Keeping the living bond between actors and remote audiences in distributed virtual theater

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ABSTRACT

This paper introduces a new method to achieve remote distributed performances using a virtual shadow theater and real time motion capture. It was used during the lockdowns in France in 2020-21 to reach remote scholar audiences with *The Wizard without Shadow* performance. After a review of remote distributed virtual experiments in performing arts, the paper details the creation-as-research process that leads to two versions of the same story. It shows how the quality of the theatrical bond between the actor and the audience of the first face-to-face version is maintained in the second remote version combining a video conference platform and live motion capture in a video game engine to bring actors performances to two remote distributed audiences.

CCS CONCEPTS

• **Human-centered-computing**; • **Interaction design**; • **Empirical studies in interaction design**; • **Computer systems organization**; • **Real-time systems**; • **Real time system architecture**; • **Applied computing**; • **Arts and humanities**; • **performing arts**; • **Computing methodologies**; • **Computer graphics**; • **Animation**; • **Motion capture**;

KEYWORDS

Avatar direction, mixed reality, motion capture, performing arts virtual theatre

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1 INTRODUCTION

Since the possibility of using digital processes in real time offered at the turn of the century by computer performances exponential growth, a widespread hybridization between real and virtual worlds occurred in the performing arts [25]. Performance capture has become an alternative to using the traditional camera for recording the actor's performance. [27] recently demonstrated how a digital cover of himself could realistically emulate his presence in a video game engine. Cinema industry is being deeply transformed by this digital turn in production pipelines for the real time shooting of virtual actors as shown in a SIGGRAPH 2016 awarded live demonstration by [1]. Previsualization techniques aiming to help actors in understanding the virtual reality which they act in, become key elements in shootings involving VFX augmented digital partners in virtual sceneries, as shown in the recent PREVIZ project [3].

On the theatrical level, the mediatized presence of the actor on the intermedia stage becomes a major issue [23]. After having confronted the actor to his own video capture on the multiple screens that nowadays augment the stage, a new step has been recently taken with the use of motion capture to transpose his expressive capacities during live performances. [20] showed how the concept of on-set previsualization allowed the tools of cinema to be creatively organized around the figures of the physical actor, his digital double and the director. Then he applied the concept to theater [21], which opens new perspectives of scenic acting as [15] approaches them through the study of the relationship between the actor and his digital doubles.

Beyond the actor's relationship to virtual worlds and avatars, there is also the question of the viewer's relationship to the hybrid mixed reality that unfolds on the stage. Two responses have been already proposed, mainly motivated by the fact of giving remote access to the theatrical performance: the first asks the spectator to connect to a virtual world, as Second Life promoted it a few years ago [26]. The second proposes to immerse the spectator in a 3D capture of the theatrical stage with stereoscopic cameras [11]. In both cases, this supposes an individualization of the spectator prior to his projection in a shared virtual reality, which transforms the concept of an audience gathered in a place to watch (etymologically, teatron in Greek means "place for viewing"). It supposes to set up a technological infrastructure far away from the current handwork cultural context of the performing arts.

This issue of a remote relationship between spectators and theater stage has suddenly become vital with the outbreak of the health crisis related to Covid 19 and the enforcement of lockdowns as the only effective response to slow the pandemic. The cinema found a possible alternative by switching its distribution towards streaming platforms, but the theater found itself totally blocked. This underlines the fragility of the live relationship, here and now, of an assembly of spectators sharing emotions with a company of actors.

This paper exposes how a solution to maintain this relationship was invented during the realization and the diffusion of the *The Wizard without Shadow* performance [31] (see fig. 1). Its production context is that of a creation-as-research [4]. It consists in exploring the relationship between a physical actor, avatars evolving in a virtual shadow theater and spectators, in a low-cost set up adapted

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to live performance and easily deployable in varied venues in order to reach a large audience. The research-as-creation started in February 2020, but it was hit by the Covid 19 health crisis which triggered a reflection on the ways to make the performance exist in lockdown conditions. Taking this issue into account early enough in the creative process led to the parallel exploration of two forms. The purpose was to share the face-to-face performance with remote distributed audiences.

Section 2 situates our research in the backgrounds of remote distributed virtual theater. Section 3 describes the aesthetical and technical context of the creation-as-research project. Section 4 exposes the impact of the health crisis on the creative process. Section 5 details the creative answer found to reach remote audiences. Section 6 is an opportunity to discuss our results and section 7 concludes and opens perspectives.

2 BACKGROUNDS

2.1 Remote distributed theater with video

Broadcasting performing arts on the TV network is not sharing theater with an assembly of spectators. Using video broadcast to build a distributed performance allowing audiences located in different places to share the same theatrical event is quite a different experiment.

A telepresence setup as described by [28] has a deep impact on the creative process of a live performance and requires from the artists an openminded approach to keep working their creativity in a new and instable technological environment. The relationship through cameras and video screens to remote audiences asks to explore specific practices and could entail a new theatrical field of performances. This was one of the results of the Shakespeare's *Tempest* distributed staging by the Miracle Theater Company [32]. Cameras and video projections setup combined with two specific software components allowed two distant audiences to attend the famous play [14]. Watching actors in remote distributed venues requires however new adapted plays to draw the best creative result from the hybridization between TV and theater.

The video duplication and the possibilities offered by transforming images in real time induce an expressive modification in the way of acting itself and specifically in the movement qualities [33]. The question of the actor's relationship to the digital environment that surrounds him on the theatrical stage is essential, especially in terms of interactions. And the issue of interacting with oneself video double as facing a magic mirror changes fundamentally with the emergence of virtual reality and 3D computer graphic images superseding the flatness of video live recordings.

2.2 Virtual Reality (VR) and motion capture

VR on the theatrical stage opens a new issue, specific to the depth of the 3D images which does not exist in the video media. This is a paradigmatic change in digital simulation which goes beyond the question of video realistic capture of the physical world. VR on stage offers the performer to play in two worlds with different rules. It asks in return to solve the relationship between physical and virtual worlds to allow seamless transitions from the audience viewpoint. This question is specifically addressed in the artistic use of natural and digital shadows in several art installations and performances [13]. The basic issues of visual continuity of illuminated bodies at the border between real and virtual spaces are both fascinating and complicated, and always playful for the spectator [12].

It is quite exciting for the performer to enter this new virtual world. And this transfer in VR has been tackled early, when VR was still an emergent technique, in a pioneering theatrical experiment by [29] in 2000. Its goal was to check if VR could be used by directors and actors to remotely rehearse a play before performing it in real life for a physical audience. And the results were positive to the surprise of the authors themselves. VR setup and control interface for directing avatars prove to be effective in helping artists to share a common space and organize the blocking. In this experiment, it was no longer a question of continuity between real and virtual worlds, but rather of substitution. VR emulated real conditions and could be a tool to bring out a show to reality. The control of the avatar, in 2000, was still done with a keyboard and a mouse.

The dissemination of low-cost motion capture devices since 2010 changes the game and brings accessible solutions to theater companies and their actors to enter and perform in VR with their own bodies. Following the classification of [22], it is important to underline that even if a virtual actor controlled by motion capture lively performs on stage, it remains a puppet under the control of another body and mind. This virtual actor, that we call an avatar, is no more a captured mirroring image of the real actor, but a complete reconstruction of the actor's movements. About this living puppet, [10] clearly formulates the dissociation between the capture of movement and its retargeting on the avatar in the context of performing arts. And he concluded that visualizing her own digital body appears to be necessary for a performer to guarantee the quality of her presence in the virtual world.

2.3 Digital double and presence effect

Presence effect is a key factor to make possible for the audience a dialogue on stage between physical actor and avatars. Originally using cameras and video screens, microphones and speakers, automatic lighting, and now by performance capture devices and sensors, actors' body and voice are mediatized and surrounded with a mix of digital and physical partners and materials. This cohabitation induces a tension between physical reality and its digital simulation [5]. As underlined above, an avatar is a puppet and not an autonomous actor. As thoroughly studied by [2], this puppet should be characterized by a presence effect to trigger the suspension of disbelief and catch the attention of the audience. Technological tools are not easy to tame, especially in the creative field of performing arts, which follow a handwork tradition sometimes mistrustful with computer uses. On the other side, theater is also an attractive field of experiment because it confronts human being to the complexity of reality, including the technological realities of our time [19].

This presence effect induces two complementary issues: the first explores the necessary conditions for an actor to immerse himself in the body of an avatar and inhabit a virtual world. Early in 2000, [24] already established some basic rules for the theatrical use of VR. This question had not been addressed in the same period by Slater's experiment because immersive technologies with HMD had not yet become sufficiently qualitative and widespread. It became a

central issue a few years later as [16] stressed on embodiment and interactions between avatars in VR. These questions concerned the immersion of the actors in VR, and do not address the immersion of the audience. This paper limits its analyses to the second presence effect issue that concerns the relationship on a hybrid mixed reality stage between physical actor, avatars and physical audience.

2.4 Relationship between virtual partners

Distributed theater experiments using video were originally developed and aimed to share the result of the theatrical process, that is a play performed in front of audiences. [32] noted that the creative team thought only after the experiment that the distributed theater setup could also be used during traditional rehearsals, for instance in the case of a collaboration with a foreign company and even if the project were performed not remotely. Indeed, it is logically expected that theater artists do not think that the most intimate part of their creative process could be successfully achieved with a video tool.

On the contrary, the first experiments about presence quality in mixed VR environments in theatrical context were limited to rehearsals. The BEAMING (Being in Augmented Multimodal Naturally Networked Gatherings) project supported two different experimental rehearsal cases and analyzed, in the wake of the already quoted pioneering Slater's work, if VR could offer a proper environment for remote rehearsals, this time by controlling avatars with motion capture. In the first case, [17] placed the director as a video image in the 3D virtual scenery where the two actors rehearsed under his guidance through their avatars. Positive results were achieved on the blocking issues and on the acting of basic emotional states.

In the second experiment, [30] let the avatars alone on the virtual stage, which the director accessed to through a projection in a CAVE. Moving along the virtual stage, he was able to make esthetical choices about the blocking. More recently, [18] gave the director the opportunity to immerse himself on the rehearsal stage, to play himself a role, to estimate the quality of the result, and to correct his own acting if needed. Indeed, rehearsing is not acting in front of a public. The relationship with the audience is of the first importance.

2.5 The bond with the audience

The question of the audience remains a blind spot in the literature about distributed virtual theater. The experiments in Second Life [26] or with stereoscopic cameras [11] already quoted in introduction isolate the spectator in his own virtual sphere. Acting avatars achieve presence effects for the spectator although the living relationship between the actor and the assembly of spectators seems lost or not taken in account in the scope of the research. [9] demonstrates an inverse situation. Immersed in a virtual world with a HMD, an actor plays a scene following directions given by a prerecorded AR interface inside the virtual world. He is physically surrounded by the audience. The audience is therefore strongly related to the actor, but the actor plays in a virtual room without spectators.

The work of [34] succeeds in building a strong bond between a spectator and a remote performer in the context of a show specifically written for the experiment. An actress wears a motion capture suit and plays remotely in a digital scenery with a feedback of her acting. These actions are transmitted over the network to a CAVE in which a spectator attends the show. The actress has also a video feedback of the spectator. During the show, some interactions occur between both and make the avatar truly connected to the spectator. The remote actions are fully transferred, and the magic of theater happens in the CAVE. In this case, there are only one actor and one spectator.

The goal of the work presented in the next sections is to achieve the same result in a show featuring 1 physical and 8 virtual actors in front of around 30 persons. How to distribute the show to 2 remote venues with twice 30 spectators and preserve the magic of theater?

2.6 Creation-as-research context

The paper is studying a professional theater production, created in January 2021 and touring in France and abroad. The production is following the creation-as-research paradigm as stated by [4], "a form of directed exploration through creative processes that includes experimentation, but also analysis, critique, and a profound engagement with theory and questions of method". It means that the current paper gives space to creative dead ends that are fully part of the research and explains which answers were found to open new paths.

It is strongly inspired by the concept of Computer Theater as exposed by [19] about a creation-as-research. In this concept, theater is used to understand complex interactions between human beings and the world.

3 AESTHETICAL AND TECHNICAL CONTEXTS

3.1 The aesthetical context

The creation-as-research *The Wizard without Shadow* aimed to create a short performance for children inside CAVOAV, a CAstelet in Virtual reality for shadOw Avatar (see fig. 1). This aesthetical concept associates a 3D set design inspired by traditional shadow theater, and virtual flat silhouette actors, called shadow avatars, after *Peter Schlemihl's Miraculous Story* by the romantic writer Chamisso [6]. It fosters the circulation between different states of realities, hybridizing physicality and virtuality in a mixed reality environment populated by 2D/3D shadow avatars interacting with living performers and audiences.

In attunement with the shadow theater context, the director chose an ancient Scottish fairy-tale, that she adapted in an original scenario with a punchline using a shadow FX. A boy, Jaimie, attends a mysterious school of magic, whose tuition is the life of one the classmates, randomly chosen by the school master at the end of the courses. Finally, Jaimie leaves his shadow as the payment, accepted by the sorcerer master, impressed by the trick. Jaimie saves everyone but becomes the "wizard without shadow". The plot focuses mainly on adventures and magic and gives large opportunities to play with playful 3D-FX featuring 6 secondary classmate characters in addition to Jaimie and the school master.

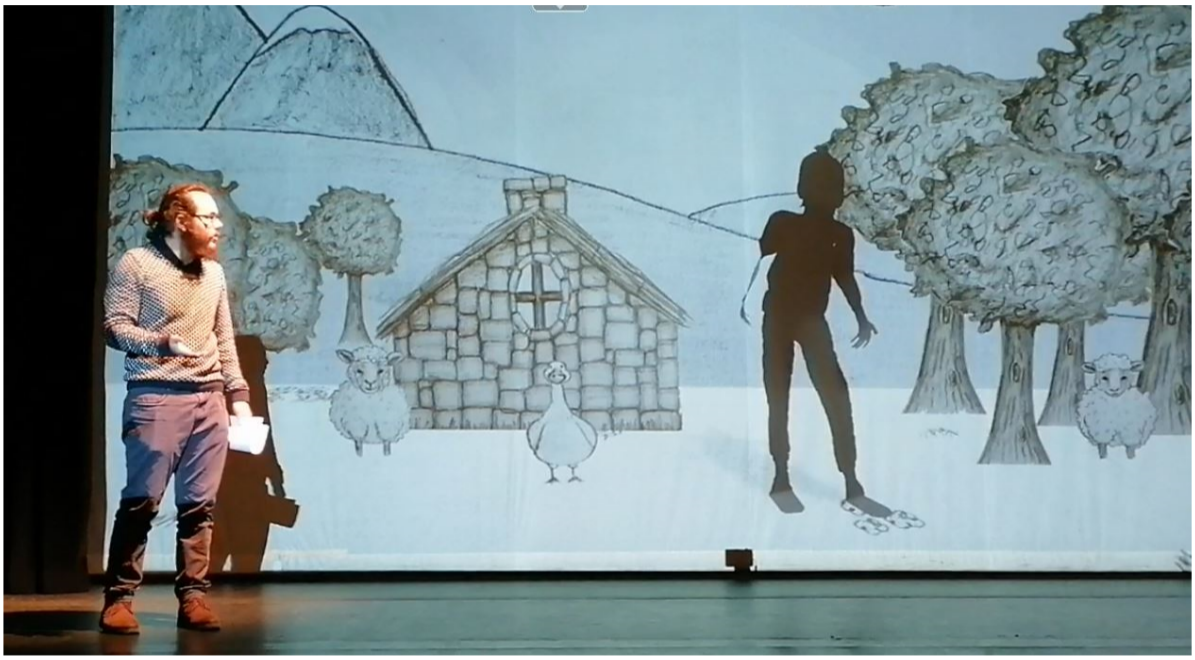

Figure 1: Dialog between the narrator and Jaimie in *The Wizard without Shadow* performance

3.2 The technical animation framework

Avatar animation is based on AvatarStaging, a low-cost framework dedicated to theatrical experimentations with digital characters and physical performers in mixed-reality setup (cf. fig. 2) [8]. An actor equipped with a costume of motion capture (a mocaptor) plays in a space encircled with screens that show the virtual world. The mocaptor properly sees the result of his acting, adapts his movements for the specificity of the digital scene and interacts with a physical actor and other virtual characters.

AvatarStaging offers a possibility to simulate live interactions between the physical actor and avatars pre-recorded animations, precisely detailed in [7], describing the feature through the practice work *The Shadow*, a previous research-as-creation in CAVOAV environment. The feature is based on a system of idle and salient actions, that makes avatars alternate between active and passive actions, passing to the waiting idle mode once a salient movement is accomplished. It permits to adapt the speed of the digital performance to the speed and intensity of the physical acting, keeping a live interaction between physical and virtual stage partners, interaction which lies in the heart of the theater.

3.3 Challenge of the creation-as-research

In the previous work *The Shadow*, the actor was sitting in the left corner of the stage behind a table next to the screen. He played the role of a narrator driving the evolution of the shadow avatars with his voice modulated in a real time musical environment. The gesture interactions between him and the avatars were minimalistic. In *The Wizard without Shadow* the challenge was to put the actor in front of the screen and consistently extend the corporal interactions between him and the avatars. The avatars should enter in a theatrical dialogue with the actor, either responding or even opposing his words. Moreover, having to direct simultaneous interactions between the actor and up to 8 characters made the challenge bigger.

AvatarStaging idle-salient feature does not require specific treatment of recorded animations, neither cleaning nor movements retargeting, that are usually a long and tedious part of the post-production process. Once recorded, animations are organized with a real time cueing system controlled by either the actor or a technical partner (called the operator). However, it asks to establish a storyboard describing a sketch of the scenes, their layout, FX and blocking of both the physical actor and the avatars. The second step consists in programming a sketch of the digital levels (sceneries and FX). The third step is dedicated to rehearsing interactions between the actor and each avatar controlled by the mocaptor, and to record the proper idle and salient avatar animations. The fourth step is the programming of all the idle and salient animations with the real time cueing system, and the final step is the rehearsal of the actor playing with the pre-recorded animations. Due to the theatrical bodily engagement in the acting, it was decided that the cues to make the avatars alive and to progress in the levels would be triggered by an operator.

4 REALIZATION DURING THE HEALTH CRISIS

4.1 Health crisis impact on the process

The conceptualization of the performance took place in February 2020. In the end of February, the scenario and the storyboard were finished. Few days after in March, the first total lockdown was

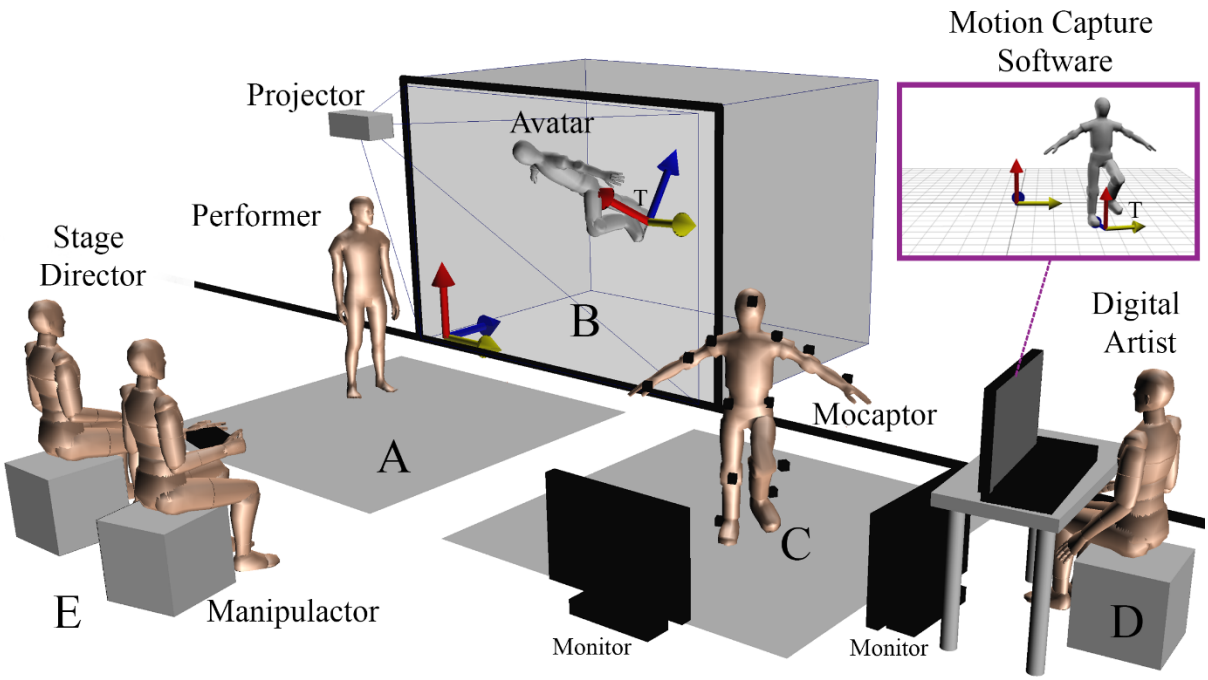

Figure 2: AvatarStaging setup

announced in France. Facing the problem of distancing, the director had an intuition that it would be necessary to adapt the performance original concept in order to share it with remote audiences, using one of the numerous available video conference platforms. The director made a hypothesis that if the actor doesn't move a lot around the scene but plays on the same spot, in the left part of the screen, it would be possible to stream his performance, replacing face-to-face acting with a live streamed close-up video of him acting in front of a webcam (see fig. 3).

The adapted performance would not need to record different types of interactions if the actor webcam image could be placed in the left bottom of the screen as thumb images in video conference platform. The spatial disposition of the avatars would be the same as when they look to the physical actor in front of the screen (see fig. 2).

In June 2020, when the first lockdown finished, the preparation of the virtual spaces started. The third step of rehearsals and movement recordings described in section 3.3 happened in September and October.

4.2 Recording of the animations

Fig. 4 shows how the actor and the mocaptor work together on the same stage. The physical actor narrates the story and the mocaptor animates an avatar in real time, being integrated in the almost completed digital space. Both actors see the result on the feedback screens and improvise with that. That poses a challenge of staging the spatial dispositions, as the avatar will not be able to change them once the sequence is recorded. The physical actor needs to know the final position of his virtual partner on the stage and the moments of gesture interactions with him. As well as the mocaptor needs to have a global vision of what is going on the digital and physical stages to be capable to react respectively to his partners and new events.

Once the actors guided by the director found interesting interactions, the whole team precises the succession of actions and the lines which will drive the salient actions of the avatar. Convincing recorded animations were expected, which the physical actor would play with in the final rehearsal step, with the help of the operator. And the second lockdown started.

4.3 Testing remote distributed rehearsals

The team decided to go on with remote rehearsals as a proof of concept testing the director's intuition of a remote distributed performance. The fourth step of the creative process was completed by programming the around 50 cues allowing the operator to trigger the recorded idle and salient animations. A remote rehearsal configuration has been set up with a web video conference platform, allowing the four members of the creative team to remotely work in November and December 2020, during the second lockdown (cf. fig. 5). The director had a computer powerful enough to play the virtual performance in the Epic Game video game engine Unreal Engine 4 and shared the real time 3D output through the platform. The actor acted in front of a shared webcam. The operator triggered the cues on the director's computer using remote control software and the mocaptor was taking the role of a spectator and critic. The hypothesis that avatars recorded spatial dispositions allow plausible interactions with actor webcam image was confirmed. But

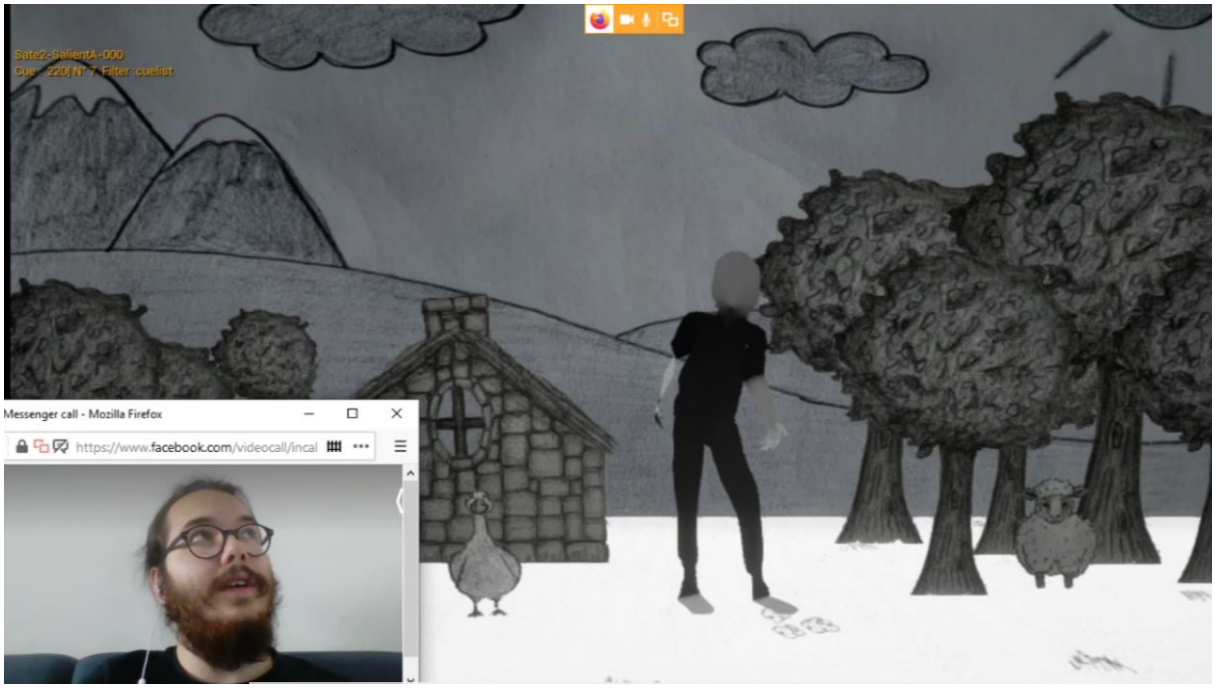

Figure 3: Same dialog as fig. 2 on a video conference platform

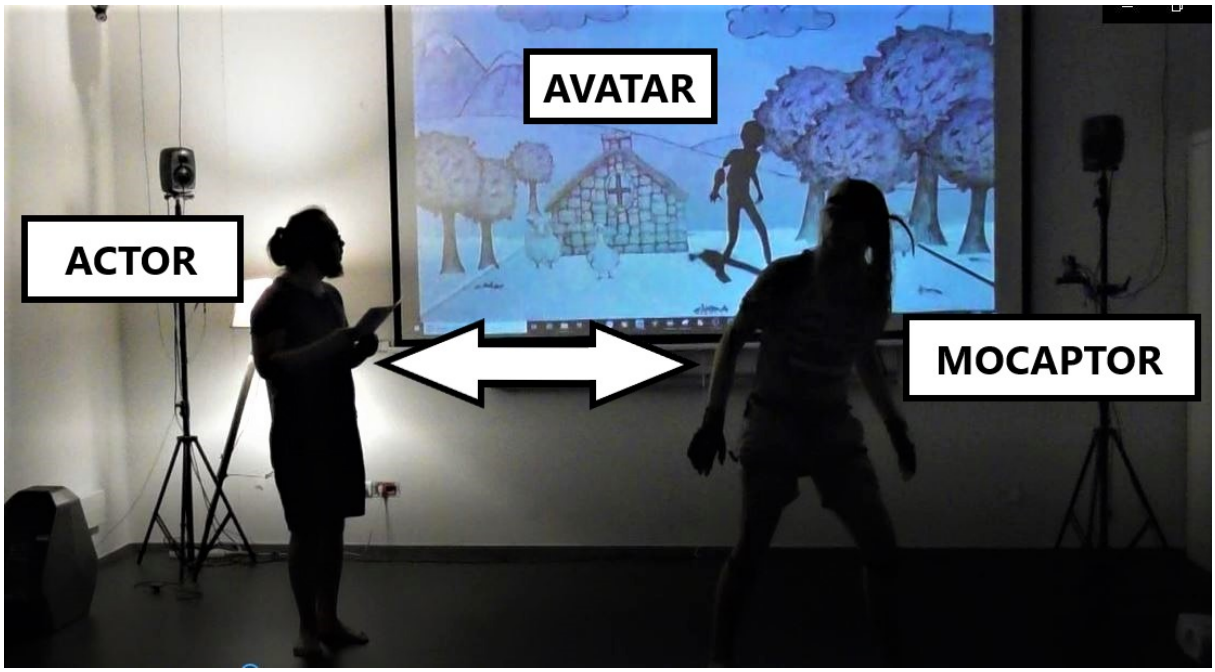

Figure 4: Rehearsals with the actor and the mocaptor

several issues were raised for adapting the live acting to the remote configuration.

As shown in fig. 1, the relation of the physical actor with the screen is natural in face-to-face performance. The screen is placed behind the actor from his viewpoint as well as from the spectators one. The actor could be semi-turned to the screen referring his regard to the audience or to the digital space. He controls what is happening with the avatars and can keep the eye contact and the

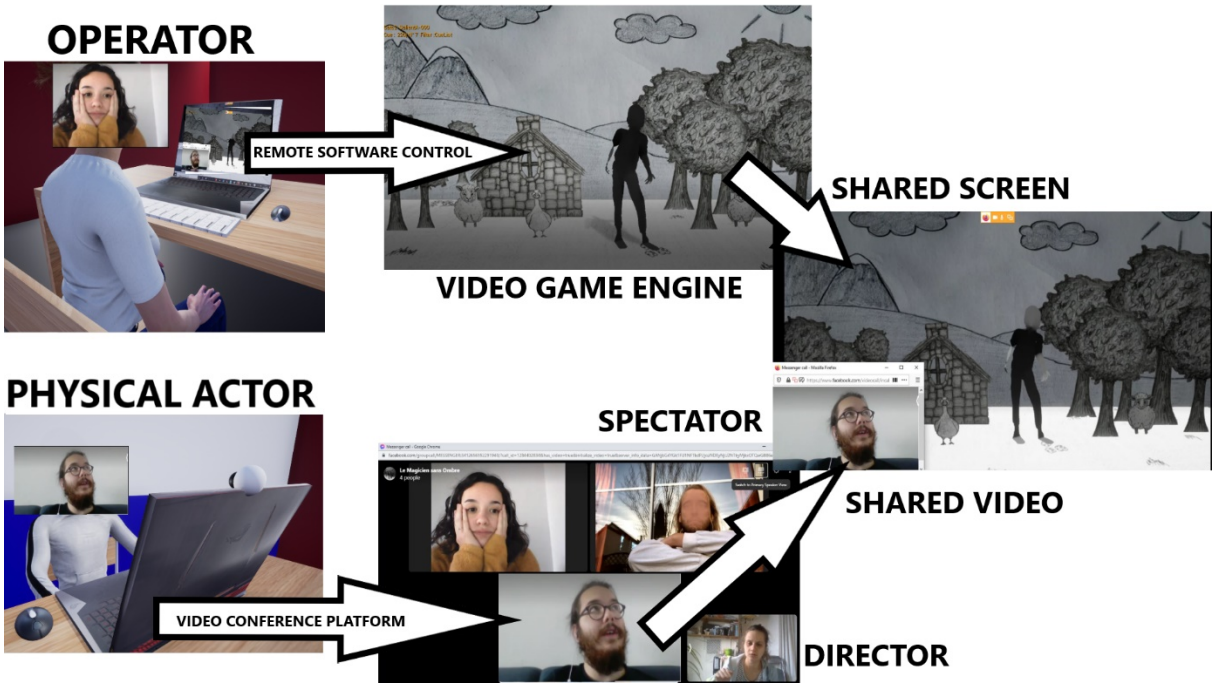

Figure 5: Remote distributed rehearsals

attention of the public. This point is modified when the acting is transposed in the remote distributed setup.

4.4 Issues raised by the remote setup

Firstly, from the remote spectator viewpoint, the screen with the digital shadow theatre is still behind the actor, though for the remote actor the screen is situated in front of him (more precisely on the director's shared screen from his computer), so when he turns the head to answer an avatar address visually behind him, he does not see the screen anymore and must play blindly. If he turns back his regard to the computer screen in front of him to watch the result, he breaks all the connections with the avatars and the contact is not convincing anymore for a spectator. Consequently, the actor needs at least one additional screen placed on his right to control what is going on with the avatars. He is confronted to the mocaptor's issue surrounded by feedback monitors to control how his virtual body behaves (see fig. 2). This change in the spatial disposition illustrates one of the numerous modifications in acting since the actor must take in account the webcam narrow frame to achieve his presence effect on the virtual stage (see 2.3).

Secondly, there is no audience in front of the actor anymore. He finds himself isolated in front of his webcam and cannot adapt his performance to the reactions of the audience. That approaches him to the unusual state of a cinema actor who must put all the energy into the camera. Reciprocally the remote spectator cannot give any feedback and get a reaction of the performer. From his viewpoint, the live dimension of the performance is not perceptible. There is no difference between a live-streamed performance and the same pre-recorded and broadcasted performance.

The third point depends on the commercial standard network bandwidth. There was a lag between the video stream of the actor and the director's shared screen of the virtual performance. That completely ruined the quality of the live interactions between the video image of the actor, and the pre-recorded animations from the videogame engine.

Rehearsing the performance was successful, but the idea of a remote distributed performance was temporarily abandoned. A better solution was to wait for the end of the lockdown and gather the team on a stage with an appropriate setup to record the video of the actor directly on the director's computer. This video could be streamed to a remote audience, or even better sent by file transfer to avoid network bandwidth disturbance.

5 CREATION OF TWO FORMS

5.1 Completing the face-to-face performance

After the end of the second lockdown, mid-December 2020, the opportunity to publicly present the work became clearer. The venue of Villiers-Le-Bel, in Paris surroundings, offered to perform the story, in the context of an educative and cultural partnership with several school classes, according three options: the pupils come to the theatre to see the live performance on stage, the team goes to the school to perform the show in the class, or a pre-recorded video in the remote setup is sent to the teacher. In this third option, after watching the video, an informal remote discussion could take place with Zoom videoconference platform (during the French lockdowns following the strict initial one, schools stay open).

Face-to-face rehearsals took place in the theatre end of December and beginning of January 2021. The performances were scheduled

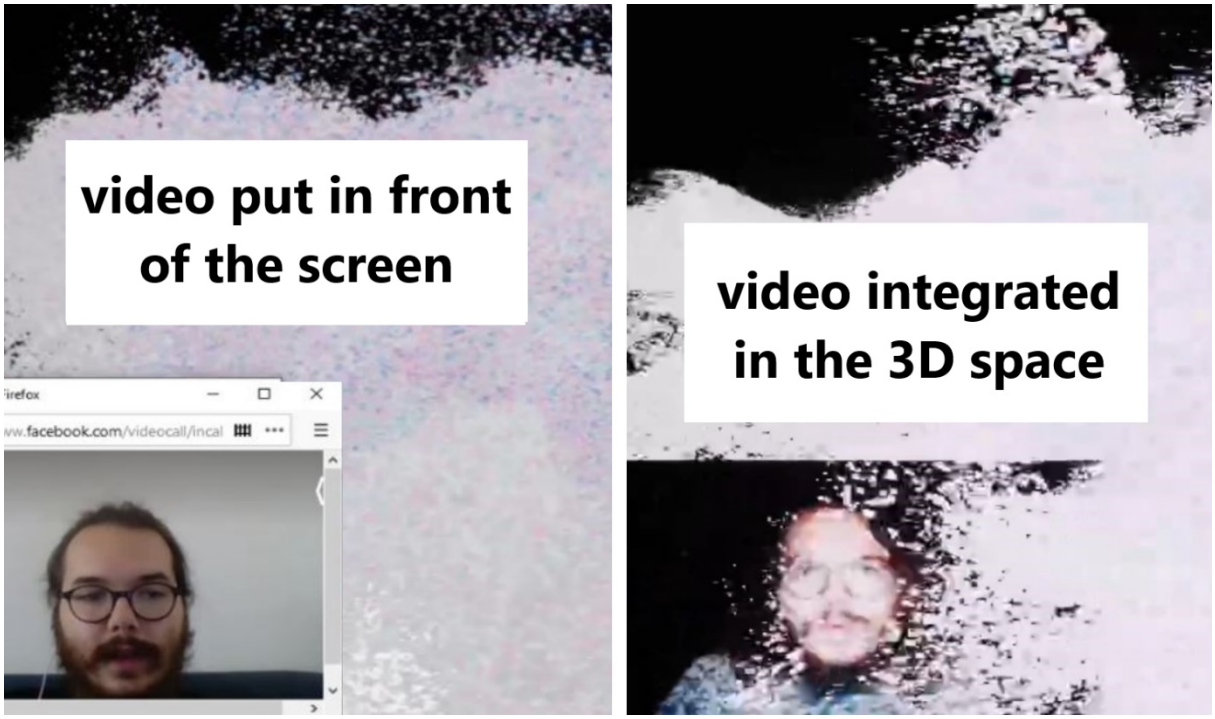

Figure 6: Video webcam integrated in Unreal Engine

for mid-January. As the pandemic situation was unstable, the kind of form the children would attend was not decided. The two forms of the performance were still to be completed.

The finalization of the original face-to-face version was easy to achieve. As the actor had actively participated in the rehearsals with the mocaptor (see 4.2) and had worked out the text during the final step of preparation during the lockdown, the interactions came naturally. The operator was already synchronized with the actor. The creative team focused on establishing the right circulation of attention between the actor, the audience and the avatars in order to achieve the proper presence effect for the avatars.

5.2 Working on the remote distributed setup

The recording of the performance for the remote exchange happened in parallel rehearsals. As exposed in 4.4, an appropriate setup allows the actor to control the avatars reactions on a big screen on his left (as shown in fig. 8A with the physical actor at the bottom left in front of the webcam and his image in the bottom left of the screen). Working on solving the delay between avatars in the videogame engine and live video image of the actor, it appears that the video of the actor could directly be integrated in the virtual shadow theater on a specific plane of the video game engine. Fig. 6 shows the consequence of this change.

On the left, a video thumb stick is placed in front of the shared virtual shadow theater. On the right, the video is a part of the 3D scenery and can be affected by the visual FX produced by Jaimie and his virtual friends. The consequence is that the relationship between the actor and the avatars is reinforced because interactions between physical and virtual worlds are visually possible [12].

The creative and educative teams finally choose the third option and connected the actor in front of his webcam to two classes at a time, also shot by webcam in order to organize a virtual audience of around 2 times 25 pupils with webcam images side by side (Zoom gallery mode). The two remote classes looked at the result on large whiteboards with loudspeakers as shown in fig. 8B and C. The creative team had this first idea: after a short introduction, the recorded performance is launched on each remote computer by the teachers and followed by a discussion with the children to answer their questions.

Nevertheless, the idea that avatars and actor are not interacting with the remote audiences was unsatisfying. At the same time there were six virtual characters that appeared on the screen only for 2 minutes and a half during the face-to-face performance, though initially the director wrote a small story for each of them to give the mocaptor the context so he could characterize appropriately their movements (see third step of the process in 4.2). Consequently, the idea emerged to create an extension of the performance pre-recorded video with an improvised dialog involving the secondary characters interacting with the actor and the audiences in real time.

5.3 A new design for interactions with audiences

Instead of classical discussion with the children in the third part of the session, the actor introduces a secondary character, for instance Giovanni. Fig. 7 shows the Zoom shared screen setup in each remote places. Fig. 7A displays Giovanni in the same virtual shadow theater as during the recorded performance (see fig. 3). Each secondary

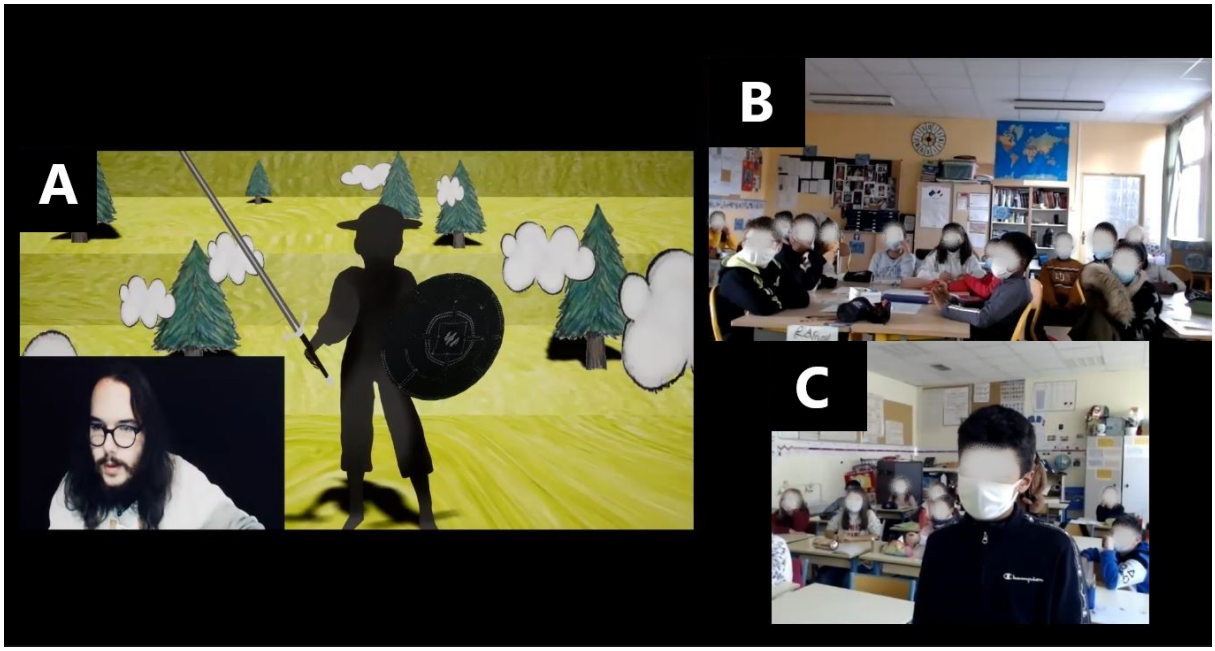

Figure 7: Shared screen introducing Giovanni to the children

character evolves in solo in a specific scenery layout. Both remote classes form the audience on the left side of the shared screen as shown in fig. 7B and 7-C. The children ask Giovanni any question, for instance about what happened after the end of the story. As the avatars have no voice in the story, Giovanni answers the questions with gestures to keep the homogeneity and the actor plays the role of a "translator", interpreting the gestures.

Fig. 8 A, B and C show the three remote distributed venues which actors and audiences interact in. Fig. 8A shows how the mocaptor controls in real time the virtual shadow avatar with a motion capture device, reminding the rehearsals in the third step (see 4.2). The actor aside the avatar, in front of the webcam and present in video, translates the gestures of his partner. Fig. 8C shows a pupil in a remote class asking a question in front of the webcam in a close-up shot, ready to interact with the avatar and the actor. Fig. 8B shows pupils in the other remote class attending to the improvised dialog. Of course, pupils in C remote class see also the direct interaction of their mates with the remote actors.

Actor viewpoint in fig. 8D characterizes AvatarStaging setup with feedback monitors allowing the mocaptor to appropriately move in the virtual scenery (see fig. 2). This time, the setup is used in its live mode. As proposed in 5-2, the video of the physical actor is implemented in the 3D environment, so the avatar has an interactive connection with him. For example, he touches him, comes in front of him, hides behind or even goes through the video-image. And the actor uses the big screen as a lateral feedback monitor to move inside the webcam video frame in reaction with these interaction gestures. Both actors, transposed in the digital world in two different ways (video webcam and motion capture), share the same scenic space and interact actively.

Moreover, the physical actor has the possibility to add and remove FX and props in relation with Giovanni acting. He becomes an hyperactor [7] who has a direct influence on the digital world. For example, he makes appear a sword and a shield in Giovanni's hands and puts a dragon to the scene that he moves with a gamepad around the avatar, so actor and mocaptor improvise a battle and react to the comments of the children. Considering the two classes, the actor organizes the questions battle and gives the turn between the two remote groups. He proposes children to come one by one to the webcam and ask his question. In his own way, often shyly, each pupil takes an active part into the remote distributed performance.

The resulting new performance corresponds to the living theatre situation. Actors and audiences are present at the same time and gather in a shared mixed place. The public stays separated from the active stage venue but can influence the performance with its reactions. The actor and the mocaptor are connected to each other in a symbiosis of improvisation, they share the same stage in two different manners and keep being attentive and responsive to the audience. The implementation of the video into the 3D scene breaks the untouchability of the image and makes it theatrically interactive. The playful reactions of the pupils show that the creative team succeeded in breaking the lockdown and delivering a remote theater performance.

6 DISCUSSION

6.1 Differences between face-to-face and remote performances

Besides remote distributed performances given twice to 2 times 2 classes, the creative team had the opportunity to present the face-to-face performance in a fifth class. Comparing face-to-face and

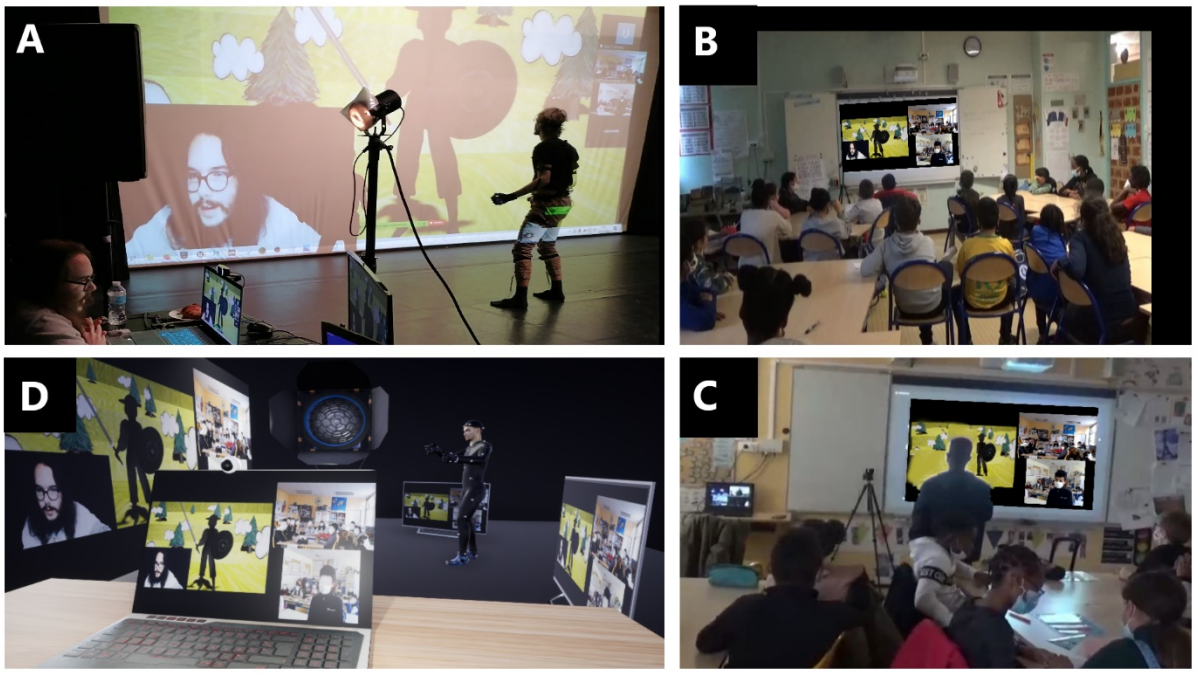

Figure 8: Remote distributed interactive setup

remote versions, interactions in the remote one are stimulated by the active children participation. Interactions are also present in the face-to-face version, but in a more intimate way. The traditional theater spectator is implicitly active during a live performance. And this implicit participation is something to rebuild in a remote context with appropriate solutions.

In the face-to-face performance, the avatars are recorded and played with a specific method that makes them alive and interacting with the actor. The actor quality of presence is strong enough to be communicated to his digital partners in a convincing way from the spectator viewpoint. In the remote context, the actor participation through a shared video image loses a part of its natural presence effect. The solution to make theater happen again is to make alive the avatars. The paper shows that systems combining real time video game engine, live motion capture and video conference platform are ready to offer solutions. The key factor of the proposal presented here is the ability of the mocaptor to play alternatively with the actor and with the pupil. Using new specific acting skills, he guarantees the bond between all the participants. He inhabits here and now the virtual shadow theater in front of two remote classes.

In addition, the liberty offered to the spectator in the remote configuration gives ideas to change the face-to-face performance. Why not changing the dramaturgy of the research-as-creation project and integrate live interaction with the audience in the story? It would ask to improve the idle-salient animation method towards integration of bricks of autonomy in the virtual character behavior.

6.2 Hybrid interactions with the spectator

The face-to-face performance focuses on a hybridization between an actor and shadow avatars on a mixed reality stage. The result conquers the young and very asking spectators. The remote performance focuses on a hybridization between video streams, shadow avatars and spectators in a mixed reality stage. The ability to reconfigure the mixed reality stage stimulate the desire to pursue the journey with the audience and to deepen the hybridization process.

The creative team realized therefore three extensions of the two existing versions of *The Wizard without Shadow*. The first one is an immersive installation in which a child meets the school master and his 7 students who perform magic tricks and invite him to do as well. The second is a videogame that a child plays with his own body: a Kinect motion capture device allows him to interact in a virtual scenery, as the mocaptor does during the remote performance. The playful goal is to touch small animals of Jaimie's parents farm and to avoid touching a Black Peter, randomly mixed in the cattle. Children are invited to practice mocaptor's skills.

And finally, the team conducts a theater workshop with the fifth class which attends the face-to-face performance. The last experience offers opportunities to introduce the children to a pedagogical practice of theater as well as storyboarding programming and design interactions and other features of digital and videogame arts.

7 CONCLUSION AND PERSPECTIVES

This paper introduces a new setup to build remote distributed performances used in the second lockdown in France to reach remote scholar audiences with *The Wizard without Shadow* show.

It started by a review of existing remote distributed virtual experiments in performing arts, from the use of video stream systems to emergent VR solutions. The continuous progress in the field of motion capture devices, real time videogame engines and video conference platforms broadens the possibilities of interacting with remote audiences.

The *Wizard of Shadow* artistic production follows a creation-as-research paradigm and uses the creative context to make research hypothesis and invent experiments to confront theory to practice. The paper described the original approach using CAVOAV digital shadow theatre environment and AvatarStaging framework to create a face-to-face performance with an actor lively playing with digital shadow avatars. It detailed how the creative team faced the lockdowns that happened in France in spring and autumn 2020 and how it imagined a solution to remotely perform the show.

The original remote project was changed when actualized in practice after the first lockdown and experimented during the second lockdown. The preservation of theatrical quality is enabled by mixing a video conference platform, a videogame engine and a motion capture device. It comes from the hybrid dimension of the face-to-face form based on the relationship between an actor and avatars. It keeps alive the bond between actors and remote audiences and led to an unprecedented new configuration that hybridized in multiple artistical sequels of the original face-to-face performance.

Three directions will be further investigated. The interactions between avatars and video streams would be deepen if all the video streams were integrated in the video game engine, actor and spectators' ones. Video streams would be manipulated and involved in the improvisations, strengthening the bond with the remote audience. Secondly, the setup could be broadened to spectators individually connected to the remote performance session. What would it change for them, considering their feelings, to share a common assembly? And finally, the journey towards hybridization would keep on by exploring a way of performing oneself the show with a mobile phone or tablet application.

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