

Situated Participatory Virtual Reality

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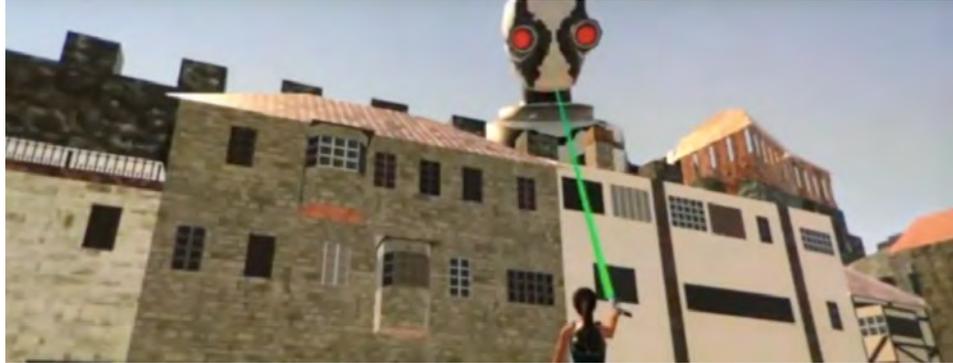


Figure 1: A Lilliput Story - a narrative for playing with different scales

ABSTRACT

Virtual and Augmented Reality is arguably one of the areas of most rapid development in the game industry nowadays. While some of the technologies have matured and different applications consolidated with market acceptance, the next frontier is still being pursued by researchers and the media.

In this paper, we contribute to this quest of effective proposals for the new media with experiments of Situated Participatory VR. They give a glimpse of what will be possible in future applications and guidelines regarding relevant authoring aspects.

1 INTRODUCTION

The area of Virtual and Augmented Reality is perhaps one of the most dynamic in terms of technological and scientific progress in the present time.

The origins of this area dates back to the 1960's, with the seminal work of Ivan Sutherland [8].

Despite of more than 50 years of development, the area while having gone through constant research progress, only recently it has been experiencing a wide adoption in our society at large.

The main reason for this recent trend is twofold. One one hand, the technology reached a level of price-performance that makes possible the effective applications for everyday use. On the other hand, the media industry envisions new opportunities in many fields, such as communications, education, entertainment, art, medicine, engineering, etc. For these reasons, there is a lot of interest and investment in VR/AR.

By now, it is safe to say that VR technology has matured and its applications are consolidated. Some examples are the 360 degrees videos on the Google Cardboard and virtual reality games on the Oculus Rift.

Nonetheless, the existing applications still have limitations both in the low-end, as well in the high-end range. They include aspects

such as the size of head mounted displays, and the need for tethered solutions.

Another important point is that most VR applications are single-player and take advantage only of the rotational degrees of freedom in viewing.

In this paper we investigate new possibilities for applications of what we call "Situated Participatory Virtual Reality". This new scenario implements multi-user interaction, full positional tracking of the players, and objects in order to create a complete sense of immersion in a tangible space. In this way, we bridge the gap between the physical and virtual spaces in VR applications.

Related research for creating experiences by combining physical sets, real-time interactive effects, and virtual reality is also being called "Hiper-Reality". One example is the recent installation developed by VOID for the Ghostbusters Dimension at Madame Tussauds Museum in New York [9].

Our research is fruit of an ongoing collaboration with the Future Reality Lab of NYU and has its foundations on the Holojam Platform. Holojam started as a multi-user interactive painting experience at the VR Village of SIGGRAPH 2015 [4].

Here we develop several VR experiments with the goal to evaluate the effectiveness of situated participatory virtual reality applications and determine the relevant authoring aspects for successful solutions.

2 VR ENVIRONMENT

The virtual reality environment at the VISGRAF Lab aims to provide an extensive infrastructure for research and development of projects related to new media. Among other facilities, it integrates two separate lab spaces for Situated VR. Currently, one space houses an Optitrack Motion Capture System from Natural Motion Inc [5], while the other space accommodates an HTC Vive play area.

2.1 Motion Capture Stage

The Optitrack System is composed of 12 cameras and the Motive Tracker and Body, a software suite for rigid and articulated body tracking. See Fig. 2.

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Figure 2: Motion Capture Stage with Optitrack System..

2.2 VR Equipment

The virtual reality equipment available in the Lab is very complete and includes most of the existing technologies currently in the market.

Since this area advances at rapid pace, our goal is to test and evaluate the pros and cons of different options in order to determine the best solutions.

In terms of Head Mounted Displays (HMDs), we are experimenting with the following equipment: The Google Cardboard and Daydream [3]; the Samsung GearVR [6]; the Oculus Rift [1]; and the HTC Vive [7].

Except for the HTC Vive that uses the Lighthouse tracking, all other Headsets have their position tracked by the Optitrack/Motive system.

2.3 Holojam

The Holojam VR Environment is shared-space virtual reality platform developed by the Future Reality Lab of New York University under the leadership of Prof. Ken Perlin [2].

This platform enables content creators to build complex location-based multiplayer VR experiences in a simple, unified Unity project. The development framework provides an extensible and clean interface, allowing for rapid prototyping and extension. Additionally, it abstracts away specific VR hardware, promoting a flexible and customizable creation of virtual reality experiences.

2.3.1 Holojam Accessories

The real players and objects participating in a Holojam system need to have their position and orientation tracked and sent to the Holojam Server.

We have designed special rigid body markers to be used in our MoCap Stage for the Holojam platform. They include markers for the Headsets, hands, and ankles of the players, the Wands, and also a Cube and a Table.

Figure 3 (top) shows two real players interacting with a cube that is positioned over a table in the MoCap studio. Figure 3 (bottom) exhibits a third person view of the simulated scene. This is an example of the tangible experience provided by the Situated Participatory Virtual Reality in Holojam.

3 EXPERIMENTS

3.1 Playing with Space

The purpose of this first set of experiments is to investigate the use of two separate VR capture locations, physically distant, but virtually integrated in the same simulated space. We developed three scenarios: the first consists of a room with a mirror; the second of two rooms and the third combining the two rooms with a glass / mirror wall.

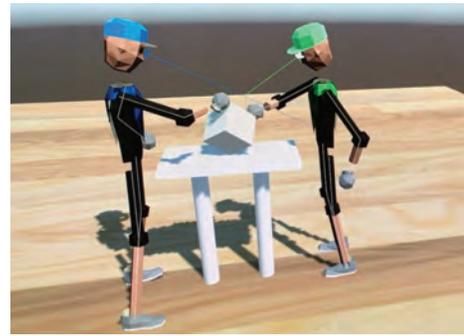


Figure 3: Real Players and Virtual Actors

3.1.1 Magic Mirror

The first experiment consists of a room in which one of the walls is a mirror. In this setting, the player, Narcisus, can explore the replication and synchronicity of his actions. See Fig. 4.



Figure 4: Narcisus

The Unity object called Narcisus contains the character model and the objects used for inverse kinematics.

The Mirror object is a plane containing a reflection shader material.

3.1.2 Two Rooms

The second experiment consists of two rooms joined together at one of the walls. The VR capture spaces are located in two physically separate areas distant to each other. But, in the virtual simulation these two spaces are fully integrated. There is also a virtual ball and the players can interact with each other through kicking the ball around from one room to the other, seamlessly. See Fig. 5.

Room1 and Room2 contain the planes that define the walls, floor and ceiling of each room. GreenLantern and Sinestro are the characters used.



Figure 5: Playing ball in two rooms

Notice that Sinestro has only objects for his Head and hands, his legs do not move. We made it this way because this character was used with HTC Vive, which only tracks the head and two controllers (each one of them is mapped to one hand).

There is a Synchronizable component to send the ball position and rotation to Holojam Server. The "Sending" flag is marked true only in one of the instances of the program. The Kick script component is used to add a force whenever some player touches the ball.

3.1.3 Mirrors and Rooms

The third experiment combines experiments 1 and 2. In this scenario now, the two rooms are joined at one of the walls, but this wall is made of a magic glass / mirror. The two players, Green Lantern and Sinestro, interact with each other dueling with lightsabers and wands that can create and destroy objects. See Fig. 6.

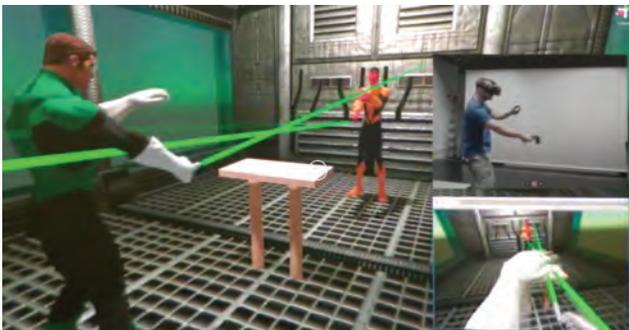


Figure 6: Rooms connected by a glass / mirror wall.

The Lantern Ring script component is used to create or destroy objects. When the wand's button A is pressed, a ray appears with an object at its end. This ray is rendered using "Line Renderer" object. Before releasing the button, the user can move the wand to adjust the position of the object. After releasing the button, the object stays at the chosen position. The created objects are stored as children of "Created Objects". When wand's button B is pressed, a ray appears and it destroys every object that was previously created with this same scheme, even if it was created by other user.

Wand's button 1 activates or deactivates the object defined by Wall attribute. It was used to control the wall with a mirror in this experiment.

SinestroRing object contains the same components, just using a different Tracking Tag, and also it does not have control over the Wall with mirror. This way, only Green Lantern can activate this wall.

3.2 Playing with Scale

The purpose of this second set of experiments is to explore the notion of scale in VR. We developed two experiments: Lilliput and Doll House.

3.2.1 Lilliput

The Lilliput experiment consists in two separate VR environments, one based on Oculus Rift DK2 and the other based on HTC Vive. These two worlds are connected, but with different scales.

In the first episode "The Beast and The Beauty", the Robot player, using Oculus Rift, is big and the girl Elaine, using the Vive is small.

SmallWorld object is positioned on the table, it has a uniform scale of 0.1, this is what makes everything inside it small, in this case it was just the character Elaine.

In the head and hands, the tag "Local Space" from Trackable component is set true:

In the second episode "The Beauty and the Beast", the Robot player, using Vive, is big and the girl Elaine, using the Oculus Rift is small. See Fig. 7.

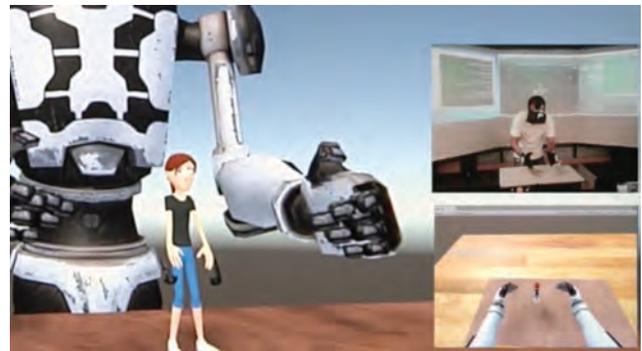


Figure 7: The Beauty and the Beast

3.2.2 Doll House

The doll house experiment consists of a scenario with a miniature house in which the player can "shrink" and get inside the house. See Fig. 8 and Fig. 9

The "world" object has a script that makes a transform transition between the current transform and a transform of some dollhouse room.

This transition is activated by another script component in the stylus object whenever there is a collision with one of the colliders that are positioned inside each room of the dollhouse. Wand's button A makes the world go back to the normal scale.

There is also a Smallworld object where the other character is positioned. It is positioned inside of the rooms of the dollhouse. The Vive objects (camera and wands) are positioned in this object.

3.2.3 Lara and The Robot: A Lilliput Story

This experiment tells a story of the encounter of Lara Croft with Robocop. Lara lives in a Lilliput city and the Robot is a giant that is exploring this land.

For this experiment, we used two groups of objects, one called NormalWorld, and the other called BigWorld.

NormalWorld contains the elements at normal size: the viewer, Lara Croft model and the Laser gun model. It is also a Holojam Synchronizable object, so it can be positioned anywhere in the city from one instance of the program, and others will see where it is positioned.

The Laser object contains a script to control a laser beam that is shot when the user presses the trigger button of the wand. It also has

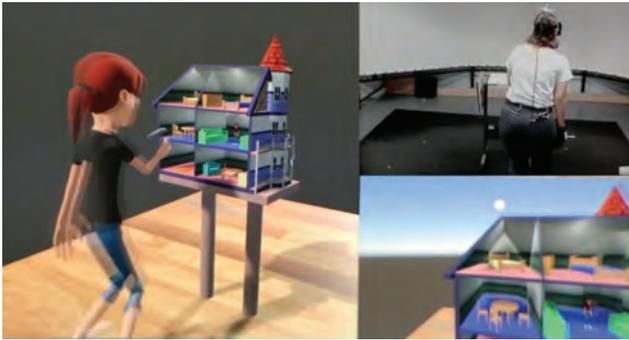


Figure 8: Inspecting the Dollhouse

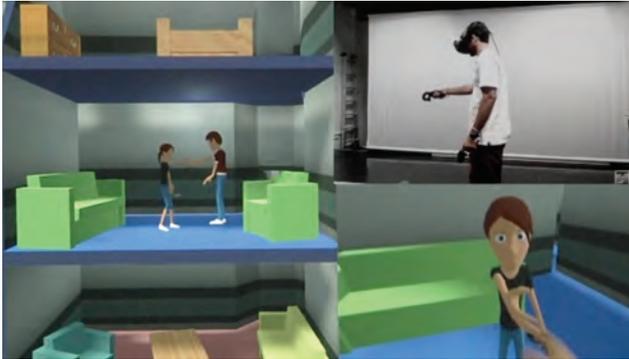


Figure 9: Inside the Dollhouse

an audio source with a laser sound that is played whenever the gun is fired. The script knows what object corresponds to the enemy, and what is the particle system that is used for generating a sparks effect when this enemy is shot.

BigWorld contains the Robot and a particle system that is used for the sparks effect when Lara shoots the robot. It has a uniform scale increasing its size by 100 times. In Fig. 10 we can see a comparison between the robot and the whole city.



Figure 10: Lara shooting the robot

3.3 Playing with Illumination

3.3.1 Haunted Mansion

The experiment in this third set consists of a scenario with an old house in which the player uses a flashlight to explore the space. See Fig.11.

Old.house is the 3d model of the ambient used for this experiment.

There is a spotlight inside the Stylus object, making it work like a flashlight. This scene is very dark, with just a couple of dim lights, so this flashlight is the only way to look around the house. Moreover, because of this darkness we didn't include the player body in this experiment. z@walk is a walking zombie animation to scare the player.



Figure 11: The zombie illuminated by a flashlight.

4 CONCLUSION

We presented a series of experiments for new media that enable situated participatory virtual reality applications. These experiences create a multi-user, interactive location-aware shared space where players engage in immersive mixed reality with a sense of presence.

Although we have not made any formal user study yet in this research, the results obtained so far are very positive and lead us to several important conclusions.

Overall, players really feel immersed into the virtual reality experiences. An eloquent evidence of this fact is the testimony of users that even after only a few minutes using the system, they “disconnect” with the real world.

Another compelling effect made possible in the system is the tangible connection with both real objects and the ambient space — which are magically transmuted in the VR setting but maintain a sense of physicality.

Finally, the shared experience among players leads to natural interactions, even when they are in different MoCap stages. This is probably due to the fidelity of the Avatars, as well as, to the audio-visual synchronicity supported by the system.

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REFERENCES

- [1] Facebook. Oculus rift, 2016. <https://www.oculus.com/rift/>.
- [2] Future Reality Lab. Holojam, 2016. <https://github.com/futurerealitylab/Holojam>.
- [3] Google. Daydream, 2016. <https://vr.google.com/daydream/>.
- [4] Ken Perlin. Holojam paint, 2015. <http://www.siggraph.org/file/siggraph-2015-vr-village-contributor-holojam>.
- [5] Optitrack. Motive, 2007. <http://optitrack.com/>.
- [6] Samsung. Gear vr, 2015. <https://www.oculus.com/gear-vr/>.
- [7] Steam VR. Vive, 2016. <https://www.vive.com/us/>.
- [8] I. E. Sutherland. Sketchpad: A man-machine graphical communication system. Technical Report TR 296, Lincoln Laboratory, MIT, 1963.
- [9] VOID. Ghostbusters experience, 2016. <https://ghostbusters.madametussauds.com/>.