Journal for the Education of Gifted
Young Scientists, 12(1), 29-45, March 2024
e-ISSN: 2149- 360X
jegys.org
dergipark.org.tr/jegys

Young Wise Publishing
gencbilgeyayincilik.com
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Research Article

Immersive realities: a comprehensive guide from virtual reality to metaverse

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Article Info

Received: 17 December 2023
Accepted: 3 February 2024
Available online: 16 March 2024

Keywords
Augmented reality
Extended reality
Metaverse
Mixed reality
Virtual reality

Abstract

This comprehensive literature review explores the diverse landscape of immersive realities, offering a thorough examination of key technologies from Virtual Reality (VR) to the emerging and innovative concept of the Metaverse. The article concentrates the nuances of Extended Reality (XR), Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), providing an in-depth understanding of their individual functionalities, applications, and evolving interplay. The paper also mentions about wearable technologies which play key role in the realization of these immersive realities. The article begins by explaining the fundamental principles of each immersive reality, tracing their technological evolution and highlighting distinctive features that define their user experiences. It then navigates through the complex intersections and synergies between these immersive technologies, shedding light on how they collectively contribute to shaping the future of digital interaction. The paper unfolds how the journey of immersive realities lead to the Metaverse which is relatively a novel paradigm that transcends individual immersive realities, creating a unified, interconnected digital space. The exploration of the Metaverse encompasses its conceptual foundations, potential social impacts, and the fusion of various immersive technologies within this evolving ecosystem. With an inclusive approach, this paper caters to both novices and seasoned professionals in the field, offering insights into the practical applications associated with different immersive realities. By fostering a comprehensive understanding of these technologies, the paper aims to empower readers to navigate and contribute to the dynamic landscape of immersive realities.

To cite this article:

Dhillon, P.K.S., & Tinmaz, H. (2024). Immersive realities: a comprehensive guide from virtual reality to metaverse. *Journal for the Education of Gifted Young Scientists*, *12*(1), 29-45. DOI: http://dx.doi.org/10.17478/jegys.1406024

Introduction

In recent decades, game-based learning has gained increasing interest among educators at higher education institutions At its core, Metaverse centered on building its virtual reality. In any case, Metaverse rapidly advanced into a multifaceted and socially centered stage that empowers the sharing of interface and socially locks in substance (Park & Kim, 2022). In the modern era of technological progress, numerous academics in the field of education have evinced a marked inclination towards reforming existing education systems to augment the educational encounter holistically. In recent times, progressions in technology have facilitated the emergence and proliferation of pedagogical approaches and educational methodologies (Muhammad et al., 2021).

The consolidation of Metaverse innovation in instructive settings has gained critical force, presenting novel approaches for student involvement and improvement of the learning encounter. One facet of Metaverse technology,

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which bears the potential to yield substantial effects on educational outcomes, pertains to the design of avatars. In virtual learning environments, avatars serve as digital representations of users and have the potential to play an integral role in promoting student engagement (Nowak & Fox, 2018). Metaverse offers prospects for experiential education that could be challenging or laborious to implement using traditional pedagogical techniques. One possible academic rewrite is that the potential of students' engagement with virtual lectures delivered by renowned guest speakers from different regions, or their ability to simulate various experimental situations in virtual laboratories, is noteworthy. This is due to the absence of limitations imposed by the availability of physical materials and equipment. The immense potential of Metaverse transcends the mere provision of enhanced opportunities for novel study visits, as it also facilitates the acquisition of new languages by means of exposure to cultural exchange. Given its merits and demerits, the innovation of Extended Reality (XR) offers a significant degree of engagement relative to elective approaches (Braguez et al., 2023) At last, it can be induced that the improvement of farther learning has been unpredictably entwined with the movements in communication and innovation all through time. Over the course of time, instructive ideal models have experienced a consistent change, impelling from conventional correspondence instruction to more up to date mediums such as radio, television, and advanced media, to capitalize on imaginative apparatuses and assets accessible. The modern age has seen the development of Metaverse innovation, which has opened novel prospects for instructive encounters that are immersive and captivating in nature. These prospects incorporate the advancement of avatars and experiential learning inside virtual situations. Metaverse and XR show a suggestion of outstanding potential in terms of expanding understudy engagement and investigating modern roads of instruction, subsequently advertising promising prospects for the imminent period of instruction.

This paper aims to thoroughly investigate immersive realities, covering a range of technologies from established ones like Virtual Reality (VR) to the innovative concept of the Metaverse. The primary objective is to provide readers with a deep comprehension of key immersive technologies, collectively known as XR (Extended Reality), including VR, AR (Augmented Reality), and MR (Mixed Reality). Furthermore, the paper seeks to emphasize how wearable technologies play a crucial role in bringing immersive experiences to fruition.

The XR overview encapsulates VR, AR, and MR as a comprehensive term, delineating XR as a spatially immersive environment with applications ranging from entertainment to education. XR facilitates 3D representation, liberating itself from conventional 2D limitations, and introduces the reality-vitality spectrum, classifying XR technologies according to their purpose-specific applications.

The VR segment explores computer-generated environments that replicate a three-dimensional world, with diverse applications in entertainment, education, healthcare, and training. Specific technological advancements, such as accessible head-mounted displays (HMDs) and motion controllers, are highlighted for their positive effects on reducing anxiety, improving interactive learning, and creating immersive narratives.

AR is emphasized for overlaying digital models onto the real world, distinguishing itself from VR by integrating real-life data with computer-generated information. The importance of AR in user engagement and its future role in the Metaverse are underscored.

The MR section categorizes MR as a subset within the realm of VR technologies, amalgamating three-dimensional visuals with authentic real-world perspectives. It duly acknowledges MR's indispensable role as a fundamental component for the realization of the Metaverse.

The paper concludes by presenting a comprehensive overview of XR, VR, AR, MR, and wearables, emphasizing their technological progress, applications, and interconnected roles in shaping digital interactions and immersive experiences, particularly in education and the evolving Metaverse.

An Overview on Extended Reality (XR)

Extended Reality (XR) is an umbrella term for Virtual reality (VR), Augmented reality (AR), and Mixed reality (MR) alluding together as a spatially immersive environment (Moro et al., 2021). Since of their availability and fetched, XR advances have been grasped in an assortment of areas extending from amusement to instruction. XR modalities produce an immersive involvement by permitting 3D portrayal of fabric without the limitations of conventional 2D display

(Venkatesan et al., 2021). All genuine and virtual mixed universes made with computers and wearables, such as VR, AR, and MR innovations, are alluded to as XR. XR includes the total reality-virtuality range, from outright reality to complete virtuality. The categorization of XR technologies may be thought of as a virtuality continuum, with applications crossing characterizing borders depending on their purpose (Milgram & Kishino, 1994). In Figure 1, AR superimposes digital objects onto the physical environment, providing users with an enhanced perception of reality. Alternately, Augmented Virtuality (AV) captures real-life physical environment and consolidates them into a virtual world.

The method involves the integration of unmistakable substances into the reenacted milieu with superimposition methods.

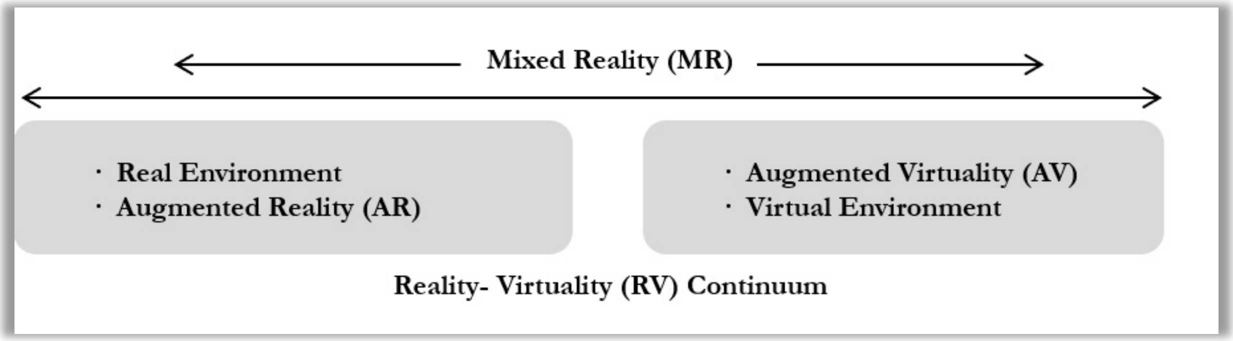

Figure 1. Milgram and Kishino's Mixed Reality on the Reality-Virtuality Continuum (Milgram & Kishino 1994).

XR, also called cross reality, encompasses various immersive technologies, related human-machine interactions, environments that depend on them like Metaverse, and spatial computing that helps enhance actions in said systems. The concept of XR technology encompasses an integration of both the tangible and digital realms, incorporating innovative concepts like VR, AR, and MR (Chuah, 2018). Characteristic and instinctive interaction is additionally conceivable with XR interfacing (Mukhopadhyay et al., 2023). Vibro-haptic and thermo-haptic sensors coordinates into these gadgets convey vibratory and warm sensations within the virtual environment, making the figment of genuine touch on the human skin, in line with the most recent adaptation of XR (Ko & Rogers, 2021).

XR innovations have gathered expanded acknowledgment in different businesses owing to their immersive and spatially intelligently characteristics. XR constitutes the aggregate of the range expanding from bona fide to reenacted situations, showing a surprising capacity to manufacture crossover universes that consolidate unmistakable and intangible components. As outlined in Figure 1, the mechanical advancement of AR encourages an improved recognition of reality by overlaying advanced objects onto the physical environment. On the other hand, the concept of Augmented Virtuality permits for the integration of genuine, physical environment into a virtual world including amusement and instruction, making avenues for investigation and inventive endeavors.

Virtual Reality (VR)

Virtual reality (VR) could be a computer-generated environment that reenacts a three-dimensional world that users can associated with utilizing specialized hardware, such as a headset and controllers (Burdea & Coiffet, 2003). VR is a rapidly developing innovation with applications in areas such as entertainment, instruction, healthcare, and numerous more (Venkatesan et al., 2021).

The concept of VR relates to a digitalized reenactment of an environment or circumstance that empowers the user to be completely inundated in a virtual world, with a three-dimensional setup that encourages interaction with both objects and characters inside the virtual environment (Slater & Wilbur, 1997; Freeman et al., 2017). This frame of innovation confers an increased sense of nearness to the user, hence making an improved encounter of the virtual world.

VR innovation has made noteworthy advance, eminently through the creation of high-quality head-mounted displays (HMDs) and motion controllers that precisely screen users' developments and give haptic feedback (Biocca & Delaney, 1995; Oculus VR, 2022). The later advancements in innovation have upgraded the availability of VR to customers, subsequently empowering its appropriation in different businesses such as amusement, instruction, healthcare, and training (Lee et al., 2018; Lee et al., 2021; Mantovani & Castelnuovo, 2003; Vogt et al., 2022).

Bhattacharjee and Moghaddam (2018) conducted a study wherein virtual reality innovation was utilized to create a profoundly immersive gaming environment with the basic objective of relieving anxiety levels among cancer patients experiencing chemotherapy. Concurring to the comes about of the examination, the execution of virtual reality gaming displayed a noteworthy capacity to decrease anxiety levels and advance unwinding among the patients. The utilization of VR is being actualized within the circle of instruction with the point of advertising understudies an intuitively and captivating scholastic involvement, as posited by Krokos et al. (2019). Within the work conducted by Liao and Humphreys (2019), an examination was attempted to examine the utilization of virtual reality as an instrument for producing immersive narrating experiences. The examiners formulated a virtual reality chronicle which coordinates spatial acoustics and intelligently components for the reason of creating a captivating and immersing account. The examination uncovered that the absorptive quality of the virtual reality storyline expanded client association and emotional response.

VR applications have found expanding utilization within the healthcare division, fundamentally for torment administration, presentation treatment, and restoration purposes (Wiederhold & Riva, 2019). Amid the method of preparing, VR recreations are connected to imitate veritable world scenarios, hence giving learners with a secure and controlled environment to sharpen their abilities (Anderson et al., 2019).

Concurring to De Kort et al. (2020), the researchers explored the capacity of virtual reality to inspire cybersickness, which is a sort of motion affliction caused by utilizing immersive technologies. The investigate demonstrated that cybersickness is a critical concern among certain virtual reality users, subsequently showing the need for extra investigation to comprehensively comprehend and reduce its impacts.

In their later review, Tarr and Warren (2021) elucidated upon the obstructions that relate to the plan, usage, and utilization of virtual reality innovation when utilized in instructive settings. The creators have recognized a few challenges that relate to the joining of virtual reality innovation. These challenges incorporate a prerequisite for specialized substance and skill, the potential for diversion and confusion, and the shortage of high-quality VR gear.

Despite its qualities and restrictions, the points of interest of virtual reality over differing disciplines have been recognized, and the imaginative medium is anticipated to assist progress and essentially influence society. VR innovation has experienced speedy advance, giving users with the opportunity to inundate themselves in computer-generated environment. VR has been implemented in diverse domains, including but not limited to entertainment, education, healthcare, and professional training. The developments in hardware, comprising top-notch head-mounted displays along with motion controllers, have rendered virtual reality more easily available to consumers. Multiple investigations have showcased the capabilities of VR to effectively diminish anxiety levels among individuals afflicted with cancer, elevate interactive learning occasions, establish engrossing narratives, facilitate pain management and convalescence, and furnish genuine training simulations.

The domain of musical experiences exhibits prospective opportunities for the implementation of VR technology. Regardless, there still exist certain challenges within the domain of virtual reality innovation, including but not limited to cybersickness, the requisite specialized content and expertise, and equipment limitations. Despite the various challenges, the technological realm of VR is rapidly progressing and is anticipated to have substantial implications on society through various domains of application.

Augmented Reality (AR)

AR superimposes advanced models on the real world, permitting users to associated with both genuine and virtual objects in their environment (Moro et al., 2017). AR looks for to upgrade real-world situations by combining advanced visual information (e.g., text, illustrations, photographs, motion pictures, and 3D virtual objects), sound data, and other outside jolts in real-time. Since reality and supplementary fabric coexist within the same put (Azuma et al., 2001; Jetter et al., 2018), this innovation gives an immersive and practical involvement to the user (Kim & Kim, 2018).

AR the physical world of the user is overburdened with virtual things (Azuma, 1997). Whereas AR cannot supplant the genuine world, by implanting or anticipating advanced components over the physical environment, AR gadgets make both physical and virtual reality obvious to the user's genuine vision. Natural understanding, movement following, and light estimation are all perspectives of AR innovation. AR devices require less equipment than VR devices (Behzadan et al., 2008). The acronym 'MR' indicates the concept of Mixed Reality, which refers to a gradient of immersive technologies that amalgamate features of VR and AR (Bacca et al., 2014). AR consolidates MR as a sub-category, giving an additional layer of interaction to the overlay of advanced data onto real-world objects, and is regularly shown as visualizations tied down within the genuine world, permitting the user to connected with it as in case it were a honest to goodness protest (Moro et al., 2021).

Although VR and AR share similarities, they also possess distinctions. VR relies solely on digital information for users to experience their surroundings, whereas AR provides users with both real-life data and additional computer-generated information, ultimately enhancing their perception of reality. It's important to recognize that all these technologies enhance user engagement and are set to be crucial elements of the forthcoming Metaverse (Shi et al., 2023).

AR advancement superimposes progressed models onto the veritable world, allowing clients to relate with both veritable and virtual objects. By combining advanced visual information, sound data, and other jolts in real-time, AR improves the user's discernment of reality, giving an immersive and practical involvement. Whereas AR cannot supplant the physical world, it overlays advanced components onto the user's environment, making both physical and virtual substances unmistakable. AR gadgets require less equipment compared to VR gadgets.

MR could be a sub-category of AR that combines highlights of VR and AR, joining an extra layer of interaction through 3d images secured within the genuine world. VR and AR share similarities but also exhibit distinct characteristics. VR relies solely on digital data, whereas AR integrates a combination of real-life and computer-generated information. These technologies play a critical role in enhancing user engagement and are expected to be fundamental elements of the upcoming Metaverse.

Mixed Reality (MR)

Milgram and Kishino (1994) define MR as a specific subset of VR-related technologies that involve the merging of real and virtual worlds somewhere along the virtuality continuum. The term VR was originally used in 1987 to allude to the usage of head-mounted displays (HMDs) by fighter pilots (Furness, 1989). According to Wu et al. (2019), MR is coordinates into learning and preparing programs to produce veritable learning encounters and to advance information securing and work environment competence.

The virtuality continuum interfaces totally genuine situations to totally virtual ones, with AR and AV sitting in between. Unlike AR, which combines virtual substance or advanced fabric with reality, AV combines digitized or imitated genuine substance with virtual environment (Milgram & Kishino, 1994). Picture processing, cloud-based rendering, 3D developments, vision tracking, spatial mapping, grapples for natural evaluation, eye tracking, hand movement recognition, and vocal input are all used in MR. MR (Speicher et al., 2019) combines 3D visuals with real-world views to allow users to interact with virtual items in the actual world. Therefore, a user may move around in a virtual environment with real-world surroundings.

Besides, MR uncovered users to sound, spatial jolts, haptics, sounds, odors, physical boosts, wind, temperature, geolocation, motion, and interactions with other genuine and virtual individuals. The virtual parts of MR associated with and react to the genuine physical environment. MR innovation and contraptions are the foremost in request and attractive of all immersive innovations (Alizadehsalehi et al., 2020). MR has common points and is seen as a to begin with organize within the building of Metaverse.

To summarize the preceding discussion and arrive at a final point, MR indicates a to a category of technologies that integrate virtual and real environments on a spectrum of virtuality. The incorporation of authentic learning experiences by MR into training programs serves to enhance the acquisition of knowledge and promote workplace competence. The concept of MR constitutes an innovative technological approach that lies in the intersection of two distinct but critical realities, namely the tangible physical world and the phenomenological digital world. By seamlessly blending 3D visualizations with authentic physical environments, this cutting-edge technology empowers users with the unique and immersive experience of interacting with virtual elements in their real-life settings. The integration of diverse sensory stimuli, including auditory, tactile, and spatial cues, serves to heighten the level of user immersion and engagement with both tangible and simulated elements. The technology commonly referred to as MR possesses significant commercial value and continues to be in high demand. This technology forms a fundamental building block in the establishment and advancement of Metaverse.

Wearables

The classifications of wearables, wearable contraptions, and wearable development relate to humble electronic and transportable gadgets or inaccessible communication-equipped computers that are joined into gadgets, embellishments, or clothing and can be worn on the human physical make-up, together with obtrusive shapes such as micro-chips or shrewdly tattoos (Luczak et al., 2020). The advent of wearable technology can trace its origins back to the 13th century when Roger Bacon, an English monk stationed in Paris, pioneered the development of displays. In his notable work, Creation Majus (c. 1266), Bacon expounded upon the technical principles that govern the use of corrective lenses (The College of Optometrists, 2019).

The emergence of the initial portable pocket watch, which facilitated ease of transportation, can be attributed to the early 16th century, with significant acclaim being attributed to the Pomander (aka Bisamapfeluhr in German) clock as the precursor to this design (Oestmann, 2016). Undeniably, the progress of wearable technologies has been accelerated by military applications in recent years, particularly during the tumultuous eras of World War I and II, which were characterized by significant scope and scale. Originally, the initial deployment of wireless systems was modified to enable communication in field-based environments (The National Archives, 2019).

The prominent utilization of wristwatches proves to be instrumental in enabling the efficient coordination and performance of multiple tasks, subsequently leading to the extensive incorporation of wearable technology in the prestigious realm of military tactics (Myre, 2017). The hearing aid is a notable demonstration of early wearable technology, having surfaced in the 1950s and undergone iterative refinement in response to technological progress (Wang et al., 2019). The post-World War II period of recovery, significant strides were made in the development of wearable technology, particularly with regards to VR. Notably, Morton Heilig obtained a license for the 'Stereophonic TV Head-Mounted Display' in 1960, marking a noteworthy advancement in this field (Ticknor, 2018). The introduction of a follow-up version of the initial device, the Sensorama Simulator, promptly ensued (Heilig, 1962).

The Hamilton Pulsar, which was introduced in 1972, is among the wearable devices which are still in use. It merits significance for being a pioneer in the realm of digital watches (Hjorth & Kim, 2018). Consequently, the global adoption of wristwatches became feasible, rendering it possible for marketing teams to incorporate them into their market strategies. Simultaneously, the preparatory wired, hands-free device prepared with consolidated flight headgear were experiencing improvement (Stamp, 2013).

The progress of wearables in the 1980s occurred at a relatively swift pace, primarily propelled by advancements in existing technologies from previous years and a novel augmented reality boom. In 1981, Steve Mann conceptualized the Eye Tap project and devised the inaugural backpack-style computer specifically designed to process and display information from a camera mounted in close proximity to the eye, presenting it on a screen positioned directly in front of the user (Mann et al., 2005).

At the outset of the 1990s, the technological landscape witnessed the emergence of the Knowledge-based AR for Maintenance Assistance (KARMA) system, which received widespread acclaim for its innovative and pioneering approach. The initiation of the project can be credited to the renowned academic institution, Columbia University (Steven, Blair, & Dorée, 1993).

The integration of the Private Eye technology within the system was performed for the purpose of attaining an overlay effect. The principal aim of this project was the production of wireframe schematics and guidelines for maintenance, which were subsequently overlaid onto the equipment undergoing servicing (Ometov et al., 2021).

Within the sphere of wearable technology, the year 1998 is commonly regarded as a significant and seminal moment in its genesis. The implementation of the payment epoch on both Apple Watch and Android Wear is a notable technological progression within the domain of mobile payment systems. The instrument that encouraged the assignment beneath examination was recognized as the mBracelet gadget (Papadopoulos, 2019). The wrist-wearable gadget was created with the main aim of empowering monetary exchanges with Automated Teller Machines (ATMs).

Over the past few years, there has been an outstanding surge within the acknowledgment and flexibility of portable innovation, such as smartwatches and fitness trackers. The advancement of these devices has been moved by progressions in sensor innovation, the miniaturization of electronic components, and improvements in remote organizing capabilities (Tao & Cheng, 2016).

The utilization of wearable innovation has too expanded past uniquely wasteful devices. Inside the healthcare segment, wearable advances serve as a implies of checking the wellbeing of patients and conveying real-time information to healthcare specialists (Gong et al., 2019). Concurring to Hickey et al. (2018), the usage of wearable innovation inside the domain of games has ended up a crucial implies of checking execution and decreasing the probability of physical harm. As per Delgado et al., (2020), the utilization of wearable innovation within the military space serves as a implies of expanding the level of officer execution and guaranteeing more prominent levels of security.

The advancement of wearable innovation over time shows a reliable direction, progressing from simple gadgets to progressively complex and complex ones. This movement has yielded an essential cluster of potential applications over assorted circles. Within the domains of wellbeing and fitness, wearable innovation alludes to gadgets that are coordinates into articles of clothing and adornments that can be worn on the body to supply tangible and checking highlights, counting biofeedback and following of physiological capacities. These technologies are designed to be unobtrusive and comfortable, facilitating continuous monitoring and assessment of fitness and health-related metrics, as depicted in Figure 2. Various prevalent wearable technologies consist of smartwatches, intelligent footwear, smart eyewear, and Bluetooth trackers, as exhibited in Figure 3.

Figure 2. Wearable technology in healthcare (Sinhasane, 2018, May 29)

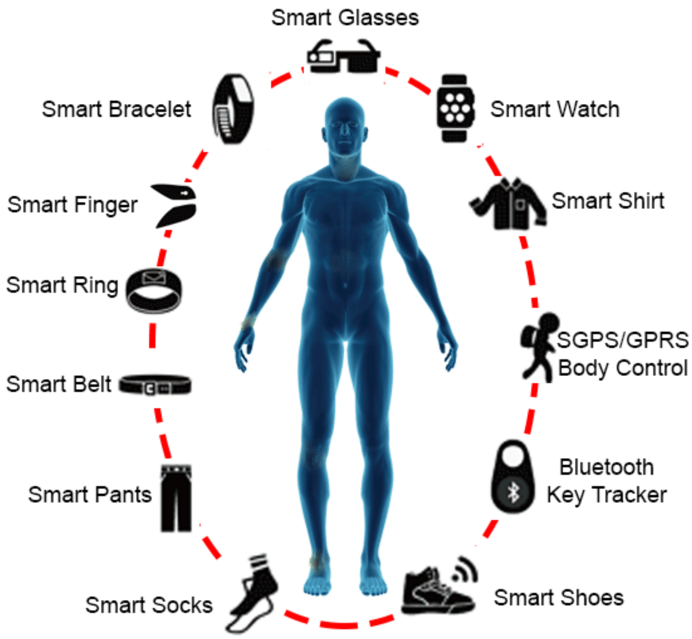

Figure 3. Different types of wearable technology (Rodrigues et al., 2018)

Ultimately, it can be posited that the field of wearable technology boasts a multifaceted lineage that can be traced back to the thirteenth century and has proficiently evolved with the passage of time. The evolution of wearable technology can be traced back to its earliest roots in portable pocket watches and displays, which have since given way to the emergence of digital watches and backpack-style computers. The modern-day wearable market now comprises a diverse range of devices, ranging from smartwatches and fitness trackers to augmented reality headsets.

The technological progressions observed in sensor technology, miniaturization of electronic components, and advancements in wireless networking capabilities have significantly contributed to the advancements witnessed in this field. The utilization of wearable technology spans across numerous domains including healthcare, sports, and defense. This technology is associated with a range of benefits such as the ability to monitor one's health in real-time, track overall performance, and improve safety measures. The trajectory of wearable technology depicts its significant potential for continued innovation and diversification, thereby providing a promising avenue for the development of exciting future applications. The utilization of haptic devices has been deemed imperative in augmenting the perception of touch and facilitating tactile engagements between humans and computational systems. Such devices have the capacity to offer immersive and true-to-life encounters. As we examine the historical progression of extended realities, charting their advancement across diverse modalities, researchers set the stage for an investigation into the forthcoming frontier of XR: the Metaverse. In this realm, immersive technologies converge to mold a novel digital paradigm, representing a new and expansive digital universe where users can interact and engage in various virtual experiences.

A Short History of Extended Realities

The fields of VR and AR have progressed considerably since their origination, boasting a substantial record of technological enhancements and noteworthy achievements. The beginning of VR can be generally followed to the center of the 20th century, wherein pioneers such as Morton Heilig and Ivan Sutherland presented eminent progressions within the field. Heilig's Sensorama, developed in the year 1950, was designed with the purpose of delivering a comprehensive multi-sensory encounter integrating the senses of smell and touch.

In 1961, Sutherland originated a prototype for the head-mounted display (HMD) referred to as the Sword of Damocles, that was capable of projecting wireframe graphics. The first settlers made significant advancements in technology, thereby establishing a foundation for the contemporary immersive technologies available today. The present discourse endeavors to investigate pivotal occurrences in the advancement of VR and AR. Specifically, this analysis delves into the initial classification of the term 'virtual reality' by Jaron Lanier, the emergence of augmented reality, as well as the advent of MR and XR technologies.

The present Figure 4 endeavors to underscore noteworthy apparatus and programs that have influenced the domain of immersive encounters historically. In view of the principle of research parsimony, the researcher focused exclusively on crucial historical junctures.

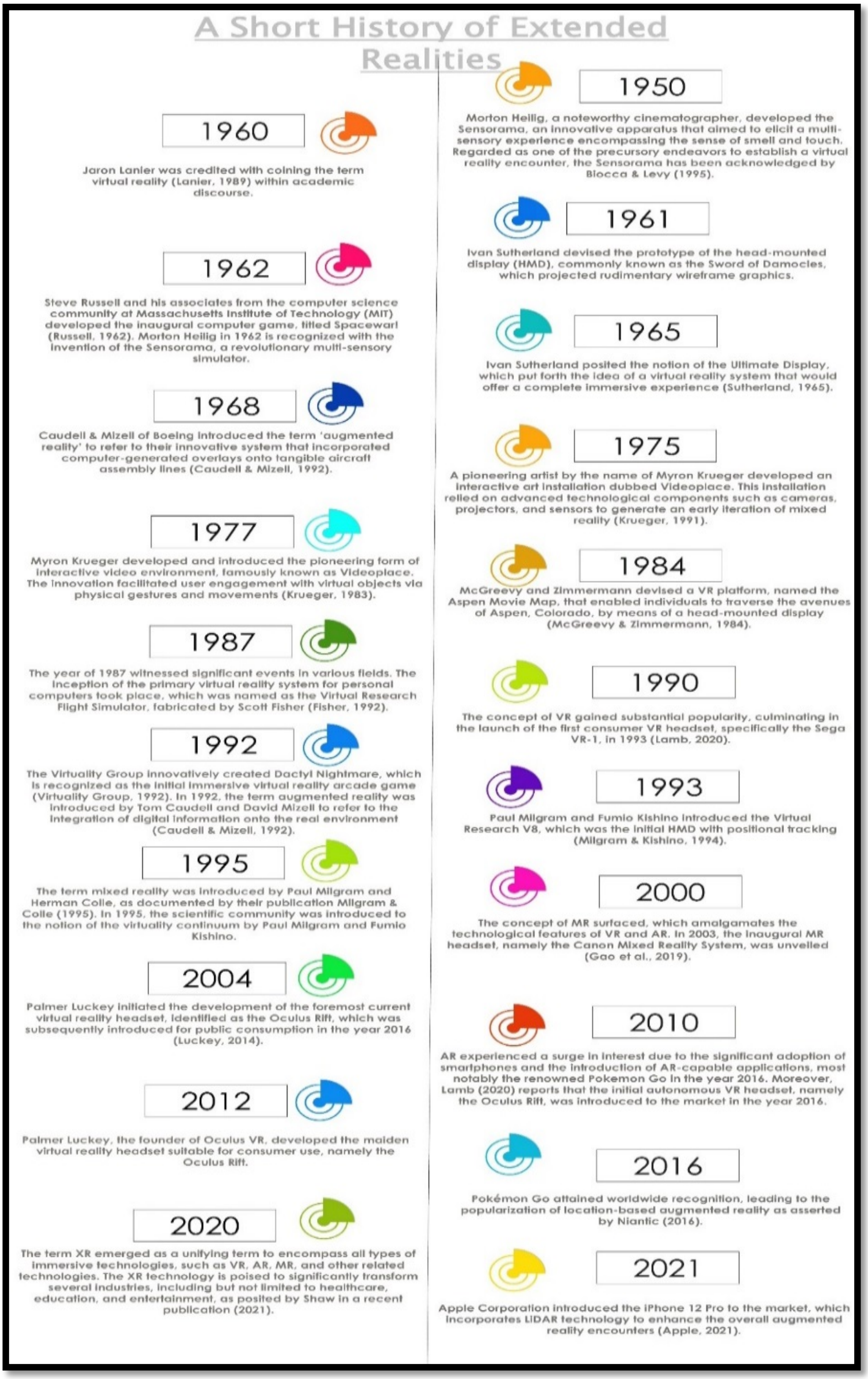

Figure 4. A short history of extended realities (Shaw, 2021)

The following bulleted timeline is an extended version of Figure 4 and provides detailed information for every crossroads.

1950: Morton Heilig, a noteworthy cinematographer, developed the Sensorama, an innovative apparatus that aimed to elicit a multi-sensory experience encompassing the sense of smell and touch. Regarded as one of the precursory endeavors to establish a virtual reality encounter, the Sensorama has been acknowledged by Biocca and Levy (1995)

1960: Jaron Lanier was credited with coining the term virtual reality (Lanier, 1989) within academic discourse.,

In the year 1961, Ivan Sutherland devised the prototype of the head-mounted display (HMD), commonly known as the Sword of Damocles, which projected rudimentary wireframe graphics. As per Sutherland's study conducted in 1968, the Sword of Damocles was the foremost instance of a head-mounted display. In the year 1961, Ivan Sutherland made a significant breakthrough by inventing the very first HMD which possessed the ability to generate a virtual environment. This pioneering invention was documented by Sutherland himself in the year 1965.

In 1962, Steve Russell and his associates from the computer science community at Massachusetts Institute of Technology (MIT) developed the inaugural computer game, titled Spacewar! (Russell, 1962). Morton Heilig in 1962 is recognized for the invention of the Sensorama, a revolutionary multi-sensory simulator.

In the year 1965, Ivan Sutherland posited the notion of the Ultimate Display, which put forth the idea of a virtual reality system that would offer a complete immersive experience (Sutherland, 1965).

In 1968, Caudell & Mizell of Boeing introduced the term 'augmented reality' to refer to their innovative system that incorporated computer-generated overlays onto tangible aircraft assembly lines (Caudell & Mizell, 1992). In his seminal work, Sutherland (1968) presents the pioneering development of an innovative head-mounted display, known as the Sword of Damocles. This groundbreaking piece of technology showcases basic wireframe graphics to the user.

In 1975, a pioneering artist by the name of Myron Krueger developed an interactive art installation dubbed Videoplace. This installation relied on advanced technological components such as cameras, projectors, and sensors to generate an early iteration of mixed reality (Krueger, 1991).

In the year 1977, Myron Krueger developed and introduced the pioneering form of interactive video environment, famously known as Videoplace. The innovation facilitated user engagement with virtual objects via physical gestures and movements (Krueger, 1983).

In 1984, McGreevy and Zimmermann devised a VR platform, named the Aspen Movie Map that enabled individuals to traverse the avenues of Aspen, Colorado, by means of a head-mounted display (McGreevy & Zimmermann, 1984).

In 1987, the year of 1987 witnessed significant events in various fields. The inception of the primary virtual reality system for personal computers took place, which was named as the Virtual Research Flight Simulator, fabricated by Scott Fisher (Fisher, 1992).

*In the year of 199*0, the concept of VR gained substantial popularity, culminating in the launch of the first consumer VR headset, specifically the Sega VR-1, in 1993 (Lamb, 2020).

In the year 1992, the Virtuality Group innovatively created Dactyl Nightmare, which is recognized as the initial immersive virtual reality arcade game (Virtuality Group, 1992). In 1992, the term augmented reality was introduced by Tom Caudell and David Mizell to refer to the integration of digital information into the real environment (Caudell & Mizell, 1992).

In 1993, Paul Milgram and Fumio Kishino introduced the Virtual Research V8, which was the initial HMD with positional tracking (Milgram & Kishino, 1994).

In 1995, the term mixed reality was introduced by Paul Milgram and Herman Colle, as documented by their publication Milgram & Colle (1995). In 1995, the scientific community was introduced to the notion of the virtuality continuum by Paul Milgram and Fumio Kishino. This concept classifies diverse manifestations of virtual and augmented reality based on the extent to which they enable immersive and interactive experiences (Milgram & Kishino, 1995).

In the year 2000, the concept of MR surfaced, which amalgamates the technological features of VR and AR. In 2003, the inaugural MR headset, namely the Canon Mixed Reality System, was unveiled (Gao et al., 2019).

In the year 2004, Palmer Luckey initiated the development of the foremost current virtual reality headset, identified as the Oculus Rift, which was subsequently introduced for public consumption in the year 2016 (Luckey, 2014).

In 2010, AR experienced a surge in interest due to the significant adoption of smartphones and the introduction of AR-capable applications, most notably the renowned Pokemon Go in the year 2016. Moreover, Lamb (2020) reports that the initial autonomous VR headset, namely the Oculus Rift, was introduced to the market in the year 2016.

In the year 2012, Palmer Luckey, the founder of Oculus VR, developed the maiden virtual reality headset suitable for consumer use, namely the Oculus Rift.

In the year 2016, Pokémon Go attained worldwide recognition, leading to the popularization of location-based augmented reality as asserted by Niantic (2016).

In the year 2020, the term XR emerged as a unifying term to encompass all types of immersive technologies, such as VR, AR, MR, and other related technologies. The XR technology is poised to significantly transform several industries, counting but not restricted to healthcare, education, and entertainment, as posited by Shaw in a recent publication (2021).

In 2021, Apple Corporation introduced the iPhone 12 Pro to the market, which incorporates LiDAR technology to enhance the overall augmented reality encounters (Apple, 2021).

Next Step in XR: Metaverse

The concept of Metaverse has garnered significant attention in the realm of XR progression. Metaverse is a virtual realm that amalgamates augmented and virtual reality encounters, affording individuals the opportunity to engage with a fabricated setting and interact virtually with other users in a manner akin to real-life experiences. The notion has been in existence for several decades; however, it has garnered fresh recognition owing to the latest technological developments and the surging fascination with simulated social encounters. After industry reports and anticipation, the industry of Metaverse is poised to ascend to a value of $996 billion by the year 2030, reflecting a compound yearly development rate of 39.8% (Globaldata Plc, 2022).

Metaverse was initially conceived by author Neal Stephenson in his 1992 novel 'Snow Crash' and represented in sci-fi films such as 'Ready Player One' (Cheong, 2022). Nearly a decade afterward, in 2003, the San Francisco-based startup Linden Lab propelled Moment presence, an advanced, virtual world in which clients seem make avatars and inundate themselves in a moment advanced presence utilizing a Web association and a computer (Linden Lab, 2003).

The etymology of the expression Metaverse can be traced back to the amalgamation of the prefix 'meta' and the suffix 'verse,' resulting in a neologism that denotes a digitized universe where individuals can engage with hyper-realistic environments and communicate with other users (Fuchs, 2021). The term ‘meta’ originates from the Greek language and is commonly employed as a prefix denoting superiority or expansion beyond a given concept or system, while the term 'universe' originates from the Latin language (Oxford English Dictionary, 2021; The Editors of Encyclopedia Britannica, 2021). As per the Online Etymology Dictionary (n.d.), the word ‘universe’ is derived from ‘universum’ of the Latin language and refers to the totality of all things or the entire world. The word ‘universe’ has its etymological origins in the Latin term ‘universus,’ which denotes the concept of completeness or wholeness.

The framework beneath thought shows socio-economic structures associated to those watched and offers modern applications and administrations. In recent times, there has been a developing drift towards the digitization of different aspects of human action such as work, shopping, conferences, and entertainment, resulting in a shift towards online formats. Especially within the framework of the COVID-19 pandemic, individuals are inclined to allocate increased amounts of time to virtual realms. The introduction of novel commercial forms has facilitated a greater number of industries to explore innovative means of development, particularly in the nascent fields of electronic games, fashion, education, and similar domains (Shi et al., 2023).

Metaverse technology is a hybrid of the digital and physical worlds that is viewed as a shared virtual place. Numerous critical stakeholders possessing dissimilar visions, motivations, and technological orientations are currently dedicating significant financial resources towards advancing the basic underpinnings that serve as the foundation for Metaverse, present across several divergent industries (Zalan & Barbesino, 2023). Facebook has announced a name change to Meta in order to transition from being only a social media corporation to establishing Metaverse (Zuckerberg, 2021).

Smartsearch (2022) underscored that Metaverse cannot be simply characterized as a mere amalgamation of diverse technologies. The efficacy of this system is dependent on six crucial technological pillars, commonly acknowledged as BIGANT (Blockchain, Interactivity, Game mechanics, Artificial Intelligence (AI), Network infrastructure, and Internet of Things (IoT)).

In conclusion, the notion of Metaverse, an amalgamation of virtual and augmented reality encounters within a virtual domain, has garnered considerable interest in contemporary times within academic discourse. The concept of Metaverse, first conceived by Neal Stephenson in his literary work, 'Snow Crash,' and popularized in contemporary literature such as 'Ready Player One,' refers to the virtual realm that enables users to engage with hyper-realistic environments and interact with others. This conceptualization envisions a digitized world that transcends the boundaries set by physical reality, providing an immersive experience. Due to technological progress and heightened enthusiasm for virtual social interactions, Metaverse industry is forecasted to attain a market worth of $996 billion by the year 2030. The concept of Metaverse encompasses the prefixes 'meta' and 'verse,' which denote an electronic dimension surpassing that of the corporeal realm. The COVID-19 widespread has brought about in a critical increment within the drift of digitization. This trend has sparked an increasing interest and exploration of advanced applications and services within Metaverse, across various industries, including gaming, fashion, and education, among others. As multiple stakeholders continue to invest in the developmental aspects of Metaverse, involving Blockchain technology, interactive features, gaming mechanics, artificial intelligence, network infrastructure, and IoT, the boundaries that separate the digital and physical worlds progressively decline, potentially enabling brand-new opportunities and transcendental experiences.

Some Contributions of Metaverse

Metaverse may be a lasting virtual zone in which people may lock in in various social, economic, and recreational exercises as an expansion of their offline lives. With the COVID-19 pandemic's expanded social separation and lockdowns, more people are finding strategies to spend time and meet social necessities whereas remaining at domestic. Situating themselves as Metaverse, enormously prevalent online gaming and social media stages are attracting unused clients with interesting virtual encounters and elating social occasions (Oh et al., 2023). Empirical evidence has consistently demonstrated that social support and interaction are paramount in safeguarding positive psychological health and overall well-being throughout an individual's lifetime (Holt-Lunstad et al., 2015). In view of the escalating impediments faced by the youthful population in accessing customary social aid, inclusive of public events and communal gatherings, digital environments like Metaverse offer promising prospects as a substitute medium of social bonding and assistance. Social bolster intervened the relationship between online community cooperation and well-being (Tang et al., 2019).

In contrast to commonly utilized e-learning instruments, counting Moodle, Zoom, Google Classroom, and Meet, Metaverse offers a one of a kind advantages through its capacity to provide a substantial sense of authenticity in virtual learning situations. This highlight has the capability to successfully remediate a winning confinement of e-learning as noted by Kanematsu et al. (2014).

To entirety up, the appearance of Metaverse has outfitted people with an enduring virtual milieu where they can take an interest in a grouped extend of social, economic, and leisure interests, especially within the setting of social separating and lockdowns as exemplified by the current COVID-19 widespread. As routine modes of social interaction have ended up obliged, Metaverse presents an elective cyber environment where people can fulfill their social prerequisites and get nurturance. Modern inquire about has illustrated the basic part of social bolster in advancing mental well-being. Considering this, rising computerized situations such as Metaverse show a promising opportunity to moderate the challenges confronted by people who have restricted get to customary shapes of social bolster. Particularly, these computerized stages have the potential to encourage social associations and help, hence serving as a bridge to fill the hole in social bolster availability.

Additionally, inside the setting of the scholarly world, Metaverse presents benefits by outfitting bona fide virtual learning situations able of settling the limitations related with routine e-learning modalities. Metaverse possesses the capacity to provide a palpable impression of reality, thereby exhibiting a promising potential for elevating the efficacy and involvement within virtual pedagogical contexts. As Metaverse progresses and expands, it exhibits potential for revolutionizing social interactions, support structures, and educational opportunities within the digital domain.

Furthermore, as the Metaverse progresses in redefining digital social interactions, it not only addresses the specific challenges brought about by the pandemic but also holds promise for reshaping various facets such as support networks and educational possibilities. The enduring virtual environment established by the Metaverse becomes progressively essential in a world where face-to-face interactions are limited.

Within the sphere of social interactions, the Metaverse provides an engaging and lively setting that goes beyond conventional online platforms. Its ability to enable distinctive social encounters, collaborative projects, and a variety of recreational pursuits fosters a community spirit that surpasses geographical limits, impacting individual welfare positively. This broadened range of social connectivity carries significance not only for personal well-being but also for the establishment of novel forms of digital communities.

Ongoing exploration and dialogue, focusing on specific aspects of the Metaverse's potential, play a pivotal role in realizing its full capabilities. It is imperative for individuals, industries, and communities to actively participate in continuous conversations, contributing to the collaborative shaping of the Metaverse's evolving landscape. Through this collective effort, we can tap into the transformative capabilities of the virtual realm, actively shaping a future where digital connectivity, support, and effectiveness are optimized, rather than merely adapting to change.

Declarations

Conflict of interest the authors declare that they have no conflict of interest.

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