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A new form of cinema with virtual reality technology: VR film

Sanal gerçeklik teknolojisi ile yeni bir sinema formu: VR film

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Abstract

Cinema has continued its quest to construct its own aesthetic and narrative forms since the first film screening in Paris in the late 19th century. At the center of this quest are the possibilities offered by the technological developments of the period. Cinema's tendency to explore and experience technological innovations has led to formal and narrative transformations over time, resulting in its evolution into different genres and subcategories. Although some film theorists have argued that this technological orientation threatens the essence of cinema as a young art form, today it is seen that the relationship between cinema and technology has reached a point of no return. Since the first film screenings, the cinematic experience has been based on the viewer witnessing images created by sequential movements in a rectangular frame on a two-dimensional plane from a fixed position. However, since the beginning of the 21st century, rapidly developing information technologies, digitalization processes and especially interactive systems specific to the gaming industry have led to radical transformations in the production, distribution and screening practices of visual arts; thus, bringing out a new form to the cinema narrative: VR Film. Positioned at the intersection of cinema and contemporary technologies, VR film goes beyond traditional viewing practices and involves the viewer in a real-time spatial experience in a three-dimensional virtual space through wearable technologies. To consider VR cinema only as a technical innovation or instrumental development would be to ignore the epistemological and aesthetic possibilities offered by this narrative form. In this framework, following the technological evolutionary line from the dark box to the invention of the cinematograph, from sound and color technologies to digital cinema, conceptualizing the interactional relationship between cinema and technology is of decisive importance in order to develop a theoretical perspective on the future of VR cinema.

Keywords: VR film, virtual reality cinema, experiential film, immersive video, VR narrative.

Özet

Sinema, 19. yüzyılın sonlarında Paris'te gerçekleştirilen ilk film gösteriminden itibaren, kendine özgü estetik ve anlatı biçimlerini inşa etme yönündeki arayışını sürdürmektedir. Bu arayışın merkezinde ise, dönemin teknolojik gelişmelerinin sunduğu imkânlar yer almaktadır. Sinemanın teknolojik yenilikleri keşfetme ve deneyimleme yönündeki eğilimi, zaman içerisinde biçimsel ve anlatısal dönüşümlere yol açarak, sinemanın farklı tür ve alt kategorilere evrilmesine neden

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olmuştur. Her ne kadar bazı sinema kuramcıları bu teknolojik yönelimin, genç bir sanat dalı olarak sinemanın özünü tehdit ettiğini iddia etmişlerse de, günümüzde sinema ile teknoloji arasındaki ilişkinin artık geri dönüşü olmayan bir noktaya ulaştığı görülmektedir. İlk film gösterimlerinden bu yana, sinema deneyimi izleyicinin iki boyutlu bir düzlemde, dikdörtgen bir çerçeve içinde sıralı devinimlerle oluşturulan görüntülere sabit bir konumda tanıklık etmesine dayanmaktadır. Ancak 21. yüzyılın başından itibaren hızla gelişen bilişim teknolojileri, dijitalleşme süreçleri ve özellikle oyun endüstrisine özgü etkileşimli sistemler, görsel sanatların üretim, dağıtım ve gösterim pratiklerinde köklü dönüşümlere yol açmış; bu durum sinema anlatısına da yeni bir form kazandırmıştır: VR Film. Sinema ile çağdaş teknolojilerin kesişim noktasında konumlanan VR film, geleneksel izleme pratiklerinin ötesine geçerek, izleyiciyi giyilebilir teknolojiler aracılığıyla üç boyutlu sanal bir mekânda, gerçek zamanlı ve mekânsal bir deneyime dâhil etmektedir. VR sinemayı yalnızca teknik bir yenilik veya araçsal bir gelişim olarak ele almak, bu anlatı formunun sunduğu epistemolojik ve estetik olanakları göz ardı etmek anlamına gelecektir. Bu çerçevede, sinemanın tarihsel gelişim süreci içerisinde karanlık kutudan sinematografın icadına, ses ve renk teknolojilerinden dijital sinemaya kadar uzanan teknolojik evrimsel çizgiyi takip etmek; sinema ile teknoloji arasındaki etkileşimsel ilişkiyi kavramsallaştırmak, VR sinemanın geleceğine yönelik kuramsal bir perspektif geliştirebilmek açısından belirleyici önemdedir.

Anahtar Kelimeler: VR film, sanal gerçeklik sineması, deneyimsel film, sürükleyici video, VR anlatı.

1. Introduction

The journey of the cinematograph, which has its roots in the idea of a simple device like the dark box discovered over a thousand years ago, leans on a new technological discovery at each milestone. In this context, understanding the relationship between cinema and new technologies will be a guide to the future prospects of this young art. This complex relationship between technological developments and cinema has not only brought new talents to this young art but has also redefined its form and narrative structure in every period of its history.

Looking at the history of cinema on a large scale, it can be seen that cinema came into existence in 1895 when Auguste Marie Nicolas and Louis Jean, aka the Lumière brothers, produced the cinematograph device that allowed collective movie watching by recording moving images and projecting them on a screen. However, when the scale is reduced, it is seen that the discovery of the art of cinema, as in all other branches of art, cannot be attributed to one person or one device. From the drawings on the cave wall to the first photograph on celluloid, from the recording of series of photographs to the collective screening, each inventor enriched the art of cinema and its industrialization by contributing to other inventors and devices with the device they produced [1],[2].

Towards the end of the 1800s, many engineers and scientists, such as the Lumière brothers, who were partially aware of each other (through events such as fairs, trips, etc.) in different parts of both the American and European continents, competed with each other in order to enliven static photographs and bring them to the masses, while at the same time producing devices with very similar features. Although the French consider themselves to be the inventors of this new magical art [3], the United States with the inventions of Thomas Edison, the British with the inventions William Friese-Greene, the French with the inventions Louis-Aime-Augustin Le Prince and the Germans with the inventions Max and Emile Skladanovski claim to have invented cinema [4],[2]. "*However, none of these people can be called the primary creators of cinema. Only a favorable combination of successive and technical circumstances made such an invention possible at this particular moment: photographic developments, the invention of celluloid -the first medium durable and flexible enough to pass through a projector- and the application of precision engineering and instrumentation to projector design* [5]."

So, who invented cinema, and what role did new technologies play in this journey? It would be misleading to define cinema as an art form that suddenly came into existence as the invention of a single inventor. Cinema should be seen as the product of collective intelligence and experience, achieved through a multi-stage journey involving discoveries in many disciplines, each of which led to the next, culminating in the invention of the cinematograph. Although the 1890s are generally accepted as the period when moving images were born, some cinema techniques developed before this date continue to be used in today's cinema, so no pre-development can be separated from cinema as an undefined period before it [2]. This is because the history of cinema did not begin with a big bang. The developments preceding the emergence of cinema came together under the title of pre-cinema and formed contemporary cinema [6].

Alim Şerif Onaran in his book *Silent Cinema History* [7], Kristin Thompson and David Bordwell in their book *Introduction to Film History* [8], and Adnan Acar in his book *Silent Cinema History* [9] classify the milestones of the long journey leading to the invention of cinematograph into three fundamental common layers: The Magic Lantern, Optical Toys, and the Invention of Photography. Although Lenny Lipton in *The Cinema in Flux: The Evolution of Motion Picture Technology from the Magic Lantern to the Digital Era* [10] looks at the history of cinema from a similar perspective to other authors, he divides the development of the art of cinema periodically into three: Glass Cinema, Celluloid Cinema and Digital Cinema, and in terms of the production technology of movement in two categories: real movement and illusion of movement. As seen in Figure 1, Lipton classifies the development of cinema from both the perspective of motion technology and the material perspective.

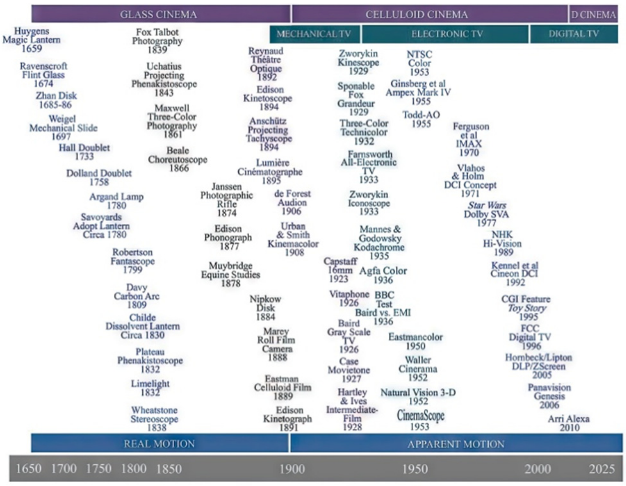

Figure 1. Cinema eras and milestones [10].

Lipton [10] argues that it is incorrect to characterize the glass cinema era as the pre-cinema period based on the invention of the magic lantern. He claims that the true starting point of cinema was not the inventions of Edison or the Lumière brothers, but rather the invention of the magic lantern. Laurent Mannoni also asserts in his book *The Great Art of Light and Shadow: Archaeology of the Cinema* [5] that magic lantern technology was not pre-cinematic and that cinema began with the magic lantern. The glass cinema period, which began with the magic lantern in the 17th century, refers to the period up to the discovery of celluloid technology in the early 18th century, during which inventors developed devices that projected moving images onto a screen by superimposing transparent or black glass plates drawn with images at a certain speed. Lipton divides the history of cinema into two categories from the perspective of the technology used to create this movement: reality and illusion. The technology of real movement, which runs parallel to the glass cinema era, refers to the illusion created by physically moving glass slides on top of each other using humans or devices in the machines of the period, while illusion of movement technology refers to the illusion of motion created by the sequential presentation of static images recorded on celluloid film at a specific speed. Onaran [7], Thompson and Bordwell [8], and Acar [9] classify the stages of the journey leading to the invention of cinematograph as the magic lantern, optical toys, and the invention of photography. The devices examined by Onaran, Thompson and Bordwell, and Acar differ from those examined by Lipton in his classification of the glass cinema era in certain respects.

Approximately two centuries after the invention of the magic lantern, in the 19th century, many scientists and explorers in both Europe and the United States developed inventions based on concepts such as eye defects and visual persistence, which were discovered as a result of research on individual physiology and focused on creating simple motion illusions with still images. Researchers were working to discover ways to overlay transparent or translucent images on top of each other while also displaying these images in regular intervals one after another. Scientists such as Count Patrick d'Arcy, Peter Mark Roget, Sir David Brewster, Michael Faraday, Joseph Plateau, and Simon Ritter von Stampfer succeeded in inventing devices that could partially convert static images into moving images by taking advantage of human visual and perception defects, resulting in the creation of so-called "philosophical toys" such as the Thaumatrope, Anorthoscope, Stereoscope, Phenakistiscope, and Zoetrope. These devices were able to partially transform static images into moving ones [10].

Optical toys, although they produce important results in understanding how movement is created and can sometimes be repeated and collectively observed, are extremely inadequate due to the extremely short duration of the moving images they create and their distance from physical reality. During this period, when efforts to invent moving images, which were carried out in different parts of the world and often repeated and imitated, reached a dead end, the solution was found in the development of a new technology: the invention of photography.

The discovery of photography was not only the most important milestone in the long journey that led to cinematograph but also served as the raw material for conventional cinema, both physically and as a document of reality, until the birth of digital cinema in the late 1990s. Like the discovery of cinema and other art forms, the invention of photography is the result of a collective accumulation of discoveries across various disciplines: from chemistry to physics, from the discovery of perspective to the darkroom, and the advancements in the field of optics.

By the end of the 19th century, the footsteps of cinematograph could be heard loud and clear, and by the close of the century, discoveries in both materials and equipment had reached a sufficient level of maturity to pave the way for the emergence of a new art form that would become a major industry in the future. Edison, whose name is associated with numerous inventions, achieved the status of one of the most important figures in both American film history and the history of cinema through his work on moving images.

Carl Antoine Lumière, in his factory in Lyon, France, where he employed approximately three hundred workers to produce photographic plates and materials, invented the Cinematograph, a device that could be used as a camera, projector, and printing machine, as a result of his work on moving images with his sons Auguste Marie Nicolas and Louis Jean, who would become known as the Lumière brothers in the history of cinema. The Lumière brothers also succeeded in redefining the future of cinema, becoming the pioneers of what would later be recognized as the seventh art form in the 20th century and eventually evolve into a massive industry.

The introduction of synchronized sound technology in the late 1920s and the subsequent colorization of black-and-white images on the magical screen doğru terim mi? Bkz: "The magic screen" ya da "the silver screen"screen—the director's dream—brought about irreversible changes in cinema. The development of sound and color technology in cinema history has been an evolutionary turning point for this young art form. Although the inclusion of sound in cinema and its use as a means of expression have significantly contributed to the existing power of cinema, they have also greatly changed the language of visual expression. However, cinema theorists who opposed this technology argued that the use of sound harmed the identity of cinema. Sound and color, which are now used as elements of creating meaning in modern cinema and whose place in the narrative is indisputable today, were hotly debated by cinema thinkers throughout the 1930s.

Hugo Münsterberg, Rudolf Julius Arnheim, Sergei Eisenstein, and Vsevolod Pudovkin, who conducted theoretical studies on cinema, argued that silent cinema already possessed sufficiently powerful narrative elements and that these elements were what made cinema meaningful and made it a work of art. They claimed that the addition of sound and color had corrupted the magical screen [11]–[13].

In the history of cinema, sound technology is the third most important turning point after the discovery of motion picture recording and editing. Despite all the technical problems mentioned above and the fierce opposition of cinema theorists, sound and color technology quickly gained acceptance and became an indispensable element of cinema. Although film theorists have occasionally predicted that new technologies would threaten cinema's traditions and even declare the death of cinema, they have failed to stand in the way of change. Throughout the history of cinema, new technologies have been the most effective tools in shaping the future of the art form.

Throughout its history, cinema has undergone a harmonious evolution alongside technological advancements. The most significant technological breakthrough in cinema occurred in the late 1990s with the transition from conventional cinema to digital cinema. This new technology has fundamentally reshaped every aspect of cinema, from production and distribution to editing and archiving.

When we think of cinema in the 21st century, what still comes to mind is the magical white screen with its moving images, which is considered to be the director's dream, and the red velvet seats arranged in front of it. However, the practice of watching films has largely shifted to individual viewing on portable devices via digital media. While new media and new technologies have introduced the concept of digital cinema into film literature, the critiques of this concept by researchers continue to be voiced loudly even today. Although terms like new media, new opportunities, and new technologies evoke positive connotations when used to describe new concepts, many film theorists argue that digital cinema contains numerous issues both in technical and theoretical contexts.

In his book *How to Read a Film* [14], James Monaco states that all art forms are influenced by the politics, philosophy, and economies of their societies, as well as by the technology of their time, and that this interaction constantly reshapes the art forms.

The interaction between new technologies and cinema has been a phenomenon throughout the history of visual arts. As Monaco mentions in his book, new technologies have periodically changed the form of cinema, while the aesthetic concerns of film have also contributed to the development of new technologies. This interaction has sometimes necessitated radical changes, reshaping the production, exhibition, and distribution methods of this young art form, closing one era in cinema history and opening a new one. In this context, virtual reality technologies, a highly popular concept today, are also enabling the emergence of a new form of cinema: VR film.

VR films that break the monopoly of the magical screen; not only transport the conventional cinema's definition of the audience, the relationship it establishes with the audience, and the interaction between the audience and the visual narrative they witness into a different medium, but also construct their own unique narrative by reimagining the methods of meaning creation inherent to technology, while leaving behind many concepts that form the building blocks of traditional cinema. In this context, while the transition from film to digital can be seen as a change, the shift from digital to virtual reality must be described as a revolutionary transformation.

2. Virtual reality cinema: VR film

2.1. The development of VR technology

Virtual reality films are produced, distributed, and shown using the capabilities of computers, information technology, gaming, and VR technology. Therefore, the technology used directly influences the form and narrative of the film. With every new technology that emerges, the boundaries of virtual reality films expand, and new elements are added to narrative and form. From this perspective, defining the historical development of virtual reality technology, the intersections and differences of its fundamental concepts, and its production, distribution, and exhibition techniques will serve as a guide in determining the direction of existing technology and narrative.

Although virtual reality technology has started to be used as a popular concept in cinema literature in recent years, the first steps of its technology date back to the 19th century [15], and the first steps of its idea date back to panoramic pictures that came into use in the 18th century [16]. The panoramic painting technique, patented by Robert Barker in London in 1787, is a new form of painting created by painting the interior walls of buildings in a horizontal perspective of 360 degrees, as well as using sophisticated lighting and special painting techniques to appeal to the imagination of the observer standing at the center point, creating an illusion of reality [17]. Although the panorama technique is an innovative technique in painting, it is not a new technological development. However, these innovative static frames, which evoke the sensation of being there, are considered the first steps toward the hyperreality created by virtual reality.

Developed in 1939 by Sawyer Photographic Company, View-Master displays two images from different angles to the right and left eyes, enabling the mind to perceive two-dimensional photographs as a three-dimensional spatial environment [14]. Developed as a commercial product and still available in working versions today, the View-Master is recognized as the first version and pioneer of the virtual reality experience.

Developed by American cinematographer Morton Heilig in 1957, Sensorama is considered the precursor to today's virtual reality technology due to its innovative technology [18]. Heilig used a special camera to shoot short videos, which he then showed to individual participants through Sensorama. The device offered users a three-dimensional, wide-angle color image, stereo speakers, fans to simulate wind, scent generators, and vibrating seats to simulate shaking—all of which could simulate not only sight and hearing but all the senses—in an individual theater booth [19]. However, it would not be accurate to refer to this technology as virtual reality. This is because interactive engagement and sensory feedback, which are the most fundamental components of virtual reality, are not present in sensorama technology [20],[21]. Nevertheless, Heilig, beyond being the most important researcher who laid the milestones for the long journey to virtual reality with his successive studies, is considered the father of virtual reality technology due to his many studies and devices on virtual reality. In 1957, he developed the sensorama simulator and, within three years, transformed it into the world's first head-mounted virtual reality headset, known as the Telesphere Mask [22]. The Telesphere Mask, which used a small stereographic video mask placed on the head, provided users with color 3D environmental images, binaural sound, taste, and smell, achieving an 80% sense of reality and becoming the first patented virtual reality headset [23].

In 1961, Philco engineers Charles Comeau and James Bryan developed a helmet called Headsight, which featured a video screen connected to a movable security camera and a motion tracking sensor [24]. This helmet contained a closed-circuit camera connected to a magnetic tracking system that moved the camera in three axes (pitch, yaw, and roll) [25]. When the user wears the device on their head and moves their head left or right, the security camera also moves in the x, y, and z coordinates, enabling the user to monitor their surroundings. This device is the first of its kind to connect real images with the human body, marking a significant milestone in VR history. The Headsight glasses were developed following motion capture studies, and the concept of alternative reality, which is now widely recognized, found its place in the literature. The Headsight device cannot teleport the user to another environment or virtual world since it can only display camera images. However, since the technology allows the user to control their visual experience, Headsight represents another significant step toward the discovery of new technologies [25].

Ivan Edward Sutherland, often referred to as the father of the Internet, computer graphics, and AR technology, laid the foundation for VR and AR concepts with his 1965 work *The Ultimate Display*, which promised an alternative reality unlike the physical images used up to that point [26]. Sutherland argued that there was no meaning in displaying pre-recorded video sequences through glasses or a desktop device and successfully demonstrated the display of graphics entirely generated by a computer using the glasses he developed. This invention creates a copy of the physical world and enables users to transcend physical boundaries. The aforementioned device is a new technology that stimulates individuals' senses in a way that enables them to perceive simulation as physical reality, granting users freedom or abilities beyond physical reality [27].

In 1970, Myron Krueger founded the first artificial reality laboratory under the name Videoplace, successfully transferring physical reality into a virtual environment and achieving real-time motion interaction in a virtual universe. Through his work, Krueger not only created a virtual world based on physical reality but also achieved the opposite of this system by beaming physical characters into a virtual world and creating real-time motion interaction in this new environment, thereby laying the foundation for virtual representation (avatar) studies [28]. Krueger contributed to the development of

AR and VR technology in two important ways. The first was to transport the physical world into a virtual environment, and the second was to create a multi-user interactive environment. Heilig's adaptation of the sensorama device into glasses led AR and VR technology toward an individual experience, and Sutherland's subsequent work also progressed in a direction suitable for the participation of only one individual at a time. However, Krueger's work demonstrated that multiple participants could also interactively exist in a virtual environment with virtual body representations.

Developed in 1985 at NASA's Ames Research Center in California for a series of space station applications such as simulating planetary exploration and training astronauts, the Virtual Interface Environment Workstation (VIEW) virtual reality headset is the prototype for today's headsets. Controlled by the user's voice or body movements, VIEW provides an interactive viewing environment that transmits multiple senses, enabling the exploration of distant virtual environments through wide-angle stereoscopic images [29]. In addition to being the first virtual reality headset with a portable screen, VIEW is also the first system to use gloves for sensory feedback. According to Fisher et al. [29], the gloves used in the system analyze the user's finger joint movements and transmit angle and direction data to the system. Thanks to this data, the user can interact with the virtual environment, manipulate virtual materials, send commands to the system with hand movements, and direct the system by pointing their fingers in the virtual environment. NASA engineers have combined Heilig's desktop devices converted into glasses, Sutherland's construction of a virtual environment on physical images, and Krueger's creation of virtual representations by transferring physical bodies into a virtual environment to create VIEW, a system that is wireless, high-resolution, interactive, and sensory feedback-enabled.

VR technology developed under the umbrella of universities or under the control of the military has become a commercial field that has attracted the interest of the private sector since 1990. SegaVR, announced by SEGA, a popular game development company at the time, was planned to be made available to the public as an entertainment tool, but technical problems encountered during development, challenges in developing games for the product, and reports of severe headaches and nausea among participants during testing led the company to quietly halt production before the product ever reached the market [30].

In 1995, Nintendo's Virtual Boy and Forte Technologies' Forte VFX1 were released as commercial products, but they failed to achieve the desired success. VR technology was not only extremely expensive for both manufacturers and users but also failed to meet the technical requirements desired by users. As a result, despite the emergence of literary works, films, and other art forms centered around virtual reality after 1995, VR technology was largely ignored by both manufacturers and users. The high cost of computer technology, the heavy weight and cable-filled nature of VR equipment, and the failure of VR technology to make the expected leap forward over time have contributed to its declining growth trajectory. The most significant user complaint regarding VR technology, and a primary issue with many virtual reality headsets even today, is that companies have been unable to adequately address headaches and nausea. The use of screens with insufficient resolution, processors with inadequate data processing speeds, and, more importantly, low refresh rates result in a lack of synchronization between the user's body movements and the virtual reality content. This lack of synchronization disrupts human perception, leading to dizziness and nausea.

2012 was a turning point for VR technology. The wave that was expected to bring about the resurgence of virtual reality came from developments in computer technology and the gaming industry. The widespread use of computers and the internet around the world and their emergence as a global market led many large companies to turn their attention to the IT sector. Desktop and portable computers equipped with graphics cards capable of displaying photorealistic visuals at over 120 frames per second and processors capable of handling highly complex real-time projects have been key factors in the renewed development of VR technology. On the other hand, advancements in display technology, the reduction of prices to segments accessible to end-users, and the availability of smooth visuals have positively impacted the development of virtual reality technology. Technological developments in desktop computers, portable devices, smartphones, and game consoles have increased the number of people who play games, and competition among game development companies has led to the emergence of many game development engines. Game engines such as Unreal Engine developed by Epic Games, Unity developed by Unity Technologies, and CryEngine developed by Crytek, which are among the most widely used globally and were originally developed for game production, now enable the design of three-dimensional models and the creation of fully interactive VR content by utilizing the engines' libraries. Therefore, the VR market, which was initially attempted by SEGA, Nintendo, and Forte Technologies in 1995 but proved technologically inadequate, has been made possible by information technologies and gaming industries, both in terms of technological infrastructure and user adoption, enabling the widespread adoption of VR technology.

Since 2012, VR technology has begun to use game engines developed and offered free of charge by the world's largest game companies for content production, while utilizing the hardware and operating systems developed by computer technology. These developments have eliminated the technical limitations in the production of VR film content and have been instrumental in the advancement of VR technology. Over time, VR equipment has become increasingly compact, wireless, and more portable compared to older models, while also becoming more affordable for end-users (Figure 2).

Figure 2. Virtual reality experience devices (VR glasses) [31]–[33].

Another significant step in the rapid development of VR technology as of 2025 was the decision of existing major technology companies to enter the VR market by providing products, content, and publishing platforms. In 2024, Companies such as HTC, Google, Playstation, Zeiss, RealWear, Goertek, Pimax, Pico, HP, Varjo, Lenovo Valve Index, Vrgineers, Sony, Samsung, Oculus, Meta, and Apple have produced virtual reality devices and content, which have increased interest in this field. Another significant factor in the widespread adoption of information technologies, computers, and virtual reality technologies was the global COVID-19 pandemic in 2019. During the pandemic, changes in the dynamics of remote work, education, e-commerce, digital shopping, entertainment, and social communication transformed the production, distribution, and presentation forms of many art disciplines and accelerated the normalization of digitalization.

By 2025, the number of companies producing virtual reality headsets will increase, and the equipment will become smaller, more portable, have higher resolution screens, and be usable for longer periods of time. The VR technology market, which is growing rapidly with the development of the gaming, computer and information technology sectors, is expected to increase from 7.3 billion US dollars in 2018 to 120.5 billion US dollars in 2026 with the innovations that VR headsets such as Facebook's Oculus Quest and HTC's Vive will bring to the gaming, cinema and entertainment sectors [34]. Investments in VR technology by popular companies such as Samsung, Meta, and Apple are also increasing the popularity of VR devices.

2.2. The key concepts

Virtual reality, after a long period of stagnation, has become one of the most exciting technology of recent years, benefiting from developments in information technology, computer technology, and display technology, particularly in the gaming industry. The interaction of VR technology with various disciplines and the technological advancements of the era have led to the expansion of its boundaries in every period, with new concepts entering the literature and intersecting at their common points. While new forms of reality that exist with current technologies and still continues to mature are expanding their boundaries and abilities by being influenced by new technologies that emerge every day, they are also collaborating with technologies that are similar to them.

Today, concepts such as Virtual Reality, Monoscopic VR, Stereoscopic VR, Augmented Reality (AR), Mixed Reality (MR), Extended Reality (XR), and 360-degree video format are often confused with one another due to the large number of elements in the aforementioned intersection sets.

According to Michael A. Gigante [35], VR is a multi-sensory, immersive, interactive, and user-centered three-dimensional graphical environment and the technology that simulates it. VR enhances the sense of reality in virtual worlds by manipulating the user's sensory, acoustic, visual, tactile, olfactory, and motion stimuli, thereby increasing the user's perception of the environment. According to Tomasz Mazuryk and Michael Gervautz [36], VR technology refers to immersive, interactive, multi-sensory, user-centered, computer-generated, three-dimensional environments and the entire set of technologies required to create these environments. According to J.M. Zheng et al. [21], VR is a simulated environment that allows participants to move around in an artificial world as they wish and view three-dimensional images from any angle, touch them, and redefine their current location. According to Kenneth Walsh [37], VR is a programmed computer that can generate a synthetic environment in which the user can interact. According to Roland Blach [38], VR is a display system created with three-dimensional graphic models that provides full interaction, immerses the user in a virtual environment, and allows them to manipulate it directly. According to Janet H. Murray [30], VR is an interactive virtual world created with computer programs and software.

Although there are some differences between definitions of VR in terms of technology and content, all definitions complement each other in terms of their core meaning. The common ground of the definitions is the simulated, interactive, and immersive virtual environment that provides the user with a sense of presence. Walsh and Pawlowski also categorize VR technology into three categories in their study *Virtual Reality: A Technology in Need of IS Research* [39]: virtual environment, interaction, and sense of presence. Roland [38] states that VR technology has three fundamental characteristics: 3D Representation and Perception, Real-Time Spatial Interaction, and Presence and Immersion. Zheng, who shares the same perspective as Walsh, Pawlowski, and Roland, also identifies the three main characteristics of VR systems as immersion, interaction, and three-dimensional virtual representation.

Virtual reality, which resembles the experience of dreaming, is a technology that allows users to experience real experiences in a virtual time and space where their connections to the physical world are almost completely severed [40]. Augmented reality (AR), unlike virtual reality technology, resembles hallucinations in a physical environment. Augmented reality, credited to Tom Caudell and David Mizell, differs from virtual reality in that it does not rely solely on computer-generated graphics but instead enhances physical reality with digital content, providing users with an interactive new digital reality [41]. AR is also defined as the enhancement of the physical world's reality through computer-generated real-time graphics [42].

Mixed reality (MR) is the combined use of AR and VR technologies and capabilities. Unlike AR, which enhances the physical reality experience with virtual information, or VR, which creates entirely computer-generated virtual worlds, MR is a new reality experience created by combining both technologies [43]. According to Zhigeng Pan et al. [44], MR refers to the addition of computer-generated virtual graphics to a real three-dimensional scene or the transfer of physical world elements into a virtual environment for experience. The first case is referred to as augmented reality, while the second is termed augmented virtuality [43].

The concept of Extended Reality (XR) is an innovative concept that brings together all immersive technologies. The XR concept is an umbrella term that encompasses all immersive forms, including AR, VR, and MR technologies [45],[46]. XR incorporates all the features of existing reality technologies and enables the seamless integration of these technologies [47].

2.3. Production method: Game engines

The rise of information and computer technologies in the early 2000s has profoundly affected not only the way many disciplines operate but also the form of game production. With the ability of computers, mobile devices, and consoles to connect to the internet, offline individual gaming has given way to online multiplayer formats enabled by cloud technologies. This format, which allows multiple players to play simultaneously, is enabled by game engine technology that supports real-time interactive gameplay and the simulation of physical laws. Today, all fully interactive VR content is also produced using game engine technology.

The capabilities of game engines directly influence the form and narrative of VR content. Therefore, examining the stages, limitations, capabilities, and qualities of the production form realized through game engines will guide the narrative method, language, and form of VR films.

The term "game engine" is defined in its purest form as a program or environment. Engines are programs or environments that bring together all the visual and technical tools necessary to create games and enable these tools to work together interactively [48]. Chaitya Vohera et al. state in their study titled *Game Engine Architecture and Comparative Study of Different Game Engines* [49] that six basic structures must be brought together to produce a game: scenario, physics simulation, animation, visual and audio elements, artificial intelligence, and real-time output. Each of these components can be produced independently using separate programs or software and then combined in a media environment to create games. However, game engines integrate all of this structure under a single umbrella.

Figure 3. Game engine companies [50].

Game companies have developed game engines that include templates that can be used for similar games as a result of the extremely high increase in the cost of software, design, animation, realistic physics simulations, and real-time output in each game they develop, and developers being unable to recoup all their investments with a single game [51]. Today, game engines such as Unity, Unreal Engine, CryEngine, Game Maker, and Godot, which are widely used as industry standards, are also accessible to individual developers (Figure 3).

2.4. Experience devices

Reducing the relationship between VR film and technology to a purely technical and instrumental issue, from the perspectives of both production form and experience devices, would be insufficient. This is because VR film production methods directly influence the content and form of the film, while VR equipment and VR experience devices also have a direct impact on the final work due to their technological capabilities. Artists throughout history have used the technological devices of their time to produce their works, and each new technological development has naturally reshaped both the work and the artist [52]. While technology creates new mediums for art, equipment and devices also give rise to new styles and forms of production. Sometimes, the work to be created paves the way for the production of technology or devices. Therefore, the relationship between technology, art, and the artist should be understood in two ways. The first is the effect of the technology used by an artist on the work, and the second is the effect of technological devices and equipment on the creation process of the work [53]. Since the capabilities of VR equipment and experience devices influence the content and form of VR films, as well as bringing about methodological and conceptual changes, examining the limits, capabilities, and qualities of equipment and devices will shed light on the journey of searching for the language and form of VR films.

Various experience equipment and additional devices are used to provide an immersive and high-quality VR experience. With today's technology, users can move and use all their senses in the virtual world through equipment and devices. Joshua Q. Coburn et al., in their study titled *A Review of the Capabilities of Current Low-Cost Virtual Reality Technology and Its Potential to Enhance the Design Process* [54], categorize the equipment required for this experience into two groups: basic requirements and secondary requirements (Figure 4).

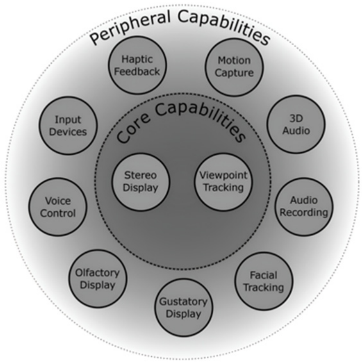

Figure 4. Components of VR experience [53].

Coburn and his team classified stereo screen and view tracking as basic requirements, while classifying tactile feedback, motion capture, 3D audio, audio recording, taste system, smell system, voice control, input devices, and face tracking as secondary requirements. Stereo screens, classified as a basic requirement, are necessary for viewing stereoscopic VR content, while view tracking is required for both the user's x, y, and z coordinates in the virtual world and for the representation of the virtual camera. View tracking ensures that the physical world appears in its correct coordinates regardless of the user's position. Different technologies are used separately or together to track movement in a virtual environment. In the first case (pan-roll-tilt), this is called head tracking; in the second case (pan, roll, tilt, forward/backward, left/right, and up/down), this is called positional tracking [54]. These two features, which are essential for experiencing VR content, have been combined in today's VR headsets. Therefore, the prerequisites for a VR experience are a stereo display and a device capable of tracking the user's field of view, which is the VR headset.

One of the important factors affecting the VR headset experience is the screen refresh rate. This is because when the refresh rate of the headset is low, problems such as dizziness, nausea, and vomiting, also known as VR sickness, occur. The main cause of these problems is that when the user moves their head from side to side, the image on the headset cannot keep up with the user's movement speed. According to Coburn et al. [54], "*if the system's response to head movement is too slow, it causes the participant to experience virtual reality discomfort, as explained above. The ideal latency should be 7-15 milliseconds. An important component of this latency is the refresh rate of a high-resolution screen. A refresh rate of 90Hz or higher is required for VR.*" Celine Tricart explains this situation in her book *Virtual Reality Filmmaking* [55] as follows: "*The brain uses information from the vestibular system to understand the body's position and its acceleration at any given moment. When this information directly conflicts with information from the visual system, it can cause symptoms such as nausea and vertigo. According to an unconfirmed but intriguing theory, this conflict leads to nausea because, long ago (several thousand years ago), humans were at risk of eating mushrooms. When the first symptoms were dizziness and a dysfunctional vestibular system, our bodies learned to automatically expel whatever was in the stomach to get rid of the dangerous mushroom, thus causing nausea. The danger has long since passed, but our bodies remember it, which is why some people experience motion sickness. In virtual reality, the participant's field of vision is completely filled by the virtual reality experience. When we move in the virtual world while standing or sitting in the real world, the conflict between what we see (moving in virtual reality) and what we feel (being stationary in the real world) leads to feelings of vertigo and nausea.*"

In addition to the basic requirements for a VR film experience, such as a stereo screen, view tracking, and high refresh rate, the way the headset communicates with other devices, and its weight also affects the experience. Today, to enjoy a fully interactive VR film experience, one needs a computer with a graphics card capable of processing high-graphics data connected to the VR headset via a high-speed cable. However, as the length of the data cable increases, its data transmission capability decreases proportionally, leading to delays and freezes. Therefore, the user of the VR headset will have limited freedom of movement within a restricted area, and the cable being directly connected to the headset will create a disorienting effect that disrupts the virtual experience every time the user touches it. Another important factor for the VR film experience is the weight of the headset. Although the weight of VR glasses has decreased to an average of 500 grams today, it is still one of the factors that negatively affect the experience of many participants. To overcome these negative aspects, many companies are developing headbands, straps, or cage systems that reduce the weight of the glasses. Secondary requirements for the VR experience, such as input devices, face tracking, haptic feedback, motion capture, 3D audio, sound recording, taste systems, smell systems, and voice control are simulators and additional devices that enhance the reality of the existing experience. These additional devices can be integrated into the system as needed based on the requirements of the VR content. In today's technology, 360 reality audio headphones, taste and smell simulators, full and half-body suits and vests, gloves, 360-degree chairs, treadmills, face masks, weapons, shoes, controllers, and triggers are used to meet these additional requirements.

The technology, connection format, and weight of the VR headset directly affect both the experience and format of the VR film, while secondary requirements such as experience devices also directly affect the experience due to their technological capabilities. This equipment and experience devices enable the user to use all of their senses within the VR film and directly affect the feeling of being there.

Figure 5. VR haptic feedback glove [56].

One of the most notable experience devices in the secondary requirement category for VR films is haptic feedback technology (Figure 5). In the 21st century, VR technologies have become highly advanced, offering extremely realistic visual and auditory feedback systems, as well as VR haptic feedback technologies that enhance the reality of virtual environments. Lu-Miao Liu et al., in their study *Haptic Technology and its Application in Education and Learning* [57], define haptic feedback technologies as *"enabling users to touch, manipulate them, and perceive the movement of objects and the tactile information produced during human-computer interaction.*" Tactile feedback systems used in VR systems to enhance immersion, interaction, and imagination are interfaces that establish communication between the user and the VR system, and they aim to elevate the interaction between the user and the film to a higher level [58].

Figure 6. VR smell simulators [59].

Smell simulators, which fall under the secondary requirement category, are another important device technology that affects the form and content of VR films (Figure 6). Erika Kerruish, in her work *Arranging Sensations: Smell and Taste in Augmented and Virtual Reality* [60], states that digital smell changes the dimensions of bodily perception in virtual reality devices. Smell technology has been experimented with in traditional cinema but has not found a permanent place in films, neither technically nor narratively.

In line with the content of the film, scents produced in a physical environment are added to the simulator in liquid or capsule form and then programmed in game engines such as Unreal Engine and Unity for use in VR films [61]. Unlike haptic feedback technologies, VR scent simulators are wireless and portable devices. The mentioned simulators communicate with VR headsets via Bluetooth technology and activate through pressure or electrical signals to deliver scents to the user using special oils, chemicals, or vapor. Through these simulators, it is now possible to experience the smell of gunpowder when a weapon explodes in a VR film, the scent of flowers while walking through a garden, the smoke of a burning tire, the freshness of the ocean, or various odors such as blood, vomit, or perfume [62].

The user's ability to smell scents within the film (even though today they can only be triggered 6 to 8 times at most) increases the reality and immersion of the virtual environment and makes the user feel even more like they are really there.

Figure 7. VR taste simulators [63].

Taste simulators, classified by Coburn et al. as a secondary requirement for VR, are striking components of both VR technology and VR films, promising to deliver real experiences in virtual environments (Figure 7).

While sight, hearing, and touch can be simulated in a virtual environment, smell and taste are produced in a physical environment and presented to VR users. Today, VR technology and smell simulations used in films consist of universally known elements that users have previously experienced. However, the sense of taste is an extremely personal sense, making it equally challenging to simulate. VR taste simulators are technologies that work by having users touch their tongue to a digital screen or stick, thereby recreating the sense of taste virtually. Nimesha Ranasinghe et al. describe in their study *Vocktail: A Virtual Cocktail for Pairing Digital Taste, Smell, and Color Sensations* [64] that they utilize three main elements to digitally simulate a flavor: smell, visual (particularly color), and taste. Ranasinghe and his team explain that to simulate the taste of an object in VR, they added the object's visual representation, taste (simulated by an electrical stimulator at the tip of the tongue), and smell stimuli (emitted by micro air pumps), thereby producing the object's virtual taste. The ability to taste virtual food in VR films transforms the film's virtuality into hyperreality while enhancing users' sense of experiencing physical sensations in the virtual world.

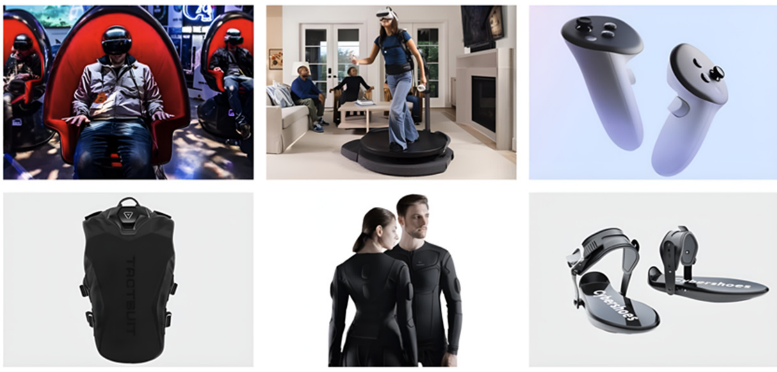

Figure 8. VR experience devices [65].

VR glasses and sound technologies, taste and smell simulators, and haptic feedback devices enable users to utilize all five senses within VR. In addition to these sensory technologies, additional devices such as 360-degree spatial sound headphones, full and half-body suits and vests, 360-degree chairs, treadmills, face masks, weapons, shoes, controllers, and triggers are also used to enhance both the realism and immersion of the VR film experience (Figure 8).

One type of haptic feedback device, VR suits use sensors to transmit virtual touches experienced by a character in a VR film to the physical bodies of the wearers. For example, in a fully interactive VR film, when a bullet hits the character or the character falls onto a hard surface, haptic feedback suits have the ability to transmit these impacts electrically to the physical body. VR suits not only transfer data from the virtual environment to the physical environment but also transfer data from the physical environment to the virtual environment. Clothing equipped with motion capture technology can transmit the user's x, y, and z coordinates in real time to the virtual space. This enables the creation of the user's virtual representations and their alignment with the coordinates of the virtual environment.

VR controllers and triggers are among the simplest and most basic devices in virtual environments. While performing basic functions such as touch, advance, pause, or trigger within a VR film, they can function solely as haptic feedback devices in the form of vibrations. VR chairs and treadmills, on the other hand, enable users to experience the 360-degree field of view more effectively and perform actions such as walking or running in all axes within the film. These devices, which enhance the reality of virtual representation, not only increase the reality of the virtual environment but also enhance the user's sense of immersion in the virtual world and the level of immersive experience.

The production, distribution, and screening of VR films utilize the capabilities of gaming technology, and the experience devices used in VR films are also equipment developed for gaming technology and the entertainment industry. Therefore, every new device developed for the gaming industry or VR technology directly influences the form and narrative of VR films, expanding their boundaries and adding new elements to their narrative and form. Beyond their significant influence on shaping the unique form and aesthetics of VR films, the technical capabilities of the mentioned experience devices and equipment directly impact the work itself due to their technological capabilities.

2.5. Searching for VR films in the light of traditional cinema

Virtual reality technology, one of the most popular discussion topics of the 21st century, brings a new concept to the cinema literature that breaks the monopoly of the magical screen: VR Film. VR films not only transport the traditional cinema's definition of the audience, the relationship it establishes with the audience, the audience's spatial experience, and the interaction between the audience and the visual narrative they witness into a new medium, but also construct their own unique digital narrative from a technological perspective by leaving out many concepts that form the building blocks of the conventional cinema form. Although the foundations of VR cinema terminology are still being laid, the intensity of work in the field is increasing day by day. The development of new fields and disciplines, the acceptance of their unique language and rules, and the widespread dissemination of the final work will inevitably take time. One way to avoid getting lost in uncertainty and darkness while working on a new discipline with undefined boundaries is to use the map of a known discipline, that is, to use the light of the known to explain the unknown. In this regard, using traditional cinema as a guiding line will help us understand VR films and explain what will happen in the future.

It is not possible to use many forms of the basic building blocks of traditional cinema such as framing, angle-versus-angle, continuity, editing, camera movements, optical movements, clear and blurred areas, 180-degree rule, 20% rule, 30-degree rule, subtitles and scrolling text in the storytelling structure of a VR film, despite them being the first images that come to mind when it comes to movies. However, it would be incorrect to view this as a limitation of the new technology. This is because virtual reality technology also possesses unique storytelling capabilities that are impossible to achieve in traditional cinema.

According to Michael Gödde et al. [66], the established rules of traditional filmmaking do not apply to VR films. The most important factor here is the 360-degree uninterrupted framing concept of VR films. There are two important questions to ask about the form and narrative of VR films: First, whether traditional cinema rules and forms can be used in virtual reality narratives, and if so, what form they will take; second, whether it is possible to create a new form of storytelling using only virtual reality technology, without drawing on the legacy of traditional cinema. Simone Arcagni and Adriano D'Aloia express this debate in their work VR Storytelling: Potentials and Limitations of Virtual Reality Narratives [67] as follows: *The virtual reality environment has its own uniqueness that inevitably influences narrative forms. Therefore, we need to explore the narrative forms it employs, which are likely related to the language of cinema and draw their power from the same foundation, yet develop along different trajectories, thereby exhibiting distinct connections and affinities. In particular, they will demonstrate the need for a critical reframing of much of the contemporary discourse on virtual reality in order to think more objectively about complex concepts and dynamics such as the screen, interaction, immersion, presence, materialization, illusion, and empathy.* As Arcagni and D'Aloia put it, trying to apply traditional cinema language to VR films would be a reductive approach. VR films should be seen as a new field of experience rather than a continuation or heir to traditional cinema. VR films break down the two-dimensional structure of traditional cinema and transport the story to another medium, offering the user a three-dimensional spatial experience. The mathematics of reducing a three-dimensional world to a two-dimensional plane and the dynamics of designing a world in a three-dimensional virtual universe are inevitably different from one another. Therefore, one of the first issues that must be examined to understand the VR film form is the necessity of rethinking, redesigning, and redefining everything we know about the frame in traditional cinema in VR films.

In traditional cinema, the functionality of the frame goes beyond technical issues and is used as a tool for creating meaning and expressing the director's point of view. Although the mental boundaries of the traditional cinema screen, which has a two-dimensional plane, can be transcended, it has sharp boundaries in technical perspective. Whether in a theater or in front of a screen, cinema viewers look at moving images that appear the same to everyone from a safe distance within the confines of this rectangular intersection. VR films transform the building blocks of traditional cinema—the two-dimensional plane, sharp boundaries, safe distance, and the act of looking—into a story-telling form unique to their technology: three-dimensional space, 360-degree framing, and the act of experiencing a position within the film. While viewers have been watching flat screens for decades, VR films offer users the opportunity to experience film spaces in physical reality with their three-dimensional structure. As Bucher [68] also states, the idea of real spatial perception is based on the user being able to move around as they wish within the film. In this new film format, the focus is no longer on storytelling, but on creating an intense experience for those who experience the film [69]. With three-dimensional spaces and 360-degree uninterrupted framing, VR film tools allow for a new level of intensity. According to Pillai and Verma [69], VR storytellers are exploring ways to capture this intensity we have not yet experienced, and VR technologies are creating a more powerful narrative form than any other medium.

The most important feature that distinguishes VR film narrative from traditional films is the 360-degree uninterrupted frame. When compared to traditional cinema, this may seem like a technical quirk, but the user's ability to move around freely within the film and experience a 360-degree uninterrupted frame fundamentally changes the traditional concepts of audience and director. The viewer, upon putting on the virtual reality headset and disconnecting from the physical world, enters a three-dimensional space and is directly immersed in the film. The three-dimensional spatial structure of VR films brings with it a 360-degree frame instead of a two-dimensional plane, an unprotected position within the film instead of a protected environment, and a personal experience instead of the act of watching. The narrative structure of VR films, their use of time and space, and their interactive form, in contrast to the passive and protected state of film and television viewers, actively involve VR viewers in the narrative and indicate that they should be defined as participants beyond traditional viewers. From another perspective, in a medium where the VR user is so active, this new form presents a series of challenges and opportunities for the designer, as opposed to the traditional storyteller. Rather than defining the VR storyteller as a director in the traditional sense, it is necessary to describe them as a narrative designer, experience designer, story developer, or content creator. In traditional film, all the dynamics of the visual world created by the director are based on the frame of the rectangular screen. While the director constructs the story according to the dynamics of this limited space, the audience experiences the story told by the director through what they see on the screen and what they imagine outside the frame [68]. In this structure, the concepts of viewer and director are sharply separated. However, unlike classical narrative, there is no frame in VR films, and the user experiences the film rather than witnessing it [69].

VR film users have almost complete control over the film with a 360-degree frame. In addition to being able to look freely to the right, left, up, or down using their body or head movements, users can physically move in the x, y, and z coordinates to change their perspective. Therefore, when the user wants to get a closer look at an object within the film, they can physically move toward it, or when they want to look at a character, they can turn to the character. All control over the viewpoint is in the user's hands. Compared to the passive viewer of traditional cinema, who witnesses moving images on a screen from a safe distance in a protected environment, the VR film user is in an active position due to their mentioned control over the film [40]. The passive position of the traditional cinema viewer does not mean that the viewer cannot communicate or interact with the film. This is because the traditional cinema viewer also interacts and communicates with the narrator through the film. However, they are engaged in the act of watching, beyond touching the film. The VR film user, on the other hand, is in an active position because they can completely personalize the experience, including the flow of the film, through their choices. In traditional film understanding, there are two types of editing forms: Cutting or Linking. In both of these methods, which have entered the literature as formalist and realist theories, the director makes selections from an existing world and presents them to the audience in the form of a frame or window, as detailed in the previous section. The traditional audience is forced to witness the selected images, which are considered the director's dream. However, in VR film, the user makes their own choices. The user can look at any object from any angle for any length of time, thereby going beyond simply directing their own film to create their own personal narrative and individualize the film. The fact that VR film opens up such a wide space for the user not only places them in an active position but also increases their control over the film and strengthens their power against the narrator's hegemony.

The capabilities of virtual reality technology can be seen as merely changing the existing storytelling form of cinema, but this is a thorough transformation rather than a simple change.

3. Conclusions

Since the very beginning of human existence, individuals have continuously sought new methods, formats, and narrative forms to express themselves. Cinema, which emerged at the end of the 19th century and rapidly evolved into a major industry, provided an unprecedented mode of storytelling through novel techniques and methods. With each successive technological advancement, this dynamic art form has not only overcome its initial limitations but has also continuously expanded its expressive capabilities. Today, the growing popularity of cinema—among scholars, storytellers, and audiences alike—demonstrates its increasing significance as one of the most powerful visual and auditory communication tools of the modern age. In this context, the ongoing integration of cinema with new technologies continues to foster innovative narrative structures, formats, and modes of expression.

In the 21st century, when we think of cinema, we still think of the place that is considered to be the director's dream, consisting of red velvet armchairs lined up in front of the magical white screen where moving images are watched, but it is seen that film watching practices have largely evolved into an individual viewing with portable devices through digital media. However, today's wearable virtual reality technologies offer a new form of storytelling: VR film. Rather than seeing this new form of storytelling as a continuation of traditional cinema or a structure that will replace traditional narratives, it is necessary to redefine it as a new art form. Just as photography did not replace painting, cinema did not replace television, and new media did not replace conventional broadcasting, VR films will not be the continuation or the end of traditional narratives. Every time a new art form is created, it does not necessarily mean that it replaces another, but that it rather encourages innovation. However, as in any discipline, until a new form finds its own path, it is compared to other similar forms, and the new form, whose capabilities and limits are not yet fully known, is tried to be understood by starting from a known structure. In this context, using the traditional cinema form as a guiding line will help to understand VR film and what might happen in the future.

As one of the 21st century's most popular concepts, virtual reality technology not only affects many art disciplines and changes the way works are produced, distributed, and screened, but also offers filmmakers and directors a new form of cinema to tell their stories. This new form in question, rather than continuing the conventional two-dimensional form of visual storytelling or the existing technical and aesthetic understanding of traditional cinema, reveals a new form and aesthetic understanding with its technological capabilities.

Today, since the relationship between virtual reality technology and cinema is still in its early stages, the discussions on VR cinema in both national and international literature have not settled on a specific axis. Since every new development in virtual reality technology or every new experience device produced directly affects the structure of VR films, academic discussions on VR cinema are constantly renewed and updated.

As a result, with its technological infrastructure, VR films not only carry the traditional cinema's definition of the audience, the relationship it establishes with the audience, the audience's experience of space, and the audience's interaction with the visual narrative it witnesses to a new environment, but also builds its own unique digital narrative in the perspective of technology by excluding many concepts that constitute the building blocks of the conventional cinema form.

4. Author contribution statement

All authors contributed collecting data, writing of the article, and evaluation of the results equally.

5. Ethics committee approval and conflict of interest statement

This study has no conflict of interest with any person/institution. There is no need for ethics committee approval.

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