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Engineering

VIRTUAL REALITY BROADCASTING STUDIO

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ABSTRACT:
IN THE PAPER, RESEARCH RESULTS FOR DEVELOPING A VIRTUAL REALITY BROADCASTING STUDIO ARE PRESENTED. THE PROPOSED PLATFORM PROVIDES USERS WITH A FULLY AUTOMATED TELEVISION STUDIO, INCLUDING TOOLS LIKE AUTOMATED CAMERA SYSTEM, MULTI VIDEO SWITCHERS, PROPS AND TEXT PROMPTERS. THE STUDIO ALLOWS THE PRODUCTIONS OF VIDEO SHOWS EXCLUSIVELY IN VR USING AVATARS IN A COMPLETE VIRTUAL IMMERSIVE SPACE AND LIVE BROADCASTING OF LIVE OR PRERECORDED MATERIALS TO THE VR DOMAINS OR OUTSIDE TO THE REAL WORLD.

KEY WORDS: VIRTUAL REALITY, BROADCASTING STUDIO, LIVE STREAMING

INTRODUCTION

The rapid evolution of hardware technology in recent years, especially in the game industry has made possible to achieve real-time rendering of very complex 3D virtual spaces where more users can interact[6]. This use goes beyond the sphere of entertainment, with applications in many fields and becomes a part of modern technological civilization. Technological development has made possible in recent years to relaunch the development of equipment and applications for virtual reality and the development of augmented reality technologies.

Virtual Reality (RV) is a state-of-the-art computer-based interface that involves real-time simulations and interactions across sensory channels such as visual, tactile, smell and taste, as

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[6] Burdea, G.; Coiffet, Ph.; *La realite Virtuelle, Ed. Hermes*, Paris, 1995

defined in[7]. More and more users will access the VR environment in the next years, and this immersive medium will become part of their lives[8].

Nowadays, there are several VR platforms which makes possible to construct a variety of scenarios and use cases, that can be editable or created by the user by the mean of some editors, not requiring a special VR experience and 3D graphic expertise. But, also, there are some of them which allow users to extend the open source platform capabilities, by own code developing, writing in diverse programming languages or augmenting the graphics look and feel. Thus, the look can be improved by importing graphics and special textures like physical based rendering materials (PBR), which assign different textures for material properties like: colors, normal map, metallic, roughness, ambient occlusion and emission.

One example is the platform Amazon Sumerian, where the user can design the scene directly using a browser application, having a Sumerian's WebGL and a WebVR based editor. These interfaces make it easy to import 3D objects (FBX and OBJ) and to place them in scenes, to add animation and script the logic that commands how the objects behave[9]. The platform also surprises with Sumerian Hosts, which create 3D characters, called Hosts, that talk to users in a variety of languages, narrate the users scenes, recognize speech and guide users through them by answering questions, by having an administrable input text and allowing customize the Host's appearance, clothing, voice and language[9]. Sumerian platform comes with a library of pre-built objects and also gives the possibility to download or import objects from third-party 3D asset repositories such as Sketchfab or Turbosquid, for those users that doesn't create their own objects. The interaction across the scene is made by using Sumerian's visual workflow or JavaScript editors. If the Sumerian platform enchants with easy construction of the scene and user-host interaction, though, it presents an disadvantage: it doesn't allow multi-user collaboration and interaction, only one session: one user - hosts is possible. This feature is instead possible in another VR platform, High Fidelity.

High Fidelity, which is an open-source engine, allows building virtual communities, it is a multiuser VR environment that allow users to interact remotely, just as they would on a real-life[10]. So users can not only interact with robots, the Hosts present in Sumerian platforms, but also can meet real users around the globe. They can enterprise different actions in the virtual environment, interacting with the virtual spaces, creating actions together, learn together or discuss, they can meet together inside a virtual conference or in a collaborating office work. Even if this platform hasn't associated pre-created libraries, as Sumerian platform does, it allows experienced users to create dynamic interactions using the JavaScript and QML language.

Taking this in consideration, our team has decided to push forward the limits of this technology and develop as an experiment a fully automated TV station with many studios and a lot of tools that made possible to create professional looking TV shows exclusively in Virtual Reality and broadcast them inside VR or to the real world. This approach has a lot of advantages, the production price being very low and regarding the diversity and complexity of props the only limit is the imagination. The users can operate cameras, mixer consoles and can be a moderator, a

[7] Jason, Jerald; *The VR Book: Human-Centered Design for Virtual Reality*, Morgan & Claypool, 2015
[8] Daniel, Shafer; Corey, Carbonara; Michael, Korpi; *Exploring Enjoyment of Cinematic Narratives in Virtual Reality: A Comparison Study*, The International Journal of Virtual Reality, 18 (01): 1-18, 2018
[9] Amazon Sumerian VR Platform; https://aws.amazon.com/sumerian/features
[10] High Fidelity; www.highfidelity.com

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presenter or an actor sharing the same collaborative space but being in different part of the real world.

THE VIRTUAL REALITY BROADCASTING STUDIO

To develop the VR platform, we have selected the High-Fidelity engine, an open-source engine that enables development based on some API for java script and qml (https://highfidelity.com)[10]. This engine allows the importing of 3D textured models in FBX and OBJ format and fully support PBR materials and procedural textures. The engine allows also importing of rigged 3D characters as avatars[11;12].

The engine can also import rigged 3D characters as avatars. The avatars can be driven by real users or robots that can include animations and speech to text NLP conversation modules and text to speech, in order to interact with real user in a natural way. The avatars driven by users follow the user movements from real life using the tracking systems and also the engine have a good physics based on Bullet for complex simulations.

In order to make more natural the movement of avatars and allow users which are using the platform in Desktop mode, without HMD glasses, to express themselves, we created scripts that allow the selection of different animations for interaction and non-verbal expression, like applause, surprise, dance, point at, and various other emotional states.

The platform includes a very good spatial audio mixer in which each user's live voice and ambient sounds included in the platform are amplified or attenuated and directed into the surround channels, depending on the spatial position of the user's avatar in relation to them.

The platform also allows the creation of spatial audio areas with different sound attenuations. For example, to create a scene and an audience, the sounds generated by the users on the stage are amplified and transmitted without mitigation to all users in the audience area. In reverse, audience generated sounds are diminished more intensely, depending on their relative position relative to the scene, so as not to disturb the performance of the users on the stage.

This system, although very advanced, is not suitable for professional television production, so we created scripts of selective amplification and individual mixing of avatars performing independently of space areas, avatars can speak or be recorded, as if they were wearing lavaliere. This is a major improvement we've added to the High Fidelity platform through this app from an audio perspective.

[11] Chaillou, C.; Froumentin, M.; *La Synthese d'images*, Ècole Universitaire d'ingenieurs de Lille, 1997
[12] Daniel, Shafer; Corey, Carbonara; Michael, Korpi; *Exploring Enjoyment of Cinematic Narratives in Virtual Reality: A Comparison Study*, The International Journal of Virtual Reality, 18 (01): 1-18, 2018

Figure 1. The lobby of the Studio

We have started by creating the domain environment and the main building of the TV studio (figure 1). On the first floor one can find some meeting rooms and a News Studio. The News Studio have two fixed cameras and three mobile cameras. On the ceiling it is included a teleprompter text tool for presenters. The teleprompter allows editing the text, changing the font size and scrolling speed. In the back of the studio, there are three big automated screens, that can be switched from control room.

The platform allows during the avatars evolution, switching a single user camera in three distinct ways: first, person-view, third person view, and mirror. These view modes are not enough for professional video production, so we extended the platform with scripts that allow us to generate an unlimited number of camera-type entities (Figure 2) that can be placed in any position in the virtual environment. They can be fixed, mobile, or automated to automatically track the evolution of certain avatars.

The picture provided by these cameras can be selected using the keypad or a button interface in the virtual master control room. This creates the possibility of recording a very qualitative and dynamic video productions, even much easier than in reality.

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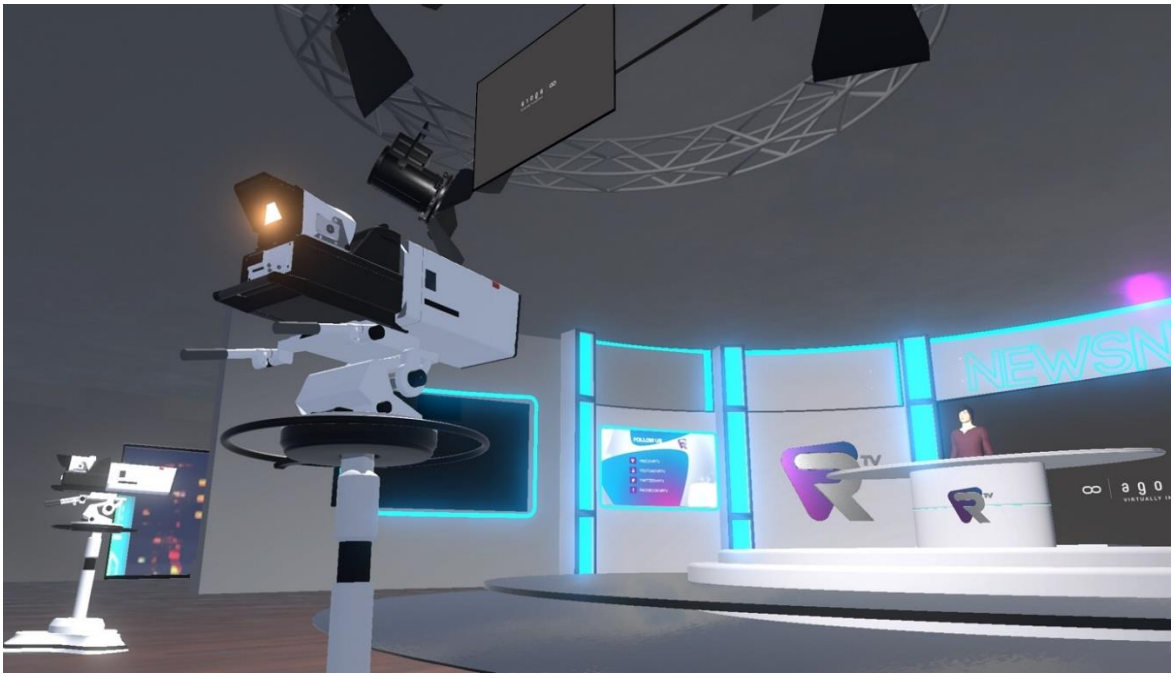

Figure 2. Multiple Camera Studio

The platform allows the creation of light, light-spot and omni-like entities, as well as color and intensity assignment. Since video productions sometimes require a live change of light parameters and timing of their evolution, we have extended the platform with scripts which allow easy access to all the studio light set parameters and their modification using a graphical console. At the same time, we have connected these lights to physical projectors or spot entities that can be easily manipulated in the virtual space manually by users, or using programmed scripts to follow predefined trajectories.

The High Fidelity platform allows video to be viewed in Chromium-based web entities, but as each user runs their own simulation in the client application, each will view the video independently. An important contribution we have made to the High Fidelity platform is to create the possibility of synchronous viewing of video files as if users present at a certain time in the same simulation would watch the same video monitor. Thus, any user's actions on the video player (play, pause, stop, scroll, or change video content) are captured using web APIs and using a NOD JS and Socket.io server to be transmitted in real time to the players videos of other users so that a synchronous view of the video is obtained.

The High Fidelity Platform allows video content to be viewed in WebM format using VP8 and VP9 video codecs and Opus audio codecs, while not allowing the use of mp4 format with H264 video codec and AAC for audio, for licensing reasons of these codecs, which makes it impossible to include live streaming systems in the platform because they exclusively use these codecs through the RTMP protocol.

A major contribution was the development of a scalable live streaming system based on RTMP, where, at the streaming server level, we included a live transcoding of the media format from H264 / AAC to WebM / Opus. Thus, any live RTMP broadcast can be included in the platform, in the web browser, in the supported format.

We have also tried WebRTC-based solutions that are wholly based on WebM /Opus, but they have the disadvantage of scalability because the web browser allows a maximum of 100 simultaneous connections.

Figure 3. Virtual Studio Set

Regarding the virtual studio sets (Figure 3), we have created the ability to remotely manage their different animations, from the technical room, as well as to change colors or background images for them, to create the best environment for live video production. Images, video, live images taken by virtual cameras as well as real-world live images can be included.

For best communication between technical team members, we created virtual intercom systems, so that user lists can be created, such that team members can communicate independently, listening to each other.

For the best presentation of moderators and presenters, we have created and included teleprompter systems, whose text content can be edited, and the scrolling speed and font size can be set live. These teleprompter systems can be configured to be visible to all users or just to certain users, so they do not appear in virtual cameras' images, which is impossible in the real world.

For the technical room, we have included command interfaces for all of these elements, so control panel virtual operators can provide technical direction in a much easier way than in the real world: they can control decors, lights, audio mixer, switching live virtual cameras, video and graphics (lower thirds, logos, texts), and control recording or live video production.

In this project, we have started by creating the domain environment and the main building of the TV studio (Figure 3). On the first floor we have some meeting rooms and a News Studio. The News Studio have two fixed cameras and three mobile cameras. On the ceiling it is included a teleprompter text tool for presenters (Figure 4). The teleprompter allows editing the text,

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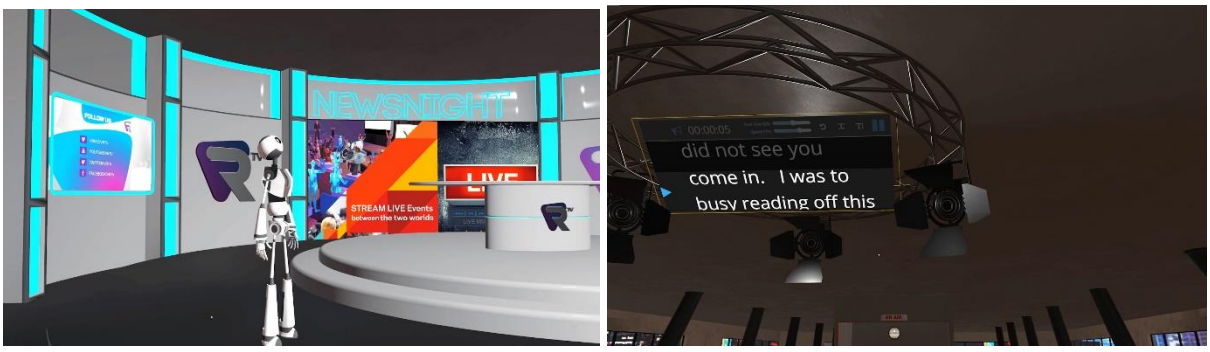

Figure 4. The News Studio and Prompter application

On the first floor, there is also a control room that includes the switching screens application, based on Node.js and the video switcher, that allows real time switching of cameras and prerecorded materials. This switcher also allows the using of video graphic overlays (logos, lower thirds, and the using of visual identity materials bumpers, tv schedule etc.).

The switcher application is based on Web sockets and use as a backend the open source OBS Studio application. From the control room the users can operate the recording application and the live broadcast application. The broadcast application is based on JavaScript and WebRTC.

Figure 5. Studios, stage and aula

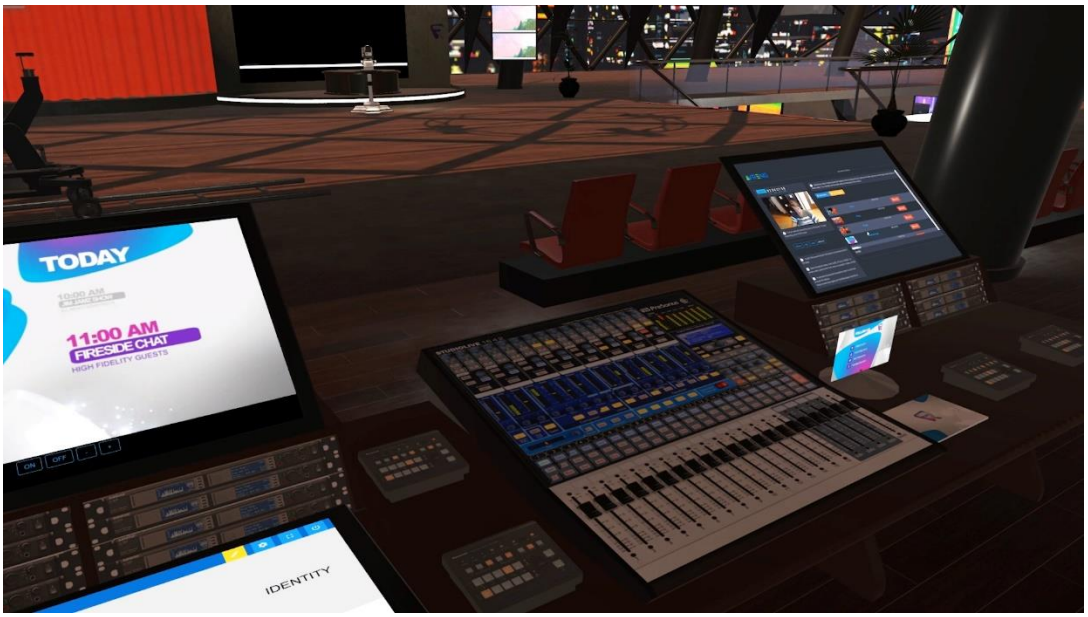

Figure 6. The Control Room

On the lobby there is integrated an NPC, a robot that act as a virtual guide to take the tour of the studio. This NPC uses a TTS (text to speech) application to talk to the users.

On the second floor there are two studios for talk show and entertainment productions (figure 7), a stage with a big video screen and an aula with chairs (figure 5) and a fully equipped control room (figure 6).

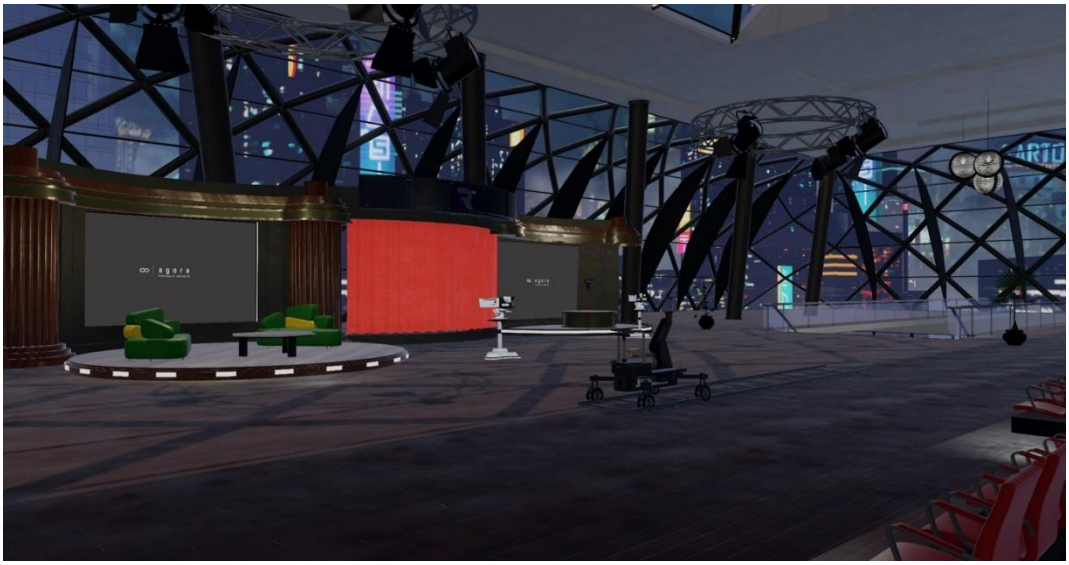

Figure 7. Talk Show Studio, Stage

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CONCLUSION

Using the JavaScript and qml API of the HighFidelity platform we have succeed to create a fully functional TV Broadcasting Studio. The platform can be accessed by installing the HighFidelity engine interface from: https://highfidelity.com/download/thanks#client

After the installation one can access the platform, by pushing the GOTO button and typing the domain name called *VRTV*.

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