

A MR-Based Multiplayer Narrative Game for Enhancing the Interaction and Immersion of Museum Exhibition

Sinan Zhang

*Beijing Normal-Hong Kong Baptist University, Zhuhai, China
t330024323@mail.bnbu.edu.cn*

Abstract. This research combines the significant impact of current Extended Reality (XR) technology on museum participation and immersion. It summarizes the current problems such as high cost, poor interactivity and strong homogenization of XR in the field of Museum Exhibition. The article will provide a new solution which includes virtual scenes based on Mixed Reality (MR) technology and real-time interaction with virtual props, combined with a collaborative system of multi-person real-time interaction, through action, eye contact interaction and special behavior. It can promote the development of the plot, and adopt an immersive multi-line narrative design, its expected result is a set of XR interactive plot system that supports 4-6 people to experience at the same time, which can be applied in the museum exhibition hall. Although there are still certain problems and shortcomings in this system, it can bring new vitality to the future of the museum, reshape the museum's interaction mode and visitor experience, and redefine the cooperation between the museum and XR technology with brand-new strategies and projects.

Keywords: MR, XR, Museum, Movie Game, Interaction

1. Introduction

Extended Reality (XR) technology acts as an invisible booster for museums for few years. Its rapid development provides new possibilities for the reconstruction of the museum experience. As an important technology widely used in Culture Creativity area. XR promotes the transformation of visitors' museum experience from "passive bystander" to "active participation", and attract tourists to reshape their experience [1]. It also improves engagement, learning, and emotional connection in both physical and virtual museum settings compared to traditional approaches [2]. Much of the potential for XR's progress in the Museum lies in building connections between multiple places. It can provide information for the conceptual understanding of the relationship between digital memory and location [3].

The research is about a Mixed Reality (MR)-Based Multiplayer Narrative Game, its objective is enhancing the interaction and immersion of museum exhibition. as the most dramatic incident in the history of the Tang Dynasty, the Xuanwu Gate incident has long existed between the written record and the imagination of later generations. It is an appropriate theme for the whole project, so that the audience can experience the turning point of history in multi-person collaboration and explore the path of XR technology to empower museum narrative innovation.

2. Research gap

With deepening application of XR technology in museums, the excessive dependence of curators on this technology has also exposed many problems. These problems not only have negative effects, but also reducing the original advantages of the museum. The following is a case analysis of these problems.

2.1. Homogenization

A simple and effective plan can bring huge passenger flow and rich revenue to the museum, but when this plan is imitated by other, the quality of the exhibition and the interest of tourists will be greatly reduced. This will also cause tourists to question the application of Visual Reality (VR) technology to museums. The actual content of the somewhat repetitive visuals and the rendering of the human actors and machinery function were rather conservative in their approach, which not offering any novel representational visualization and remaining in the safe zone of a generic and conventional depiction [4].

2.2. High cost

An immersive VR experience requires complete equipment and sufficient space. The immersive exhibition "Symbiosis" at the Portland Museum in the United States adopts customized VR glasses and gloves to give visitors a new audio-visual experience. The complete hydraulic system and tactile suit can experience the wonders of nature in the future world by imitating the real touch. Although the effect is outstanding, the cost of research and development and the price of equipment are extremely high. As a non-profit organization, most museums cannot afford such high operating costs, so it is difficult to promote such projects on a large scale [5].

2.3. Lack of interaction

According a research on HoloLens. It has observed that the availability of HoloLens glasses is very low, and the UI is not very intuitive compared with ordinary smartphones [6]. XR actually can increase engagement, but it may also risk distracting visitors from the core museum experience. The whole experience should remain memorable and meaningful, which combined with interaction to remain attention and attraction of visitors [7]. Like the VR exhibition in Spanish Prado Museum and French Osray museum. They pay more attention to the ornamental and experience of XR, but therefore ignore the interactivity, making the audience unable to substitute and creating a sense of separation from the exhibition itself.

3. Melody: a MR-based multiplayer historical narrative game "incident of Xuanwu Gate"

The research presents a project is designing for the museum, which can enhance the interaction and experience of visitors. The MR game of "The incident of Xuanwumen" multiplayer XR interactive plot system, it includes high-precision restoration of the three-dimensional scene of Chang'an City and Xuanwu Gate in the Tang Dynasty, virtual characters designed based on the image of historical figures and interactive mechanisms that support multi-person real-time collaboration.

With the support of MR technology, the project has created a virtual scene of Tang Dynasty. 5-6 players wear VR equipment and play roles in the story in the same scene. Each of them has their own characteristics. The whole story is divided into four chapters, and players will promote the

development of the plot through their own choices. Every character's decision and behaviour will affect the development of the plot. They all have their own storyline, and the superposition of various factors may produce an ending that is completely different from the real history. While improving the interactivity and immersion, it also increases players' interest in this history.

3.1. Technology

3.1.1. MR display technology

The main reason for choosing MR technology is that it can not only create a virtual space, but also restore the structure of Tang Dynasty architecture, interior decoration and Xuanwu Gate through exquisite modelling like Figure1. It can accurately restore the scene and give players a new sense of historical presence. MR technology can interact with real-life people or props in real time, which is convenient for the communication of actions between two players. According to a research, MR technology has both the role of virtual reality and augmented reality, and provides more emotional value for tourists among many XR technologies [1]. In addition to rich information, it is also considered to make the experience more "humanised" and "warm". MR promotes the participation of visitors, so users don't have to rely on their imagination [8].



Figure 1. Visual scenery of Xuanwu Gate through MR display (picture credit: original)

3.1.2. Multi-person space synchronization system

According to research, it introduces a new level of interaction which can be lifelike and share new real-time human-computer interaction forms for game experiences and virtual museums with using multiple devices [9]. It mainly provides support for the player's physical displacement and multiplayer online. It has been showed on figure 2. The whole system locates their position in real time through SLAM technology and builds a complete environmental map at the same time. When two or more players are in the same virtual space, the whole system will achieve the unification of spatial anchor points to ensure the spatial accuracy required for multiplayer interaction. At the same time, the system will synchronously calibrate the movements and relative positions of all players through the positioning system on the player's MR glasses and gloves to ensure the smoothness of the whole game process.



Figure 2. Multiplayer interaction in games. (picture credit: original)

3.1.3. Multi-modal interaction system

Palma and Perry use XR applications to interact with physical replicas in a virtual environment. Facts have proved that interacting with the physical objects mapped in the VR experience can increase the user's sense of reality and participation [10]. The combination of MR gloves and eyeball capture system can capture every action of the player as much as possible and give timely feedback. As showed on Figure 3, players can interact with other people, virtual props, or real models in a variety of ways to promote the development of the plot.

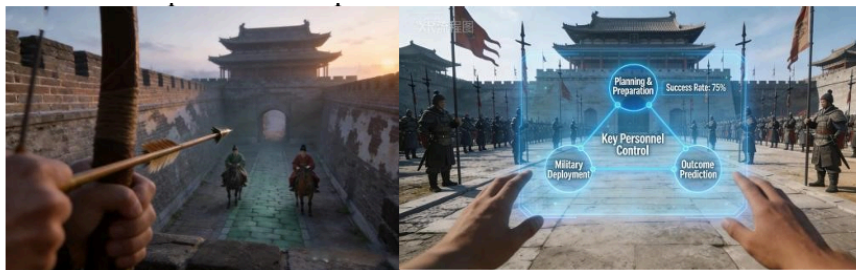


Figure 3. Examples of multi-modal interaction. (picture credit: original)

3.2. Method design

3.2.1. Conceptual design

Beside The technology used in the research,the idea of the Game design is come from the classic movie game on PC or Video Game Machine. The example includes famous game DETROIT: BECOME HUMAN and HEAVY RAIN. The kind of game is choosing different options to make new story, which improves the interactivity and adds to the immersion of the player's plot. The research has learned from the basic gameplay of such games and build virtual scenes in combination with MR technology, so that players can really immerse themselves in it.

3.2.2. Plot design

This game is designed into four chapters, and the whole plot can be roughly summarized into four parts which includes "decision", "preparation", "action" and "ending". Each chapter has its own unique gameplay and tasks.

The content of the first chapter is mainly about Li Shimin's need to make decisions and whether Fang Xuanling, as a counsellor, participates in the uprising. The plot not only involves the choice of two people, but also depends on the practices and attitudes of the other four people.

Chapter 2 will be divided into two virtual spaces. Players are divided into two groups of actions, one is to persuade the guards, and the other is to gather troops. These elements will play a decisive role in the third chapter.

Chapter 3 is a long chapter. Players will switch from the battlefield to the palace and other scenes, which is different from the previous two chapters. There are more action scenes, and will be affected by the previous choice.

3.2.3. Operation process of the game

After the player enters the scene, the whole system mainly promotes the plot through the player's behaviour (Figure 4). It is roughly divided into two purposes: selection or interaction. Players can make choices in three ways. they can take a choice by moving to the options, make choices through special gestures and make a choice by focusing on the options with your eyes.

After making a choice, the system will determine and calculate the impact, and then enter the next player's behaviour until the end of the chapter.

Meanwhile, players also have two ways to interact. Firstly, they can read the information of items or characters through eye interaction. Secondly, they obtain information through hand movements (grabbing, wiping and touching, etc.)

After the interaction, the system will determine whether it is necessary to choose. If necessary, it will directly enter the selection process. If not, it will directly settle the impact of the interaction.

At the end of the three chapters, six players will directly enter the bystander mode and observe the ending they have written from a third-person perspective. The whole process cannot be involved, and players can only observe from different angles. This way gives players a more vivid historical narrative, so that they can remember this history more deeply.

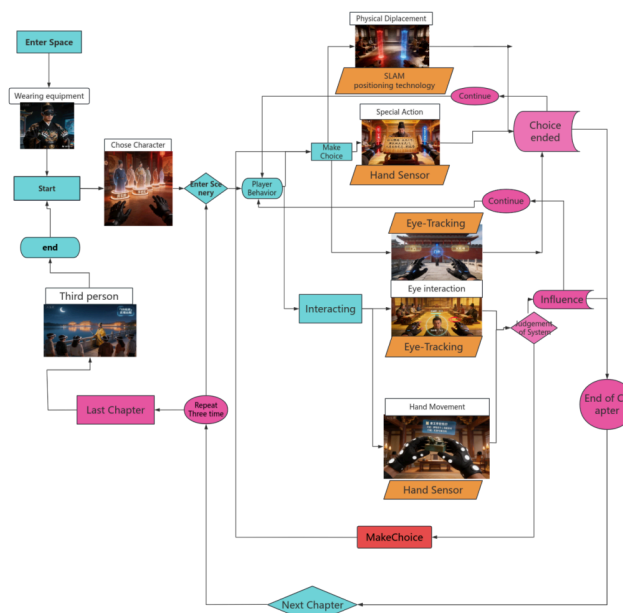


Figure 4. Process and operation of the game

4. Conclusion

The paper hopes that this project can finally present a complete set of "The Change of Xuanwumen" multiplayer XR interactive plot system. It can be installed in historical museums, ruins museums or

cultural and tourism complexes as a permanent immersive experience project; it can also be combined with the Tang Dynasty cultural relics in the collection to form a double narrative of "physical + virtual". Space, so that the audience can get a deeper historical understanding in the comparison between virtual reality.

The research makes full use of the advantages of MR technology to solve the current problem of XR exhibition to a certain extent. The new game mode and immersive gameplay bring visitors an unparalleled experience. The adoption of simple MR equipment greatly reduces the cost pressure, and the diversified use of physical modules in the scene also improves the utilization of space. SLAM technology, eye tracking, multiplayer online and other technologies complement each other to build a highly interactive world. Every character or item can interact, which also enriches the gameplay.

In addition, there are still many problems to be solved, such as many technical problems to be overcome, how to promote this project to more museums, and how to solve the problem of space. The paper will continue to explore this project, further develop the freedom of the game and the depth of exploration, and launch more themes and stories after full promotion to improve the attractiveness of visitors. Bring more possibilities to the future of combining XR and museums.

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