Proceedings of the 2023 International Conference on Software Engineering and Machine Learning
DOI: 10.54254/2755-2721/8/20230151

The application of VR in game design

Minyi Li

University of Wisconsin-Madison, Madison, WI, 53715, USA.

mli675@wisc.edu

Abstract. As VR has been applied into many fields, and in recent years, video game developers tried to use VR in game deign because they always looking for new technology that can give players a better experience. This paper introduces the reason of why developer choose VR including the evolution of hardware, game design principles, cross-platforms, and combination of video game and health/education. Specifically, this article focuses on how virtual reality has become a part of the gaming landscape through the history of video games. Then, this paper analyses the contribution of VR to game design and the application of VR in cross-platform is described. Finally, here are some examples of how VR games can help people in other fields. The application of VR still has many exist issues that need to be fixed, but its benefits are irreplaceable for new game style and performance. In the end, this paper summarizes the research content and prospects the future.

Keywords: game design; VR; cross-platforms; video game.

1. Introduction

Virtual Reality, known as VR, is a technology that allows people to experience another real world different from the one we are living. VR has been developed for about half century, but it only became popular in the public for about a decade ago. At the beginning, VR aims to make new solutions in different fields such as medical, military, and industry. In 1990s, some companies designed commercial VR and tried to promote it into the public [1]. However, due to the immature technology in both computer science and VR field compared to today, the cost of VR is very expensive. After a long period of technological development, VR finally became more popular for us in 2010s. Today, VR not only still plays an important role in those fields in the past, but also break new ground for new fields. In video game fields, developers are always looking for new technology that can give players a better experience. During the way of exploring, VR is one of the technologies that developers that want to implement into game world. As a result, many VR game devices are designed, and many VR games are created.

The relationship between VR and game field are more complicated than above simple introduction. Therefore, in this paper, the main topic is why the game field chooses VR as a tool for better experience, and what benefits the game field has gained after using VR. To be more specific, this paper will first talk about how VR gradually became part of game field through video game history. Next, how VR make contributions from game design perspective will be explained. Then this paper will expound the application of VR in cross-platform. Finally, this paper will give examples of how

DOI: 10.54254/2755-2721/8/20230151

VR games helps people in other fields. Through those ideas, this paper will summarize why the application of VR to the game field will help the development of it.

2. Game history and the emergence of VR

In any specific computer science, the development of software and hard core always complement each other. For video games, this means that both the creativity of the game and the flexibility of the hardware are important. In the last century, when video games were just beginning to emerge, hardware technology was immature. Therefore, game developers at the time always tried their best to make games as impressive as possible in limited computer storage. Arcade, as a mainstream game carrier in the past, although it gives game developers a certain space for creativity, the hardware performance is not satisfactory. In order to allow video games to show better graphics, and to allow people to enjoy video games in their own homes, consoles were invented [2]. To this day, many companies around the world have developed consoles. Some of them, like Atari, have already withdrawn from the competition, while others, like Sony, Nintendo, and Microsoft, have established themselves in the console field through continuous iterations. Consoles aren't the only video game carriers, however. The development of PC has not been stagnant, and because of its long-term excellent hardware performance, many video games also are chosen to develop on PC. Compared with the console, although the PC does not have a fixed hardware configuration, if players are willing to buy more advanced hardware equipment for their PC, the performance of some video games will be significantly better than the console. However, whether it's an arcade, console, or PC, people get the picture by looking at a display. Getting an immersive feeling is what many developers want to bring to players for a long time, but no matter how realistic the picture is, simply pressing a button and looking at the screen only bring limited feeling. During the exploration of hardware, VR entered the developer's sight.

Technology is not the only thing that needs to be evolved in VR, people is also required to be considered. As VR creates a world with reality that separate from real world, players will not feel fully immersion no matter how good the game and device are since players' bodies are still in the real world. If this problem is not treated seriously, it might cause future serious issue or even damage to users [3]. In 2022, multiple Australian universities researchers formed a team to investigate the symptoms that will occur to players after using VR for a period of time. To maximize the objectivity of the experiment, 40 gamers and 40 non-gamers are formed two different groups, and both groups played games under same conditions and amount of time. The main observation of the research showed that all players experienced significant cybersickness after 30 minutes of playing, and they did not adapt VR in a short time that researchers expected. Although gamers recovered more quickly than non-gamers from cybersickness because of their previous game experience, it was sill suggested that game developers should design each level that can be completed less than 30 minutes or leave reminding to ask players take a rest each 30 minutes. Therefore, this newly research exposed that recent VR technology were still lack of protection for users, and optimization of adopting user experience is still not developed enough to protect users.

3. Diversity of VR to help with game design

There are many things that need to be considered when game developers design video games. Game design is not as simple as "make something I think it is cool". Instead, there are many experienced theories and ideas which create a good game. Different designs require different condition to achieve, and more and more examples have showed that VR plays a pivotal role in some game design ideas.

In 2005, researcher James Paul Gee propose 13 principles on how to make good video games, and these principles are later called Gee's Principles. Gee divided game design into three parts – empowering learners, problem solving, and deep understanding. Empowering learners means that players are the most important factor developers should consider, and the game should always be designed based on player's experience. Problem solving means that the foundation of a game is to guide players solve problems that developers set, and those problems should be carefully considered

DOI: 10.54254/2755-2721/8/20230151

with certain guidelines. Deep understanding means that the game should have a complete system that is worth for players to explore [4]. By using of VR, there are 3 specific principles that will get huge benefits from it - Co-design, customization, and identity. Co-design is to make "Your actions and choices in the game have direct impact on your character." Since VR has first-person immersion, it is easier to hint people what result will be on yourself through different decision with detailed design. Customization is similar but "Your actions and choices in the game have direct impact on the game play." Therefore, the way of design is as same as co-design but with more environmental change and game story effect. The identity is "You build an emotional connection with your character which allows you to view your avatar as an extension of yourself." It is a challenge for many game developers because use identity principle means that the protagonist players controls need to be more customized by players, but that requires game developers to create more free choices for players. In VR, the protagonist players control has more freedom of movement compared to traditional video games, and that makes VR game players able to interact with more items/non-player characters while game developers do not develop with too much work.

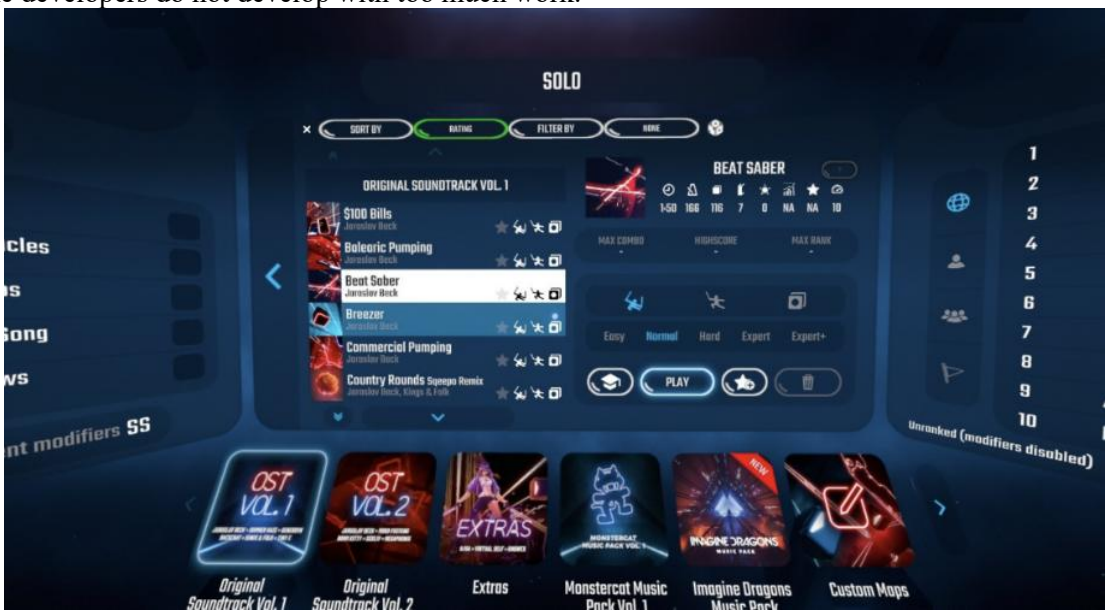

Figure 1. Beat saber main menu that players can see.

The majority of VR devices are usually a combination of hand-held controller and joysticks. In order to show the characteristics and fun of VR in terms of free interaction, developers have tried many ways to create some special 3DUI (UI stands for User Interface) that only VR could present. A general example is the difference of 2D interface. In traditional video game, since the image is shown on a screen, which is a flat platform, UI is designed to be flat. Although some video games UI are in 3D style in order to fit their game art style, they are still a relatively flat. This limitation does not exist in VR games. In VR game development, the logic of UI switch from player-based to environment-based [5]. This is because player is a free moving object, and it is weird to make UI keep following players in a stable position. One way of implement this method is surrounding UI in VR game Beat Saber. In Beat Saber, its 3DUI surround players with 3 boards (Figure 1). These board compose of a multi-screen which gives players a special visual performance that cannot be achieved in traditional video games. Another special 3DUI that game developers need to consider is locomotion. It is conflict when VR games requires players to walk through a place and players only play the game in a limit area. It is clear that use position sensor and force players to walk around in their house is not possible, so some in-game UI are needed to replace the actual walking. According to IEEE's summarization, there are two mainstream solutions: click-walking and teleport. Click-walking means that players use joysticks

DOI: 10.54254/2755-2721/8/20230151

to point the position they want to move, and the character will automatically move to the destination [5]. Teleport even requires less develop progress since the teleport point are preset location. Both ways good to deal with the inconvenience, but it does not mean that they do not have any disadvantage. While players do not really walk in click-walking which may cause visually-induced motion sickness, teleport has lower spatial awareness since it has no animation for traveling.

4. Cross-Platform development

Besides those contributions the discussed in the previous paragraphs, another important advantage it has is the flexibility on different device. Because of such convenience, VR can be used as a communication tool to provide people with a new way of socializing, and it can also provide new experiences on different platforms.

Figure 2. VRChat logo.

Figure 3. VRChat gameplay screenshot from official website.

The emergence of the Internet shortens the distance of people's communication, and also promotes people to conduct more network social activities. Many video games are designed with social as their feature. However, traditional online chat rooms are limited to graphic images and text, while video games cannot fully serve social purposes. In this case, the application of VR has opened up a new way for the online socializing (Figure 2). In 2017, an online virtual world platform was introduced to the Steam, a well-known video game digital distribution. In this game, players are allowed to create their own characters and worlds. Unlike other video games that set players to achieve certain objects, VRChat does not require anyone to do anything. In other words, players are free to do anything with anyone in the game. In VRChat, most people joined a server that was created by others to find someone to interact with. Sometimes they play some games together, and sometimes they just chat [6]. The most important reason of why VRChat is more “social” than traditional video games is that VRChat requires VR as necessary hardware. Head-mounted VR enables players to observe the world

DOI: 10.54254/2755-2721/8/20230151

intuitively with their eyes when entering a virtual world, and the player interacts with more ease than keyboards and gamepads. When players talk with others with head mounted VR, it will give a more realistic feeling than a display screen.

Based on the feature of reality, VRChat extends its advantage into helping people exploring the outside world at home regardless of the reason they cannot go outside. In 2021, National Astronomical Observatory of Japan, short as NAOJ, faced a problem where people are not able to visit the observatory due to the pandemic (Figure 3). After trying some virtual tour on YouTube and Facebook, the lack of immersion leads the experience worse than expect. Therefore, NAOJ build a virtual observatory model in VRChat and invite people to join the virtual tour on VRChat. This tour was involved by 47 guests and a staff member, and the results is totally out of their expectations. In general, most guests agreed with that VR had great potential on online virtual tour because its 3D environment gives enough immersion to let people feel they are really there, and the interaction between staff and guests is as convenient as reality. However, two major problems were also mentioned in the article. The first one was that the immersion of VR depends on the quality of model, which means programmer need to spend more time on building the environment if they want to give people the best experience. Second one was that unlike face-to-face tour, the staff could not see the face of guests, which made the staff unable to check the reaction of guests and make sure everyone understand his introduction.

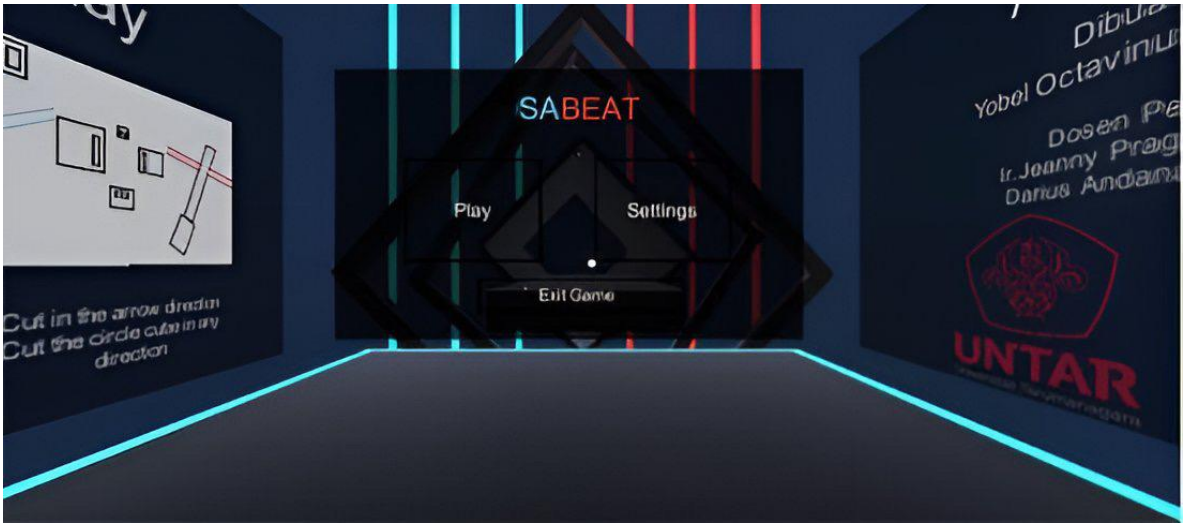

Figure 4. Sabeat main menu that players can see.

VR game also have its unique feature on mobile platform. Nowadays more and more people have smartphones and many game developers make games on mobile to get profit from it. A critical problem for mobile game is that mobile does not have a valid import hardware like controller for console or keyboard for PC. To deal with this problem, mobile game always put virtual control buttons on the screen. This solution seems to be good, but games with complicate control system will make players hard to control through such a small screen, and players are unable to see many parts of screen if there are too many buttons. Therefore, VR is used to eliminate the inconvenience of mobile games [7]. In 2020, a team from Tarumanagara University developed a game called “Sabeat” (Figure 4). This game was defined as VR rhythm game and was able to play on mobile with a special flashlight. The playstyle is similar to another VR rhythm game on PC called “Beat Saber”. In each level, Sabeat requires players to cut all incoming cubes with their flashlights in a music flow, and players win if they successfully cut over 70% of total cubes. After a test with 31 game test respondents, the result showed that even though most players never played any rhythm VR game before, they still learned how to play the game quickly and started to enjoy the game. When respondents rated the difficulties of each level, they responded that game become harder and harder when keep playing, which fitted the

DOI: 10.54254/2755-2721/8/20230151

design of developers. There were also two major problems were found from this test [8]. One was that players might experience dizziness when playing such rhythm VR game because rhythm game requires player's concentration to be keep focusing and VR game requires players to put their full attention into virtuality. The other one is that VR mobile game needs extra devices to play, which against some mobile gamers' reason on why they play mobile games – because one mobile is convenient enough.

5. VR game contribution in other fields

VR has been around for a long time in many other fields, so it is not surprising to see VR applications in education and health. Today, many developers try to apply VR video games to these fields. Unlike traditional entertainment video games on the market, these video games have been specially designed to focus more on helping specific groups of people.

Figure 5. An older adult who was experiencing VR.

Helping older adults avoiding Alzheimer is always an unavoidable topic in the world. The entertainment that older adults can do is limited, and some older adults are not able to do difficult activities. When combining video game into VR technology, developers could create video games that serve for older adults, and these games are easier to learn for them compared to console and PC [8]. In 2006, a team from the University of Sydney wanted to encourage older adults to do more physical exercise. The team indicated that those new high technology are hard to learn for older adults, so they need to develop a VR game that requires less control and combine it into accessory that older adults usually use (Figure 5). As a result, the experience combines mainly recumbent tricycle and other support accessibilities and devices the game into to part: competitive and affiliative. Older adults in their experience successfully played those games with interactions, and the team concluded that this VR game can motivates older adults to engage in physical and cognitive exercise. Furthermore, the use of virtual navigation technology can also be extended into other fields that might help everyone in real world navigation [9-10].

The contribution of VR for normal people and disabled people goes both ways. While old and disable people can get help from VR, normal people can be educated about disability from VR. For example, people with blindness lost their sensor of seeing, but they developed their other sensors, like hearing, much better than people without blindness, and normal people could not understand such

DOI: 10.54254/2755-2721/8/20230151

feeling by description. In 2019, faculties from Delft University developed a VR game named Loud and Clear. This video game is an escape-room-like game but without any visual scene. Players need to escape from different place in each level with only audio. After the test with 26 players, they found that players gain a new perspective on what challenges people with blindness face in their daily life, and they learn some abilities on how to interact with environment without visualization. In the end, researchers planned to improve the game and push it to school/museum for education.

6. Conclusion

In conclusion, VR is still a relatively new technology in video game field. When players enjoy the new experience from VR, developers should keep focusing on improve the security of VR. Much research has shown that the use of VR nowadays has many problems and disadvantages. Some of the problem can be dealt with in a short time, but others need more experience on developing and designing. On the bright side, VR solved many problems and explored a new world for game developers. Game developers can apply more visual performance that past video games unable to complete. In the future, there will be more VR games with better designs, and VR will leave an indelible mark on game history.

References

[1] Baas, B., van Peer, D., Gerling, J., Tavasszy, M., Buskulic, N., Salamon, N. Z., Balint, J. T., & Bidarra, R. 2019, Loud and clear: The VR game without visuals. Lec. Not. Com. Sci., 180–190.

[2] Steed, A., Takala, T. M., Archer, D., Lages, W., & Lindeman, R. W. 2021, Directions for 3D user interface research from consumer VR games. IEEE Trans. Vis. Com. Gr., 27(11), 4171–4182.

[3] da Silva Marinho, A., Terton, U., & Jones, C. M. 2022, Cybersickness and postural stability of first time VR users playing VR Videogames. Appl. Erg., 101.

[4] Octavinus, Y., Pragantha, J., & Andana Haris, D. 2020, Android rhythm VR game “Sabeat.” Mat. Sci. Eng., 1007(1).

[5] Ijaz, K., Wang, Y., Milne, D., & Calvo, R. A. 2016, VR-rides: Interactive VR games for health. Seri. Gam., 289–292.

[6] Hiramatsu, M., S_Asagiri, Amano, S. G., Takanashi, N., Kawagoe, S. K., & Kamegai, K. 2021, Virtual ALMA Tour in VRChat: A Whole New Experience. Com. Ast. Pub. J., 30, 18–27.

[7] Gee, J. P. 2005, Learning by Design: good video games as learning machines. E–Learn., 2(1), 5–16.

[8] Cho H I . 2019, A Study for properties of Spline to 3D game modeling. Int. Conf. Adv. Learn. Tec 981

[9] Hu C C , Chi M T , Chang T K . 2018, Design and Evaluation of Game-Based Learning Module for 3D Modeling Int. Conf. Adv. Learn. Tec. 118.

[10] Amani N, Yuly A R. 2019, 3D modeling and animating of characters in educational game. J. Phy. Conf. Ser. 1193, 012025.