A Generalized Framework for Immersive and Interactive Theater

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Abstract

This paper presents a generalized framework for virtual reality (VR) theater that provides audience with immersive and interactive environment. This framework consists of interface, player and scenario especially for interactive storytelling. These components and relationships among them are defined in detail in this paper. And, we address some issues of VR Theater: flexibility and scalability. The proposed framework can offer a way to investigate and develop VR Theater.

Key words: Immersive VR Theater, Framework

1. Introduction

As the performance of 3D graphic cards for personal computer has been enhanced with more features such as vertex shading, pixel shading, and genlock for PC Cluster in recent years, conditions are more favorable to research and develop VR systems. But, it seems that the prospect of VR is not very good at the moment because we are still trying to find the killer applications for VR.

To find them, we make an effort to formulate our research, VR Theater that provides immersive and interactive storytelling to the audience. This paper proposes a generalized framework for VR Theater based on our previous work, Toppan VR Theater[1] and Gyeongju VR Theater[2]. This framework will provide a guideline for researcher to analyze and develop VR Theater applications. We hope our proposed framework will contribute to make VR Theater to be one of the killer applications.

In section 2, we introduce our related work. Section 3 proposes a generalized framework for VR Theater, its design and its functionality. Section 4 presents raised issues, followed by a conclusion and future work.

2. Previous Work

2.1 Toppan VR Theater

"MAYA – Kingdoms of Mystery –" hold from March to May 2003 in the National Science Museum, Tokyo. This theater, which was a part of the museum's exhibits and drew a total audience of 100,000 public visitors, also doubled as a verification experiment for the project. To exhibit the reconstructed Mayan ruins, we implemented the virtual environment "Virtual Copan" using a high-end VR system, which we called the "VR Theater" and several personal devices such as PC-based VR systems.

Our constructed VR Theater has 14m x 4m cylindrical screen with a 9-meter radius providing 150 degrees horizontal by 45 degrees vertical field-of view. This theater has the capacity of 150 visitors. For processing the visual display, a high-performance graphics workstation (SGI, Onyx 3400, Infinite Reality 3, 3 pipes) rendered high-resolution and high-quality images in real time, according to the actor's input through an input device. These images are projected on to the curved screen by three DLP projectors with a resolution of 3000 x 1000 pixels [4,5].

Also, in a waiting area called "Steel a plaza", we set up two PC-based VR systems. The visitors can use these VR systems freely, while they are waiting for their booked time. These VR systems are integrated to the Theater type VR system through a gigabit ether network. So he/she can freely explore the "Virtual Copan", or participated in a guided tour that is being shown in the theater.

To implement the virtual museum exhibition, the "Excursion Metaphor" is proposed, which can complement a real museum exhibition without reducing the educational effect. We integrated different types of VR systems by using Scalable VR architecture [3]. By augmenting real museum exhibitions with interactivity and the capability for communication, our concept enables a more effective and impressive learning experience than a conventional museum exhibition.

2.2 Gyeongju VR Theater

Gyeongju VR Theater was build for the Gyeongju World Culture EXPO 2000, held in Korea from September 1 to November 26, 2000. VR movie, "Intro the Breath of Sorabol," was the theme movie and was seen by almost one million people [6].

The aim of designing and building the VR Theater was to construct a versatile public demonstration for VR technology as a new medium for interactive storytelling of diverse kinds of artistic expression and edutainment of virtual heritage to the public.

The VR Theater facilitates an immersive environment by automatically controlled visual, aural, and olfactory rendering. There is a 27 x 8m cylindrical screen with a radius of 37m. To make passive stereo image, six double-stacked projectors are used with a resolution of 3780 x 1024 pixels and a brightness of 4000 ANSI lumens.

For interactive rendering, an SGI Onyx2 system with six IR2 graphics pipelines is employed that also powered with fourteen 300 MHz R12000 MIPS process and 2GM of RAM. The graphics pipelines provide an additional 64MB of fast texture memory. For audience interaction, the 651 keypads are used which have six keys (for directional and two selection). We designed a special keypad that mimicked the functionality of the computer mouse to generalize input capability.

To provide 3D surround sound, the sound system consists of 6-channel audios that are routed to 24 speakers by the crossover network. In addition to this, the subwoofers are attached to the access floor underneath the seats in order to provide vibration. Another facility to provide immersive felling is a fragrance control system that controls the type and amount of fragrance, and the time of release.

We felt the Gyeongju VR theater project was successful in keeping the attention of the audience throughout the show and made their experience enjoyable. Among approximately 1.7 million visitors for the Gyeongju World Culture EXPO 2000, more than 67% rated the VR show as the best out of a dozen other shows. We owe the success to two main factors [m]. One was that the technology remained invisible, which kept the audience focused on the contents. Operations of the complex hardware systems, projectors, computers, and ventilation system were all remarkably stable with few failures: fewer than ten shows were affected by technical difficulties out of 2,500 shows since its opening in September 2000. This demonstrates that the technology for running a fully automated VR theater is mature and ready for public deployment in various forms, depending on the application needs. The VR contents certainly had the public appeal in our experience [7,8].

3. Framework

In this section, we describe a generalized framework for VR Theater. The basic components of our proposed framework are interface, player and scenario. Each of them can be more classified as illustrated by following Figure 1. This section presents these components and discusses their relationship in detail.

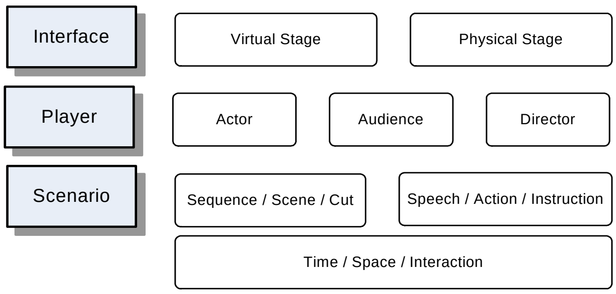

Fig. 1 Key Components of Framework

In first, this paper defines the interface as a place or area of activity where something important happens. In second, the player is defined as someone who is taking part in an activity or event. Lastly, the scenario is defined to specify controls of the player and the interface in the view of time and space. And, all objects referred by storytelling should be included in a scenario also.

3.1 Interface

VR Theater aims to provide audience with immersive and interactive environment as mentioned before. This means that not only virtual space but also real space should be considered at the same time. So, we divide the interface into virtual stage and physical stage.

In this paper, virtual stage is a computer-generated synthetic space, which includes static object and dynamic object as illustrated by following figure 2. Static object is something that doesn't move around in virtual space like terrain, building, tree and so on. On the other hand, dynamic objects can update their location or shape in run-time.

And, dynamic object is also classified into two: animation object and interactive object. Animation object enables to change according to its predefined information so that it is not allowed to modify their state in run-time. But, interactive object generates his or her update in run-time. This means that interactive object can communicate with the player during a storytelling.

And, physical stage includes all kinds of facilities in VR Theater. Concerning this paper, some of them are specific to the delivery of sensory information to the player, mediated by various display functions. For example, visual display, auditory, olfactory, and vibration can be involved in display function.

And, input devices are included also in physical stage for the purpose of providing the player with interaction. For example, joystick, vision-based tracking and sound level meter can be included in input devices. It should be noted that physical stage as well as virtual sage is controlled by the scenario as mentioned before.

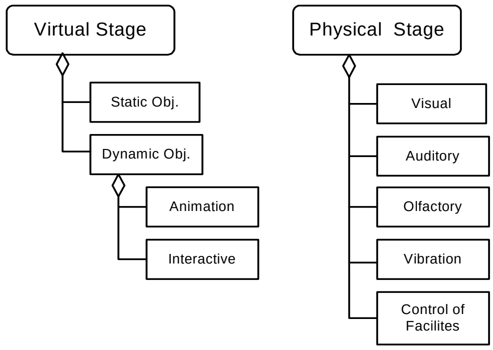

Fig. 2 Classification of Interface

3.2 Player

In VR Theater, there are several different kinds of players comparing with other applications. So, this should be considered for the design of framework. In our framework, the player is classified according to their role – that is actor, audience or director as described by Figure 3.

The actor is someone who performs an apparent individual nature of something on the stage. Usually, actor uses one's own body and voice to express to audience. As a part of medium, the actor is important and closely related to the story telling. The audience is a group of individuals gathered together at a certain time and place for no purpose than to see the performance. And, the director controls and manages the content and flow of storytelling in order to ensure the quality and completeness of a theatrical product.

The actor is divided into virtual character and real character. As the name suggest, virtual character is computer-generated synthetic character. On the other hand, real character is played by human. We also classify them according as their stage. If they play on the virtual stage, we can consider them as a kind of video avatar.

And, on-stage character plays a role just like a common theater. And, off-stage real character can be divided. If they have the same time as storytelling, they are in stage of online. If not, they are in stage of offline.

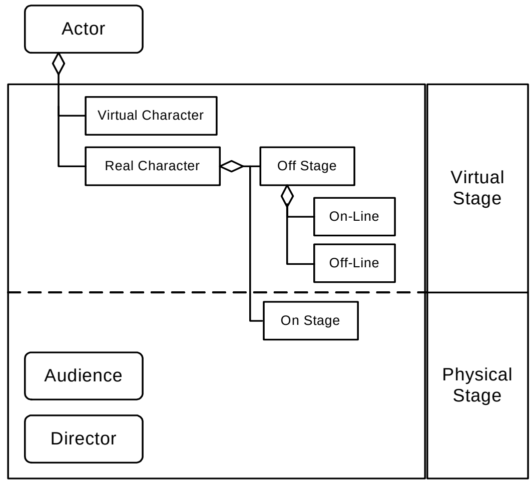

Fig. 3 Classification of Player

3.2 Scenario

Scenario describes the control flow a sequence of scene elements for storytelling. In this paper, we define sequence, scene and cut as basic building blocks to composite a storytelling.

The sequence is composed of more than one scene. Each scene includes more than one cut with sharing a single virtual world. And, the scene can be transited based either on time or user input. Scene transitions and world changes can be overlayed. And, each cut can specify its own feature such as view position, time of day and so on. For example, some cut navigates the virtual world according as the camera paths predefined. Some cut allows navigating interactively.

The order and time of sequence are static. The order of scene is static but the time is flexible. The order and time of cut are flexible. We define action, speech and instruction in order to control the actor or the interface by means of sequence, scene or cut. So, this enables us to control them in the view of time, space or interaction. And, we can define interaction between the player and scenario.

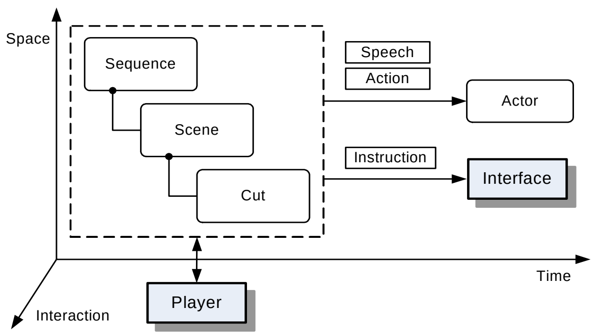

Fig. 5 Classification of Scenario

In view of relationship, basic components of framework can be illustrated by below figure. This framework provides interaction among interface, audience and actor. There are many different kinds of interaction. First, the audience can interact with computer-generated actors or real actors through the interface including virtual stage and physical stage as mentioned before.

When real actors play on a physical stage, they also need to interact something in virtual stage. And, interface and actor are controlled by scenario for a storytelling. This means that scenario is used to control anything included in both virtual and physical space. And, director is allowed to control something specified in a scenario description.

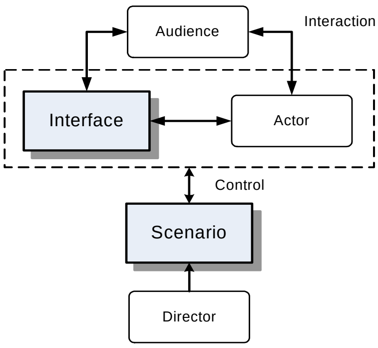

Fig. 6 Relationship within Framework

4. Raised Issues

In this section, we address that scenario description for storytelling is very important in VR Theater because of following reasons. First, the public no longer is interested in such VR applications that are very difficult to produce VR contents in spite of its immersive and interactive environments.

Therefore, VR Theater application should also provide an easy way to make VR contents without advanced programming. Second, VR contents are restricted by scenario description when making a storytelling. For example, it may be difficult or impossible to make some parts of VR contents because of a way of scenario description. This means that scenario description should be designed to support important and attractive feature of VR effectively such as interaction and real-time performance. Lastly, scenario description can be extended to specify new type of interface, player, or interaction according to VR contents.

In addition to this, interaction should be provided to multiple different players such as actor, audience and director in VR Theater. Above all, interaction for the audience was very important and difficult issues for us. As the audience usually shares interface for interaction just like a display screen, this makes them difficult to identity their own interaction.

For examples, if each audience can controls his or her own virtual object, it would be difficult for the audience to find a corresponding object in a VR Theater including hundreds of people. If some virtual objects are controlled by more than one audience, it would be difficult to expect the reaction of object because of the interference other audience. For above reasons, group interaction for audience is very important subject for VR Theater.

5. Conclusion and Future Work

In this paper, we proposed a generalized framework for VR Theater that aims to provide the audience with immersive and interactive environments as a new medium for interactive storytelling. This framework consists of interface, player and scenario as described before. Each of them is designed to support not only virtual but also real space, multiple different kinds of players, and the control of the rest of the framework respectively.

Future work for this paper includes investigating the features and functions of similar VR systems in view of our framework. Another important our future work is to propose new scenario description based on XML to specify a storytelling in VR Theaters.

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