Avatar Based Multiplayer Functionalities in Next Generation Communication and Learning in Virtual Reality Social Platforms – Case MarISOT Room

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Abstract — Virtual Reality Social Platforms are increasingly in use in conferences, and exhibitions. COVID-19 pandemic is the main reason for a rapid growth but there are reasons such as climate change to believe these technologies will be used widely once we will enter to the post pandemic era. In this paper, we will introduce our vision to combine social functioning and hands-on-training features in one package. We have participated in and organized various events using existing virtual reality social platforms. We will analyze in this paper their pros and cons plus introduce our own technology trials. As a result, we have better understanding what development tools and how much resources would be needed to be able to create the first minimal viable product combining social functioning and hands-on-training features.

Keywords: Virtual Reality, Social Platform, Virtual Training, Hands-On-Training, Multiplayer Functionalities.

I. INTRODUCTION

Due to COVID-19 pandemic more immersive communication and learning environments are requested by not only event organizers, but also education and training institutes both from public and private sectors. Interactive technologies such as virtual and extended reality sets the user in the middle of an immersive digital environment unlike any other technology before and could be used to alleviate the effects of current social distancing.

Scientists around the world from different fields of science have now organized virtual conferences during this pandemic. For example international society of palaeontology have found several reasons to continue organizing events virtually such as equity, and reduction of CO2 or paper waste [1]. International society of urology in turn have identified a need for a hybrid model where real and virtual agora are combined [2]. This hybrid model underlines the main challenge conferences organized using webinar technologies such as Microsoft Teams, and Zoom are causing – a lack of natural interaction in real time and in real world.

During a virtual event, a lot of terminology could be used amongst the participants and organizers that is unique to the virtual world. For example, the digital representation of someone within the virtual world is called their Avatar [3]. This avatar is visible to others and is what represents the user. Avatars can be customized by the user to look like the user or however they like. A virtual conference space belongs to the emerging technology of shared virtual environments (SEVs) in which virtual worlds are developed for education, entertainment, work, and training purposes [4]. SEVs can be applied for virtual conferences, were apart from that conference room, nothing else exists in that world. A world could, of course, be a lot bigger and represent an entire company or organization.

About conferences and seminars, the word webinar exists to describe a seminar conducted over the internet. Such webinars usually have a presentation in the form of slides or videos and allow online interaction between the presenters and the participants. Many platforms capable of hosting webinars exist. Some allow the use of 3D avatars and other provide a simpler, 2D, approach like video conferences but more interactive.

All these platforms provide each their own metaverse. The word “metaverse” comes from the prefix “meta”, meaning beyond, and “universe”. It describes a virtual universe shared amongst its users allowing them to interact with each other within the boundaries of the platform [5]. A metaverse can have multiple worlds and each world multiple users that can travel between any of the worlds of this metaverse. Some companies have used other terms to describe their digital universes such as ”Magicverse” [6] or “Omniverse” [7], but the most commonly used is “Metaverse".

The structure of this paper is as follows. In Chapter 2, we will describe the background for this paper, why current technologies are appropriate organizing events and training sessions using virtual reality social platforms. Then in Chapter 3, we will introduce main terminology and technology review in this field with our own findings. Based on this in Chapter 4 we will explain why multiplayer functionalities are needed. Finally in Chapter 5 introduces our previous experiences in multiplayer functionalities and benefits in hands-on-training which will be followed by Chapter 6 in which our first test applications will be introduced with key findings. At the end in the conclusion, we will summarize how realistic it would be to build own

technology covering both hands-on-training and virtual reality social platform.

II. RESEARCH BACKGROUND

Industry giants such as Microsoft and Facebook are spending a lot of resources in the development of virtual reality social platforms. While buying Oculus, Facebook revealed their intention to integrate virtual reality in their social platform business. Just lately Facebook has launched their virtual reality social platform called Horizon [8]. Microsoft in turn has introduced HoloLens concept years ago. After launching Microsoft Mesh in March 2021 it is obvious that AltspaceVR, Mesh, and Teams will be merged together forming a new social platform concept [9].

This paper illustrates how Turku University of Applied Sciences has applied multiplayer functionalities in maritime safety training (in MarISOT project). This MarISOT case study shows how we have tested different virtual reality platforms, analyzed their pros and cons, and finally developed own technology solutions using two different game engines (Unity and Unreal Engine) to find out how much time and resources it would take to develop own technology to tackle challenges identified once using existing platforms.

During this study we have organized and participated in various virtual events in which virtual platforms available in the markets have been used. Valuable data of pros and cons of existing platform and of the requirements of creating own technology was collected from expert interviews.

In this paper, we also want to underline the need of virtual reality social platforms in education and training. Based on our experiences while participating in and organizing own virtual events we have identified a need for more interactive content. Especially in education and training there is an urgent need for hands-on-training environments separately such as MarISOT project shows but also as a part of virtual reality social platforms. In this paper, we aim to illustrate how this type of extension could be designed and implemented in the near future.

III. AVATARS AND VIRTUAL REALITY SOCIAL PLATFORMS

Virtual or synthetic worlds defined by Castronova [10] are computer-generated physical spaces which are represented in three dimensions and which can be experienced by many people at once. One of the key elements in virtual worlds is the use of avatars. These computer generated visual representations of users can be visualized in second-person VR systems [11,12]. Users tend to have a greater control over their own avatar representation or ability to design [13].

Second Life launched already in 2003 has been one of the first and the most prominent example of virtual worlds [14]. Later technologies such as MootUp, Breakroom, LearnBrite, Virtway Events, Engage, Microsoft AltSpaceVR, Facebook Horizon, Glue, Mozilla Hub, VRChat and VirBELA have been among the most commonly used virtual platforms [15,16]. Typically these virtual reality social platforms require registrations which enables both public and private events to be organized.

These platforms offer tools to facilitate presentations, talks, screen sharing, viewing videos, and VoIP communication. Main differences can be found from license policies, some of these are open source, free to use, customizable, and even offering recreational tools and limited scripting options. The maximum number of participants per event vary a lot from tens to hundreds of users. Some of the most advanced can be used with or without VR headsets and offer more photorealistic presence and spatial multiplayer experiences such as the enterprise edition of AltspaceVR built on Microsoft Mesh [17]. Quite many of these require the installation of the application. There are also non desktop 3D browser based platforms such as MaxWhere which have same tools to organize events such as conferences or exhibitions [18].

Based on experiences gathered from events such as IEEE CogInfoCom 2020 organized in MaxWhere VR workspace and based on literature review we decided to organize our first own virtual event in Microsoft AltspaceVR in March 2021 (Fig. 1).

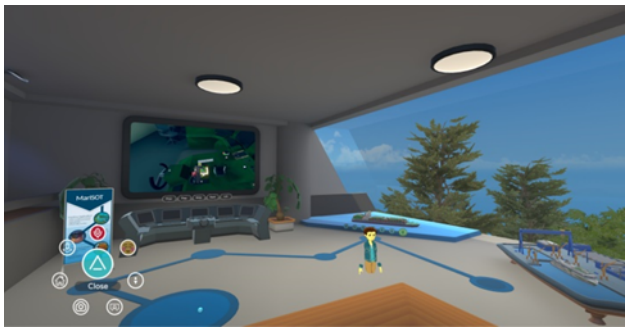

Figure 1. MarISOT virtual space in AltspaceVR

IV. EXPERIENCES WHILE USING ALTSPACEVR PLATFORM

We decided to create a modular environment, made to be modified easily, that can suit our needs for this and any future event. The entire environment was built as an FBX file which allows easy transfer between game development platforms and all of its textures maps use one master-texture which colors and shades everything, which helps us save on file size.

The ways to participate the event was through joining the AltspaceVR directly or by watching the YouTube livestream that was set up. Detailed instructions were sent to the participants to cover any technical issues they may come across while trying to join. The YouTube livestream was streamed from a “camera man” within the AltspaceVR environment that was showing his point of view, following the action to include everything that was happening such as the speakers’ presentations, the interviews and tours of the environment

The two biggest more decorated rooms at the front had a huge glass wall that could oversee the Auditorium allowing indoor viewing of the speakers. Those rooms were dedicated to TUAS and MarISOT. The MarISOT room (Fig. 1) featured detailed ship, loading bay and command bridge models. Above the life size command bridge a video played showcasing gameplay from our VR command bridge application that uses the same model.

AltspaceVR allowed the implementation of multiple useful features that we made sure to utilize. It featured two build-in media player screens. One for uploading videos and pictures and scrolling through them like a slideshow, very useful for presentations, and the other for sharing one's screen. The second was used for the speakers' presentations as it allowed a lot more freedom and it also allowed MS Teams communication and video. Because anything on screen could be shared, we were able to bring up a Teams video call on the Auditorium screen to let speakers that were not able to join through AltspaceVR speak and have their presentations. AltspaceVR also featured useful access control for administrators of the event, allowing them to mute or enhance the voice of any participant, remove potential troublemakers and keep track of everyone that joined any room of the event.

Many other useful features were thought up by our development team that could easily be transferred between different social platforms and game development engines. Such features were roll-ups and posters were participants created their own designs with information to be displayed, video players with pre-loaded videos, animations that showcased the function of complex machinery (Fig. 2). Detailed miniatures of objects, rooms and buildings as well as 360 picture spheres, the users could walk in and look around, allowed users to get a more immersed and engaged in each exhibition. Last, but not least, the wonderful environment with beautiful, animated trees and grass, its blue sky and sea and the natural ambient sounds of birds and wind all came together to create a relaxing mood for all participants.

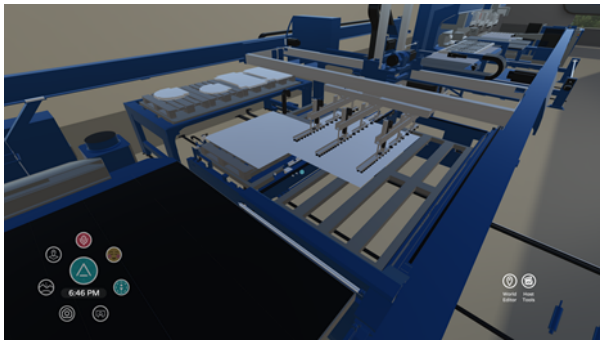

Figure 2. An animated machine in AltspaceVR.

AltspaceVR came with some limitations. One of these was that we had to split the audience to groups of 50 and distribute them between 2 instances of the event. The maximum of number of users per instance were 50 but the total amount of events participants can go over 250. However, the admins could "mirror" the speaker's avatar as well as their presentation on all instances at the same time so that all users could participate. Unfortunately, only users on the same instance as the speaker could directly interact with them such as ask them questions.

Another limitation was the world size that could be uploaded per world. Because of that we had to split our event space between 2 worlds, one for the main event and one for the student projects. These events were connected via an easily accessible teleporter, but it required loading every time you teleported which could take some time on low end computers and laptops.

A part of joining the event was making an account and in extension customizing your virtual representation, also known as your avatar. Some users did not bother with customizing their avatar, but most did, either making their Avatar closer to their real self or just make it fancy based on their ideal look. Avatars allow everyone despite their real life looks or physical ability to co-exist within the virtual world. This creates a homogenous visual aesthetic to the world's inhabitants look similar to the overall art style, but each has unique characteristics that set them apart. Some users however expressed that the cartoony art style of the avatar creation provided by AltspaceVR was not to their liking as they obviously cannot express emotion like a real face can and the lack of legs and arms can break their immersion.

Most performance issues we encountered could be ignored for high-end computers but make the experience un-playable for low-end machines. Such issues were the low framerate caused by too many active polygons always present. This was fixed through clever use of LOD and culling. Another issue was the over-use of Artspace's multimedia players which cause a RAM overload for low-end computers. This was fixed by uploading videos as part of the world which increased download time but did not require further loading from the users.

AltspaceVR does allow custom worlds to be imported by Unity, but it does not allow custom scripts. It makes sense why Microsoft would not allow potentially malicious foreign scripts to run on their platform but that limits the creative capabilities of the custom world creators greatly.

V. NEED FOR MULTIPLAYER FUNCTIONALITIES

First participation and later organizing virtual events revealed various usability, user experience and other issues to be tackled. First of all, users seem to prefer solutions which can be used easily without any kind of installations and registrations. Users prefer web-based solutions which typically don't consist of avatars neither a possibility to use VR glasses with high quality graphics.

However, web-based applications also come with their own shortcomings. A web-based application cannot outperform an installed application on processing power as it is developed very linearly to be able to run online. Because of that many features found on downloadable applications are missing. They also tend to look a lot worse on the graphical side as they need to be able to load quickly.

In addition, our partners have been asking opportunities to collect a lot of data from the events. Existing platforms are quite closed environments and therefore we decided to start developing own solution including front- and back-end to be used in virtual events and/or training sessions requiring hands-on-training features.

We have years of experience in virtual safety training for example in maritime sector such as MarISOT project [19]. While organizing events in AltspaceVR various discussions led in questions why hands-on-training cannot be integrated in exhibitions where for example visitors could operate in a ship command bridge or in a ship engine room environments and learn more about these products.

By saying all this we have now developed own technology using Unity and Unreal game engines. In addition, we have integrated multiplayer functionality to ShipSEVR training episode developed earlier together with Wärtsilä and Ade [20]. Next these multiplayer functionalities are described with main findings.

VI. MULTIPLAYER FUNCTIONALITY IN VR TRAINING

The virtual ShipSEVR training episodes consists of a 3D ship engine room space where trainees are expected to find certain devices and equipment by utilizing the available technical drawings. This solution brings just in time all required documentation visually and easily available. The first tests in Wärtsilä were quite promising. In the classroom, students cannot fully understand real-world challenges and context. And in the harsh ship engine room conditions it is challenging to read and follow documentations effectively. ShipSEVR was originally designed to tackle above mentioned challenges. During these first tests the lack of real time introduction was identified.

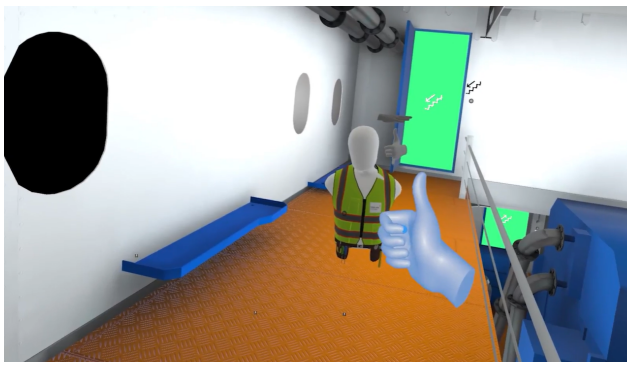

Figure 3. Verbal and non-verbal communication between trainer and trainee.

Therefore we decided to integrate multiplayer functionality to the existing ShipSEVR training episode. The current version is built on Oculus Quest VR headsets utilizing Oculus SDK, and Photon Bolt Unity plugin. This new version includes VoIP communication with avatars. Also hand tracking is applied to offer more natural interaction (Fig. 3) methods based on our previous experiences reported in [21].

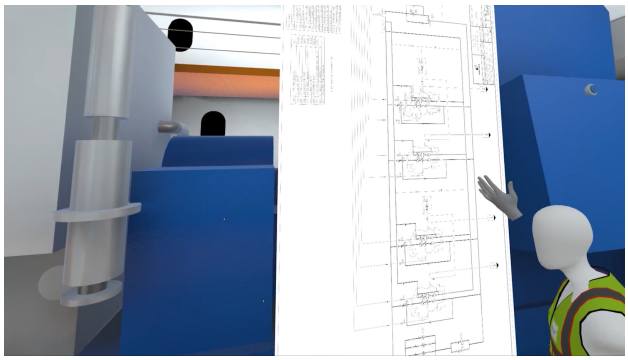

Figure 4. Multiplayer functionality in ShipSEVR training episode enabling interactive schematic reviews

It enables for example interactive schematic reviews (Fig. 4) in VR between a trainer and trainees which can be present in a same location and just in time opening an appropriate documentation to be explained in details in a way which is not possible in traditional training sessions (classroom vs. field work training). In addition, this way a special expert can coach novices around the world even during pandemics such as COVID-19.

VII. INTEGRATING HANDS-ON-TRAINING IN VIRTUAL REALITY SOCIAL PLATFORMS

So we have now developed two test applications to be able to understand better the potential of own technology to be used while organizing upcoming virtual events (Fig. 5). These findings are reported in details in [16]. In this testing phase, we identified next features to be developed first: virtual reality mechanics, multiplayer, VoIP, messaging and video player. In fact, these findings are based on just around one month work of one single developer during spring 2021.

Figure 5. Avatar and environment in Unity (left) and UE4 (right)

Unreal test application was developed with UE4 using blueprints while Unity test app was scripted in C#. Three game development experts were testing these applications and first findings are reported as follows:

The applications had some differences in the features to see which were preferred by the testers. Unity version had a text chat that used hardware keyboard inputs and the UE4 version had a virtual keyboard. The input for UI interaction in Unity was the A-button in Oculus Touch controller and in UE4 the same interaction was handled with the Trigger button. VoIP had a channel open all the time in Unity and UE4 version had the channel open only while holding down the A button. The UE4 version had a more sensitive inputs with teleportation that triggered when the user touches the joystick while Unity required a press of the joystick. Video player functioned in a similar way on both applications.

Each application also had different environments. Unity version had a very basic scene that was made for our previous project and the Log Cabin by Gabro Media asset was used as an environment for UE4 version. The latter had ambient sounds in the environment while the Unity environment was completely silent. Unity had 3D models for user avatars and UE4 version had only cubes to display user position and rotation.

Based on the feedback given by the experts, the VoIP system could be altered in a way that a certain input opens the voice channel and leaves it open until next input. This solution would not require the constant holding down of the input button and remembering to do so.

VIII. MULTIPLAYER FUNCTIONALITIES IN UNITY AND UNREAL

Unity lacks built-in multiplayer functionality and relies on plugins for networking. Photon Bolt was used for the prototype, but it might prove out to be non-ideal solution in the long run since it only supports 16 simultaneous participants in one room according to their website, but the limit could be raised by contacting Photon. Up to 50.000 users could be logged in simultaneously to the same server so the problem might be something that could be worked around with mirroring. Another solution could be to use another plugin called Mirror that has no such hard limits but provides no servers. The Photon Bolt costs 370$ per month for 2000 connected users while Mirror is open-source.

Photon Bolt's networking is based on a client-server architecture which requires more from the host but prevents vulnerabilities that come with P2P. Mirror provides the possibility to use P2P but the possible vulnerabilities require more research.

Unreal provides built-in networking through Steam which was easy to implement by using VR Extension Plugin. The plugin also provides a lot of optimization and features to VR development and is open source with credit requirements to MIT license. The networking in Unreal has no hard limit and is entirely dependent of the hosts hardware since it uses client-server architecture. This could also be worked around by using mirrored functionalities between the servers like AltSpaceVR does. The popular video game Fortnite has a limit of 100 simultaneous players in a game with Unreal's networking solution. Unreal Engine is widely regarded as "battle tested" by the game industry professionals and it's built-in architecture helps a lot with project scalability which makes it a strong candidate for virtual reality social platform development.

Creating customizable avatars inside both engines is very straightforward and there are no major problems with creating such a system in either.

IX. IMPACT TO THE MARITIME SECTOR

The research conducted on and presented in this paper have specifically and strategically applied in the maritime and shipping industry. Shipping is the most international industry which requires extensive teamwork and complex activities that needed to be delivered at the end ports and at sea. To support such operations large teams of experts, need to be in the same place to assure clear communication, coordination and understanding of the work to be delivered.

The existing Virtual Reality applications in the shipping industry revolutionized human interaction and eliminated distances without affecting the quality of collaboration and the expected working and learning outcomes. The challenge however remains on the delivery of gamified multitasking activities, especially on technical work, with the same effectiveness virtual reality offers to the single user task activities [22]. To tackle this challenge multiplayer functionality had to be developed.

This research integrates avatar technologies to achieve a gamified multiplayer functionality within virtual social and professional spaces that extend physical space limitations and allow avatars to move freely within them.

The case of the SiphSEVR engine room has been specifically selected in this work to emphasize the multiplayer need when perform technical tasks. Effective synchronization between ship engineers is vital the ship sailing performance, fuel optimization, and accident reductions or elimination. The integration of the virtual spaces with the multiplayer functionality allows more participants to join a virtual session including experts, instructors, trainees, and even observers or examines.

The virtual delivery of such multiplayer training scenarios in limitless and personally customized virtual spaces can increase the learning outcomes thought the practical real time collaboration of the users. Furthermore, it extends the virtual reality training limits to cover activities, generate new training needs and expectations and redefine the concept of virtual reality training in the ever-demanding shipping industry.

X. AREAS OF FURTHER RESEARCH

The integration of avatar based multiplayer functionality in virtual social and professional learning and working spaces presented in this research expands the virtual training horizons but also indicates the needs for further research that can lead to green (sustainable) [23] and pink (social) [24] corporate strategies and innovations.

Bringing together numerous users, through their avatars, to collaborate and participate in working and learning activities sets the ground for the introduction of cognitive and behavioral science technologies that can help analyze and understand human behavior, predict human actions, and improve training and collaboration effectiveness. Such research is in progress and we achieved the first results using eye tracking technology [25], hand tracking [21] and neural networks for the back end data analysis and decision support system.

Our cognitive science approach in virtual spaces is in early experimental stages where data is also collected on the avatar's behavior and attention on exhibits, objects and devices within a customized space. Attempts will be made to expand our work using existing natural language processing and speech recognition work that has been tested in this research. This can be achieved with the introduction of chatbots, translations, speech to text, text to speech and other technologies.

Based on the results it is withing our plans to transfer this research and strategy on a mobile phone version for nomadic participants.

XI. CONCLUSIONS

The post-pandemic ere will be characterized by the tremendous changes in social and professional activities. Virtual reality introduced technologies, ideas and concepts that prior the pandemic was considered mostly as cost centers than profit centers. The new reality unleashes the potential of virtual reality and introduces emerging technologies that will have a protagonist role in peoples lives.

This research presented the first results of multiplayer functionality in virtual social and professional spades. The case is implemented on the maritime industry and builds upon the ShipSEVR technology for virtual reality safety training in engine rooms, and on the MarISOT virtual social platform. The integration of the two projects used avatar technology to study the communication and learning effectiveness.

Different feature implementations were also tested inside Unreal Engine 4 and Unity to determine how much time and effort would be needed to create a simple prototype with a single developer. These implementations were cut short halfway due to lack of time, and some parts were just left to speculation.

There was no single platform that had all the features the department wished for but the one that met most of the set requirements proved out to be AltSpace VR which the School of ICT had been using in the past.

The expert reviews and feature implementations gave an indication on what it would take to develop an entirely new platform suited for the TUAS School of ICT needs. It was generally agreed that such an undertaking would take a few years if it were to be fully polished and would require a team of multiple talented individuals. However, a simple prototype could be completed in a few months, but it would not include most of the requested features.

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