Integrated Application of AR Technology Development and Drama Stage Design

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With the continuous development of science and technology in China, more and more high-tech tools are appearing in our lives, one of which is AR technology. Augmented reality is now widely used in gaming, e-commerce shopping, and interior design. With the development of digital media technology, contemporary theatre design often incorporates new technologies, one of which is augmented reality, which uses Internet of Things (IoT) technology to build different devices onstage, allowing images from computers to be shown virtually on stage. Augmented reality technology can enhance the appeal of theatre and create a new theatre atmosphere for the audience. At the same time, the deep involvement in the narrative is conducive to the creative transformation and innovative development of the art of theatre in the new media era. The following question is how to make AR technology more suitable to enter the theatre without dramatically affecting the core content of the play. This study will elaborate on the media characteristics and interactive relationship of AR technology and analyse and demonstrate the expansion space brought by augmented reality technology to theatre art by some case studies. In addition, it also attempts to put forward some ideas and suggestions on design aspects such as presentation, communication, and styling and to study the pros and cons of the new technology on theatre stage design so as to make a judgement on the future prospects of AR technology in a wide range of entertainment applications.

1. Introduction

In recent years, AR, also known as augmented reality, has been mentioned in the development strategies of major technology companies around the world, and the two are inextricably linked [1]. VR/AR technology is evolving at a mind-boggling pace, bringing a new, more intuitive, and accurate way to interact with virtual data in an age where people are no longer limited to the size of traditional displays and where VR/AR technology will be increasingly used in our lives due to its specificity and broad application potential [2]. Therefore, AR technology will no longer be limited to a specific field in the future, but will have a huge strategic value globally, and it will become a technology, a new way of life, and a technological revolution that drives the economy [3].

In 2018, an AR play called "Gulliver's Travels" was staged in a theatre in Tel Aviv, Israel, to good acclaim (Figures 1 and 2). This combination of digital media technology and traditional children’s theatre is a new way of presenting theatre. The traditional theatre stage takes the form of a framed stage performance, with the set mostly placed within the framed stage [4]. Generally, traditional scenery mainly includes hard scenery (flat films, three-dimensional scenes, and three-dimensional combination scenes) and soft scenery (painted canopy, curtains, gauze painted scenes, net scenes, and rope scenes). In recent years, some forms of theatre scenery are no longer limited to traditional forms and traditional stage spaces, some have stepped out of the box and filled the theatre with immersive experiences, some have turned traditional scenery into a fusion of mechanical equipment and projected images, and some have even started to be minimalist, using digital images in some scenes. VR’s
Institute presented an experimental play called “Wings.” “Wings” uses modified i-glasses (head-mounted displays), AR glasses with a semisilver-plated mirror, and two small LCD screens, from which the stage and the LCD images reflected in the mirror can be seen from the audience; the sound of the headphones is also combined with the real voices of the actors onstage. Through this special way of viewing, the director hopes to allow the audience to step into Emily’s chaotic inner world and immerse themselves in Emily’s character, feeling her anxiety and confusion [5]. Although AR technology has developed rapidly in recent years and has been embedded in some theatre stage designs, there is still a series of contradictions that prevent it from being widely used and produced.

2. Overview of Relevant Theories

2.1. Media Effects of Augmented Reality Technology. Augmented reality is a technology that calculates the position and angle of a camera image in real time in real images and imposes corresponding images, videos, and 3D models. The goal of this technology is to superimpose virtual worlds into the real world on the screen and be able to interact with them. Simply put, the main function of augmented reality is to superimpose virtual information in the real world and make a certain virtual picture combined with the real picture.

Similarly, as a new form of media, augmented reality has its own unique series of advantages. First, augmented reality can have a very low impact on the real picture while delivering information. Augmented reality information is often displayed in two ways. One is to collect real images through the camera and to fuse the screen with the virtual part, and the other is to project the information directly onto the glass or other media to form a translucent lighting effect. Each form is based on the lack of affecting users’ judgement of the real world. For example, the AR navigation function currently used by Baidu Maps ensures that people can see the road ahead, identifies the space, marks the direction arrow close to the ground, and surrounds other information around the edge of the screen. The on-board HUD system is similar to Baidu Maps, with glass as the medium for real driving information, and the appropriate opacity is set without affecting the driving safety (Figure 3). Second, augmented reality can achieve a better sense of presence and interaction. Based on different sensors or interactive devices, users can more intuitively and easily operate a series of product functions provided by the platform. In addition, augmented reality is still a relatively popular selling point at this stage, and through the definition of hot words, projects involving augmented reality will receive wide attention. For example, Apple has been implementing the AR function, which can realize AR virtual modeling, distance measurement, interior design, and other functions only through one mobile terminal (Figure 4).

Technically, augmented reality can be used to enhance the sensory experiences of human vision, listening, and touch, allowing the audience to experience a mixed reality state between being completely virtual and reality. ([USA] Kipper, Lamborah. An Introduction to Augmented Reality Technology [M]. Zheng Yi, translation. Beijing: National Defense Industry Press, 2014.) It is for this reason that augmented reality improves users’ immersive experiences to some extent, allowing them more opportunities to interact with the platform and pay more attention to the information presented. Therefore, to a large extent, augmented reality can appear as an auxiliary media form in many fields, especially a series of entertainment platforms, but currently there are few cases of using augmented reality on the drama stage.

The AR ecosystem has taken shape and has a wide scope for development. The authors of this study believe that the development of application technologies on VR smart terminals is an inevitable trend for the development of AR technology in the future. However, the present AR smart terminals have problems such as low resolution, delayed vertigo, and poor rendering performance, which will become bottlenecks for the rapid development of AR technology.

AR theatre is a product of the development of AR technology, and with the continuous development of AR technology, AR theatre has taken on different forms of expression in various periods. AR technology applied to theatre creates new forms of theatre and new languages, creating infinite possibilities for the theatre. The narrative theory of AR theatre still needs to be constantly summarised and improved in the continuous innovation and exploration of AR theatre in order to promote the development.
2.2. The Internet of Things in AR Technology. The key technology in AR technology is the Internet of Things (IoT), while IoT is a technological revolution that will be the future. In the era of IoT, the next generation Internet can facilitate the coordination and communication between people, society, and intelligent things. At present, the research on IoT is mainly conducted from the association and processing of things, while relatively little research has been conducted on the human and social aspects of IoT. Intelligent and network as its basic support, the IoT is making a new wave in today’s world, and it has formed a complete set of sensing systems with social attributes. Most IoT research ignores the direct or indirect connections between sensing devices, i.e., with the people around them, or even with everyone in the entire IoT. In networking, stage AR is a collective term for the various relationships between devices on the stage. In the IoT, theatre stage device relationships are object-to-object relationships, with connections between objects through relationships, attributes, functions, and other factors.

3. Introduction to Application Methods

3.1. IoT Device Data Collection. This AR device data collection was carried out through IoT technology. The target objects in an IoT system have their own unique identification characteristics and are associated with their targets through wireless and wired networks, thus forming a virtual network similar to the Internet [6]. The nodes of the IoT include the objects themselves, the target identification, and the sensors, all of which are made up of physical networks. Information data collection in the IoT is characterised by the following:

1. The geospatial distribution of IoT nodes is real, so the geographical distance of each node reflects its geographical relevance
2. The sensors in the IoT nodes have a certain radiating area in geographic space, so the coverage of the nodes is limited within the geographic area
3. Different sensors are configured by the same nodes and process different data so that they can enhance or complement each other, thus making the information collection by the network nodes more reliable and stable
4. The nodes themselves gradually evolve towards an embedded system with an independent set of data processing functions that can complete requests to the server as required and send relevant information to the server as required, thus reducing the communication between the nodes and the server
5. Data requests are triggered by events and events related to both the node, sensor type, and time, and the relevance of these events to both the node, sensor type, and time determines the amount of data to be uploaded
6. As the amount of data uploaded by a node increases, the more information is obtained and the more valuable information is collected

With the continuous development of embedded systems, the computing power of network nodes is increasing, and their main functions include data storage, information filtering, setting collection cycles, and transmission. Therefore, when the server passes the requested information to the node, the node can provide the corresponding data to the server according to the required information. In addition, as IoT nodes gradually develop towards multidimensionality, they are able to meet different state requirements and provide corresponding information, making them complementary and verifiable in the collection process, thus further enhancing the trustworthiness of the IoT data.

Figure 5 depicts the basic principles of IoT information data collection in this AR choreography design, which uses event triggers to send requests to the nodes and corresponding sensors. The node itself is able to process the data, obtain the specific request from the server, and complete the collection of the required data using functions such as information filtering and then transmit the collected data to the corresponding requesting server.

3.2. AR Technology and Theatrical Stage Design. Augmented reality technology, similar to other digital media technology, can create a new drama atmosphere, show the narrative space with stronger drama tension for new audiences, and boost the innovative development of drama art. However, some drama critics believe that the addition of new technology hinders the spread and interpretation of the drama itself. At present, AR technology is being
incorporated into drama. The aforementioned Israeli AR children’s “Gulliver’s Travels”, which requires people to sit in the theatre and wear a pair of glasses to see the final composite effect of virtual images and real performance. This form is still rare in the two major producers of Britain and America. Incorporating AR technology into drama is in the process of encountering a series of problems, especially in stage design such as how to reasonably balance the modern style and the traditional style and how to balance form and content.

In 1987, the School of Drama at the University of Kansas in the United States began to explore how to apply computer animation technology to the theatre stage. With the emergence of virtual reality technology, since 1992, the University of Kansas established a virtual reality theatre art called, i.e., VR, Research Institute, and launched The Adding Machine, Wings, Tesla Electric and Machinal, and three experimental plays of hybrid VR technology. Similar to now, virtual reality technology at the time meant that viewers could change their perspective in a computer-modeled 3D image and have the illusion of “walking through it.” The application of virtual reality technology in drama, no matter at that time or now, refers to adding some virtual elements composed of computer images on the theatre stage, such as computer synthesized backgrounds or virtual actors(Figure 6).

Due to some immaturity of AR technology, visual angle, resolution, environmental adaptation, and other aspects are not perfect. At present, there are a few cases of augmented reality application in drama, but it can be explained through some other performance cases. For example, at the Suning Tesco 1031 Super Show party on October 31, 2020, Xue Zhiqian performed “Foreign Things” and the martial arts program “Heroes of Heaven and Earth” at the Spring Festival Gala in 2021. In 2004, Shanghai Theatre Academy began to engage in the application research and creative experiment of new media technology in stage art creation. In December of the same year, the Shanghai Key Laboratory of
Multimedia Virtual Space Synthesis was officially established. At present, the laboratory has been approved as the key laboratory of digital performing arts integrated innovation by the Ministry of Culture. In the past 12 years, he has also created a number of new media stage art works. Among them are the large-scale multimedia musical “Guanyin Bodhisattva” (Figure 7) and the new media dance poem “Extreme Realm” (Figure 8).

Such performances are mainly through early modeling and positioning, real-time synthetic rendering during live broadcast, output to the client to watch, and spread through mobile phones and other media.

4. Comprehensive Application of Modern Technology and Traditional Sets

The drama stage design itself is designed through the interpretation of the drama’s content and combined with the stage designer’s own style. At present, the rapid popularization of modern digital image technology has been widely involved in various stage performances. The drama stage is more suitable for the application space of new technology. The support of new technology will contribute to the long-term development of drama art. However, it is precisely because it belongs to the traditional performance form that there will be some contradictions in the process of integration. First of all, there are many set forms of traditional dramas, divided into realistic sets and nonrealistic sets, made by hand painting or modern industrial technology. The various components of the stage set need to meet the overall style requirements. Take the 19-year version of Turandot performed at the Metropolitan Opera. The story of Turandot is set in the east of the Yuan Dynasty (Figure 9). The protagonist is a Yuan princess named Turando. Therefore, the stage designer chose to restore the imperial palace of the Yuan Dynasty to the real scene. The selected materials are mainly wood and stone, the color is inclined towards wood and gold, the stage structure is mainly a real model. They tried 1:1 to restore the interior of the palace, including pillars, thrones, and steps. Professor Hu Zuo of Shanghai Theatre Academy also mentioned in his “Stage Design”: for stage design, unity is to form the various visual elements into a unified whole. Like other plastic arts, to achieve the unity of the visual form, it must consider the unity of the modeling form, the material, the unity of the color, and the relationship between the whole and the local and the primary and secondary relationship. When AR technology participates in the design of a drama stage, designers should pay attention to ensure the unification of style. The unification of style is derived from the unity of material, color, modeling, and other aspects. The large use of AR technology to achieve the effect of the stage and a large reduction of the traditional set way help to improve the unity of the overall texture. The set of the AR play “Gulliver’s Travels” is an empty environment. The three-dimensional model set is designed in advance on the computer, and it sets the time and place where these digital background pictures appear, so as to create a unified visual style. In the design process of AR images, it is necessary to maintain the same style of the design as far as possible, especially when the AR technology or other digital image forms are used for stage design, and the combination of the traditional scenery is very important. A whole is often not just a simple sum or sum of the parts, the various parts of the whole are determined by the internal structure and nature of the whole. Therefore, according to the theory of the gestalt organization method, people always organize empirical materials into a meaningful whole in a certain form in visual perception. To put it simply, in terms of stage sets, when people watch a whole performance, they will classify the different set parts according to certain rules. If they want to form a unified style, they need to reduce the media types of stage design as much as possible.
choose the digital image style to create, we design around it as much as possible.

The traditional drama stage design style includes both realism and freehand brushwork, especially in Chinese opera, where there are many freehand brushwork scenes. In terms of style selection, most of the stage design needs to be planned and combined with specific scripts in the early stages, and AR technology is not suitable for dramas with various themes. The traditional set style can satisfy most of the realistic style of drama. However, some romantic works may require some special effects, similar to the special effects in movies, to further enhance the atmosphere. Before determining the stage style of the play, it is more important to communicate with the director and determine the presentation style of the play in this performance. Relatively speaking, realistic style works may not require the substantial participation of AR technology. Moreover, the current augmented reality technology is not necessarily suitable for the construction of realistic styles. Some romantic or fantasy plays are more suitable for using AR technology, using a series of similar visual effects as film special effects to present the stage design with impact and immersion. For example, in Gulliver’s Travels, the dwarf and the giant need to have a strong size comparison, which can intuitively present the real “dwarf” and the virtual “giant” picture to the audience.

5. The Balance of the Form and the Content

In The Art of Theatre Art (Theodore Shank) writes, “the purpose of a theatrical artist is to use any and all possible resources to present virtual behavior as direct, visible, and audible experiences.” The full value of drama lies in whether the stage resources can be effectively used to simulate the “real” world outside the stage, making the resonance and empathy between the audience and the drama. AR technology can enhance the organic connection between the audience and the drama. AR technology can provide a stronger sense of atmosphere and immersion. Creators can use the space of the entire theatre to produce a more immersive atmosphere device, setting the entire theatre environment in a certain theme. The intervention of augmented reality technology and virtual images strengthens the audience’s immersion. He Wu and Zhou Yue from Sichuan Normal University expressed the stage set design and artistic conception based on mixed reality technology, which expanded the physical and artistic space of the stage. The set range is no longer limited to the stage area, but extends to the entire theatre. With the support of 3D projection technology and virtual reality technology, the theatre can be set inside. With the theatre stage as the center, the set range radiates outward, and the set is integrated with the real space that the audience is in. The appropriate stage atmosphere also allows the audience to fully immerse themselves in the drama performance. These added virtual parts can further enhance the atmosphere brought by traditional lighting. With the addition of AR technology, the performance space of drama can also expand the performance elements. For example, add some theme elements related to the drama content to the wall or some translucent visual effects. In this way, the whole theatre environment can be integrated into the performance of the whole drama theme, thus eliminating the alienation effect of the “fourth wall” to some extent.

At present, the balance between form and content is common in new media dramas. The application of AR technology faces the same problem in drama stage design, and more attention should be paid to the balance between the two [7]. The domestic drama market is relatively small, and there is a small audience, aging, theatre decentralization, and other phenomena. Drama creators try to explore new media dramas in order to adopt some new technologies to attract more audiences. AR, or augmented reality, is currently a popular technology that will attract more attention and is more acceptable. This situation has parallels to some Hollywood films. In recent years, more and more sci-fi blockbusters, such as the Avengers series, have invested a lot of money in visual effects. In terms of perception, it is indeed well-made and broke many box office records, capturing a large number of new audiences who have not seen the original manga. However, the story line is relatively flat. For Martin Scorsese, director of “The Walker” and “The Wolves of Wall Street,” these simply cannot be called “movies.” Compared with the dramatic art, the audience’s aesthetic acceptance psychology is limited by its own historical conditions. The application of AR technology is in drama stage design. At present, the exploration of slightly more than content is temporarily beneficial to the popularization of drama, but its disadvantages may reduce the artistic quality of drama itself. The Chinese dramatist Mr. Jiao Juyin said, “The two major departments of stage performance are the category of human performance, and the other is the category of material image.” This large quantity and category are integrated together, which becomes the image of the whole performance. When the two parts can be properly combined, an excellent comprehensive art can be formed. The creation of drama content often occurs when the playwright hopes to imitate and express some things and behaviors in human life through the form of drama. For dramatic art, AR technology is a means to assist the narrative. Its function should help to weaken the obscurity of dramatic expression, make the abstract lines and dramatic elements concrete, and thus arouse the resonance and empathy of the audience. Instead, we should not blindly pay attention to the formal beauty through AR technology and ignore the dissemination of the content of the drama itself. The application of AR technology also needs a longer time to make digital media more effectively integrated into the drama stage [8].

AR drama is still in the stage of exploration and experimentation [9]. As far as the current situation is concerned, AR drama is a new form of drama art that uses the characteristics of “AR narrative” to create and perform and has the characteristics of immersion and interaction. It has a narrative story ending, but the presentation and the
audience’s viewing form have changed [10]. Compared with traditional plays, movies, and dramatic literary scripts, it has its distinctive features, see Table 1.

Modern society itself has a certain impetuosity. People’s life pace is gradually accelerating, leading to people preferring “fast food culture.” Although this is an unavoidable objective situation, the appreciation and pursuit of elegant art is always in the mainstream of people’s spiritual lives. For drama art at the top of art as a spiritual product rather than a simple entertainment tool, the creators are required to grasp the organic balance between modeling media, stage form, and drama content.

6. Conclusion

With the development of virtual reality technology and its universal application in various fields, traditional media and traditional art forms are also facing this transformation and inheritance. In the process of integrating the present AR technology into some offline entertainment activities, especially in some theaters, there are still some objective conditions restricted. For example, its positioning accuracy and development and promotion costs. More importantly, for traditional art creators, they are skeptical of accepting the new technology. For example, in the eyes of some drama workers, this may not be a real drama, but may belong to another art form. The involvement of AR technology blurs the boundary between drama and movies or games. The development of AR technology is also the only way for the evolution of communication media, and its unique way of information presentation method can provide more possibilities for different fields. For creators, more advanced media forms can enhance the interest and topic of their works themselves. In the works of art, technology always serves as the artistic content. “Only technology theory” obviously does not work. It can be integrated with the content, style, and theme of the program, and only the technical means to add color to the program can achieve the integration effect that complements each other.

Although AR technology has gradually matured, its application on the stage can still be further expanded.

6.1. Let AR Multiscene Perform Virtual Fusion. At this stage, AR technology is basically the fusion of a scene and a real stage. In the future, it could be integrated with multiple scenes to achieve more exciting visual effects and enhance the sense of art.

6.2. Enhance the Expressive Effect of the Stage. AR technology can make its scene wider in the future. The effect achieved by the present AR technology may only be a part of the stage. In the future, the entire stage should be able to experience the effect, including the auditorium and guest seats, while creating a more poetic and picturesque scene. The effect allows the audience to experience the visual impact.

6.3. Optimizing the Cost of AR Technology. At this stage, although AR technology can bring us a very strong stage effect, the cost of AR technology is still very high, so under the future trend, the cost of AR technology application should be further reduced so that AR technology can be more applied on the stage.

It is expected that, in the future, VR/AR/MR, holograms, engine animation, virtual idols, and artificial intelligence can be perfectly combined with a series of art forms so as to derive new art forms with various forms and unique styles and realize the creative transformation and innovative development of drama art, which is also the development of new media.

Data Availability

The data used to support the findings of this study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflicts of interest.

Acknowledgments

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References


Table 1: Comparison of narrative features.

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Table 1: Comparison of narrative features.