postsecondary settings as a visual translator. Three key themes emerged from semi-structured interviews: (a) how accessibility affects productivity; (b) how accidental learning affects social relationships; and (c) how sense of self is affected. Conclusions are drawn regarding how Aira, in accordance with the Seven Vectors of Identification Development, helps BLV students have a full college experience.

4. Components

Everyone who uses augmented reality has an engaging experience. Currently, using glasses or the lens of a camera is the most common way to view augmented reality (AR), but as the interest in the application of technology increases, additional hardware and lens alternatives are becoming available. Several methods and technologies are commonly used to deploy augmented reality (AR) for those who are visually impaired. Here are a few of the key components:

4.1 AR enabled Devices

For visually challenged people to get the augmented material, AR-capable devices are required. Smart glasses, smartphones, and tablets with cameras and screens fall under this category. The hardware should have enough processing capability to support the seamless operation of AR apps.

A real-time view of the user's surroundings is captured using the lens on the AR-enabled smartphone. It serves as the AR system's input method, enabling it to examine the surroundings and overlay pertinent information.

4.2 Sensors

The person's location, orientation, and mobility may be determined using additional sensors like GPS, accelerometers, and gyroscopes. With regard to navigation and awareness of space applications in particular, these sensors contribute to improving the accuracy and reactivity of the AR experience.

4.3 Network Connectivity

AR systems for those with vision impairments frequently require internet connectivity in order to access pertinent information and services. This enables the retrieval of real-time data, such as map data, services based on location, or cloud-based object identification.

4.4 Computer Vision and Haptic Feedback

For detecting and comprehending the visual world, object identification technologies and computer vision algorithms are essential. These tools analyse the camera input, identify text, objects, and landmarks, and then provide the user the appropriate auditory or haptic feedback. Haptic feedback is utilised in certain AR apps to help visually impaired people understand information [18]. Devices that vibrate or provide tactile feedback, such as vibration motors or specialised gloves, can do this. Users that get haptic input may find it easier to understand spatial data, object boundaries, or navigational hints.

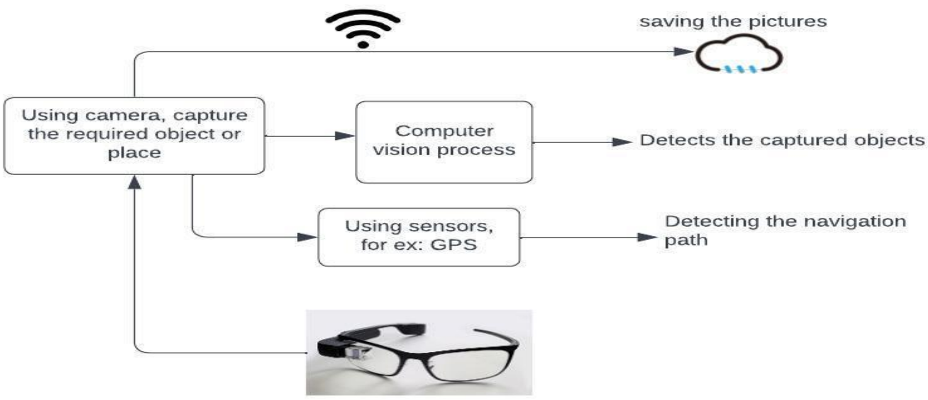

Figure 6. Structure of the Components of AR Smart Glass for Visually Impaired

5. Applications

Different technologies are collaborating with AR to create a new, helpful creation for humans. Similar to how AI, machine learning, and deep learning are merged with augmented reality to benefit people and advance the technology field, some technologies combine with AR to provide immersive advantages.

5.1 AR with AI

When integrated with AI, AR may produce effective tools that are specific to the requirements of individuals with diverse disabilities. Here are various methods of augmented reality (AR) that can be created for people with disabilities.

Real-time audio explanations of the world might be provided through AR glasses or other devices, assisting users in navigating and better understanding their surroundings. With cameras and sensors, AI may recognise challenges, people, and things in real-time, as well as provide the user with audible cues or haptic feedback. Greater freedom might be provided through text-to-speech technology by reading out written language from things like menus, signs, and papers. AI algorithms could analyse real-time traffic and challenges to provide alternate routes, warn users about potential hazards, and assist with other impairment solutions [19]. For example, AR glasses with AI-powered language translation may assist people with hearing impairments and interact with people who speak different languages.

5.2 Wearable Devices in AR

For those who are blind or visually impaired, wearable augmented reality (AR) technologies offer the potential to improve their independence, mobility, and general quality of life. These gadgets employ augmented reality technology to give visually impaired individuals immediate information and support. AR technology is used in smart glasses to superimpose digital information over the user's field of view. It can offer haptic feedback and audible cues to assist visually impaired people in navigating their environment, identifying objects, and reading text. Such gadgets are provided by companies like OrCam and Aira.

5.3 Computer Vision in AR

In AR, computer vision is used for object identification, which is the process of identifying, tracking, and detecting real-world objects and overlaying virtual material on them. This is essential for developing immersive and realistic AR experiences. Cameras are used to record pictures or videos of the user's surroundings, which computer vision algorithms then analyse in real time. By using techniques like edge detection, pattern recognition, and machine learning, these algorithms are able to identify objects based on their visual characteristics, such as size, shape, and colour. When an item is recognised, AR systems may superimpose virtual content—such as 3D models, animations, or text with pertinent information—on top of it.

6. Conclusion

This study shows how augmented reality benefits those with disabilities like visually challenged, in addition to those who are blind, deaf, and mental retarded. By allowing them to explore a virtual field, which they are unable to find in the physical world. Here, it is discussed how various technologies and solutions may help persons who are blind or visually impaired deal with challenges in daily life. In the future, augmented reality will be coupled with 3D to examine products, integrated with AI to explore various sectors, and be attached to a pair of glasses that include a head-up display, a camera, a microphone, Bluetooth connectivity, and touch buttons, among other features.

Reference

[1] Zhao, Yuhang, Michele Hu, Shafeka Hashash, and Shiri Azenkot. "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. 2017.

[2] Lo Valvo, Alice, Daniele Croce, Domenico Garlisi, Fabrizio Giuliano, Laura Giarré, and Ilenia Tinnirello. "A navigation and augmented reality system for visually impaired people." Sensors 21, no. 9 (2021): 3061.

[3] Froissard, Benoît, Hubert Konik, Alain Trémeau, and Éric Dinet. "Contribution of augmented reality solutions to assist visually impaired people in their mobility." In Universal Access in Human-Computer Interaction. Design for All and Accessibility Practice: 8th International Conference, UAHCI 2014, Held as Part of HCI International 2014, Heraklion, Crete, Greece, June 22-27, 2014, Proceedings, Part IV 8, pp. 182-191. Springer International Publishing, 2014.

[4] Wang, Xuetong, Lu Liu, Xiaojun Hu, Yue Wu, Yuying Liu, Bingbing Ni, and Bilian Ke. "Comparison of changes in visual fatigue and ocular surface after 3D and 2D viewing with augmented reality glasses." Displays 78 (2023): 102401

[5] Younis, Ola, Waleed Al-Nuaimy, Majid A. Al-Taee, and Ali Al-Ataby. "Augmented and virtual reality approaches to help with peripheral vision loss." In 2017 14th

International Multi-Conference on Systems, Signals & Devices (SSD), pp. 303-307. IEEE, 2017.

[6] Ouali, Imene, Mohamed Ben Halima, and Ali Wali. "Text detection and recognition using augmented reality and deep learning." In International conference on advanced information networking and applications, pp. 13-23. Cham: Springer International Publishing, 2022.

[7] Hervás, Ramón, José Bravo, and Jesús Fontecha. "An assistive navigation system based on augmented reality and context awareness for people with mild cognitive impairments." IEEE Journal of Biomedical and Health Informatics 18, no. 1 (2013): 368-374.

[8] Lee, Hee-Man. "Implementing Augmented Reality By Using Face Detection, Recognition And Motion Tracking." Journal of the Korea Society of Computer and Information 17, no. 1 (2012): 97-104.

[9] Lannan, Amanda. "A Virtual Assistant on Campus for Blind and Low Vision Students." Journal of Special Education Apprenticeship 8, no. 2 (2019): n2.

[10] Shneha, P., P. Redd, and V. M. Megala. "Artificial intelligence for vision impaired people." Int. J. Latest Trends Eng. Technol (2018): 31-36.

[11] https://www.investopedia.com/terms/a/augmented-reality.asp

[12] https://www.techtarget.com/whatis/definition/augmented-reality-AR

[13] https://en.wikipedia.org/wiki/Augmented_reality#Possible_applications

[14] https://www.distat.co/post/what-is-the-difference-between-ar-and-vr-and-how-each-one-helps-with-visualized-learning

[15] https://www.arthouz.com/auction/

[16] https://www.queppelin.com/ar-glasses-for-navigation/

[17] https://www.auganix.org/holo-light-develops-ares-augmented-reality-workspace-for-cad-data-visualization/

[18] https://www.allerin.com/blog/the-role-of-computer-vision-in-augmented-reality-and-virtual-reality

[19] https://builtin.com/artificial-intelligence