Immersive Possibilities: Archiving Sound Art of Live Performance in the Context of the Metaverse

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Abstract

This article introduces the new dynamics and challenges in making sound art virtual while posing new questions about previously neglected aspects, such as archiving sound in a virtual space. By referencing the historical examples of Ryuichi Sakamoto and Nam June Paik, this article recognizes the limits of previous archiving methods and technologies while revisiting the essential question of power under emerging media and algorithms. With a focus on virtual archiving, this article investigates the new boundaries of sound art in an updated context while advocating an alternative framework to evaluate the relationship between the virtual and real, not only as a fluid location as put by Gilles Deleuze, but also as an integrated system to be located in time and space.

keywords

Sound Archiving, Sound Art, Live Performance, Virtual Reality, Immersive, Metaverse

Introduction

Sound art has been a crucial part of human aesthetics for millenniums. Although it has taken various forms and directions throughout history, its charm keeps tempting us to ask the one question: How can we obtain a more immersive experience of sound art? This question, historically related to "fidelity", now extends to "immersiveness" as technology has pushed forward the boundaries of both scope and quality which are crescively interrelated.

In "Polyphonic Materiality in Extended Reality," Australian scholar Kate Geck reframes this "immersiveness" as the replacement of the physical with the virtual and a polyphonic assemblage: "We interact between physical objects and digital surfaces [6]." Additionally, Keck usefully points out the necessity of "dismantling" the conflation between the real and virtual while emphasizing the agential "realism" of the digital. What is missing here are the specific circumstances under which the "assemblage" occurs and this "realism" works or needs to work, which touches down to the differences and consistencies of interactions. To examine these patterns, although previous scholars in archive studies have shown interest in digital materiality and stewardship along with the interactive potential in "fostering innovative, expressive communication [13]," the idea of performance and archiving has been confused, and their relationship remains nebulous. Additionally, while articles like "Multi-Generation Digital Stewardship: XR Art & Technology Archives" has teased out the synthesis of the preservation and production, the ontological, social, and aesthetic consideration is lacking in "baking" the preservation and management of digital content "into the production process [9]." Besides, social and art-historical connections in archive studies are downplayed as compared to traditional mediums and performative elements.

To build on the research above, we should return to the process of producing immersiveness and its objectives. Logistically, the question of sound art is also twofold: How do we render both performance and archiving immersive? The latter entails urgent attention and engagement from scholars, artists, and engineers.

We can find previous attempts at answering the question in the history of new media art, which illustrates provocative possibilities. In 1980, German electronic music pioneer Klaus Schulze opened the Ars Electronica Festival with a live recording of a concert, challenging the boundary between "live" and "archive" in a performative way. Since then, "Digital Music & Sound Art" has been a category of Ars Electronica for decades. However, it was not until recently that the rise of the metaverse opened the door for immersive archiving and performance. Overall, finding pointers to references was still uncommon. Nevertheless, this has been somewhat altered by "Robots, Bass, and Hot Algorithms!" (see Figure 1) by Portrait XO, Moritz Simon Geist, for Ars Electronica. Additionally, Nelo Akamatsu's "Chijikinkutsu" (see Figure 2), which won the Golden Nica for Digital Music and Sound Art in 2015, exemplifies the exciting developments in this field. More recent examples continue synthesizing performance and archiving as a new methodology while expanding performativity. Championing the spontaneity and transferability of the archived and ready-made sounds from modern and historical Japan, Japanese digital musician Meitei redefines the role of sound archiving and foregrounds its potential in the immersive future.

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In this vein, this article evaluates the current challenges and specific proposals for archiving sound art in the metaverse to reconsider live performance. It also examines the relationship between sound-art archives and the metaverse community from a social perspective.

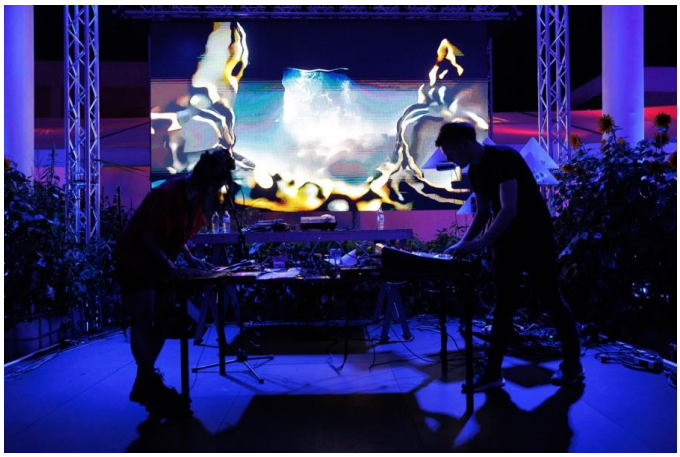

Figure 1: Robots, Bass, and Hot Algorithms! / Portrait XO (US), Moritz Simon Geist (DE).

Figure 2: Chijikinkutsu –Installation view, Blue Project Foundation, 2018 – Courtesy Blue Project Foundation, ph Nelo Akamatsu.

Before we delve into the archiving aspect, being familiar with certain figures and the history of sound art is conducive. Starting with Asia, Ryuichi Sakamoto is one of the forerunners of contemporary experimental sound art. He believes technology is the key to maintaining a holistic awareness of the world [1]. Since the late 1970s, he has been key in redefining the intersection between sound and art in Japan and internationally. His works range from his film scores, for which he won an Academy Award and a Grammy in 1988, and his influence on the development of electronic music through the Japanese Band Yellow Magic Orchestra (YMO), to his active work on climate change, remaining an essential reference in the scene [2]. The "async" was released in 2016 as his artistic exploration of electronic music and unique experimentation on ambiance.

It is equally important to highlight his attitude toward archiving. From analogs to optical discs and his online concerts, which can be accessed through live streaming and archived replays, Sakamoto has always been mesmerized by the ideas of "misunderstanding" and "spatiality," which became more conspicuous in his recent works. In 2021, his audio-visual exhibition "Seeing sound, hearing time" in M Woods Hutong Museum, Peking, demonstrated his concept of "installation music" in which sound becomes a spatial entity through a shared space of audio-visual-environmental effects. In such a space, the sound is often recycled and recollected as recursion, and this process reconfigures the physical space, rendering it synesthetic and absorbing. In another work, "Is Your Time (2017)," which incorporates a piano washed up on the shore after the tsunami from the Great East Japan Earthquake in 2011, he observed the encounter of memory and archiving. The archived sound of nature now involves object- and memory-archiving, conferring a transcendental sensibility to the technical act of archiving. The concept of "misunderstanding" also recurs in this action as Sakamoto often laments and celebrates simultaneously the "impossibility" of recreating even his old works: misunderstanding makes any archiving a necessary "mistake" while laying the ground for creating something "new". In other works involving natural sounds, archiving became the main method of creating a piece because nature cannot be asked to replay or perform at will. Accordingly, "misunderstanding" and "spatiality" construct Sakamoto's attitude towards archiving and performing, which converges rhythmically throughout the process.

While Sound Art of Live Performance is still in its sunrise phase, its popularity has far-reaching implications, thus making its archiving equally crucial. As a form, although live performances can be broadcast easily through national or private outlets, archiving this type of work in an immersive manner will become increasingly difficult as time and volume accrue. This situation called for a flexible and durable medium to accommodate the increasing demands of artists and audiences alike. With the rapid development of metaverse technology, Ryuichi Sakamoto's Sound Art of Live Performance and the work of many other sound artists will conceivably become less challenging to archive while obtaining greater longevity, sustainability, and accessibility. Specifically, this article summarizes two methods of archiving live performances in a metaverse: audio rendering and music visualization. Through the two methods to be discussed, the immersive experience, the integrity of the work, the authenticity, and the anytime, anywhere access to these properties are amplified. This possibility of archiving also returns the power to the audience, often monopolized by the company or the performer.

Related Work

Sound has consistently been an integrative factor throughout the history of new media art, although it is debatable what defines this "newness" exclusively. This "newness" often connects emerging subject matter and media technology. Previously, it can be explained by the "five principles of new media", so insightfully put by Lev Manovich in *The Language of New Media*. They are numerical representation, modularity, automation, variability, and transcoding dcitemanovich2002language. The last two characteristics are the most relevant because variability can be understood as the dynamic of techno-sensory connection whereby the immersiveness is gradually enriched and complete. The last princi-

ple of "transcoding" also demands our attention, especially from an audial perspective. In the specific act of archiving, the human and machine cooperate in recreating sounds while constantly influencing each other's choices. In this process, archiving never remains a one-way input of passive actions.

In the same book, Manovich uses transcoding to describe the blend of computer and culture and "traditional ways in which human culture modeled the world and the computer's means of representing it [15]." In sound art, "transcoding" takes on another meaning: the computer will represent the sound based on the human model. At the same time, the human sound will also increasingly imitate its counterpart. This blend explains the development of immersiveness in curation and art practice. More profoundly, it accounts for a strong narrative already latent in art history: to be immersive has always been one of the objectives in performing and archiving contemporary art as if the "immersiveness" or "completeness" equates to the artistic "truth" that both Plato and Merleau-Ponty sought after. Without archiving, performance art would cease to grow and reach its audience.

For example, Nam June Paik's video-audio performance at "Good Morning, Mr. Orwell" demonstrated blending the human and computer sounds manual by patting the monitors and maneuvering the knobs, setting an early example for today's DJ or VJ or even the live performance in metaverse because the show was also broadcast live to a global audience. WNET TV traditionally archived the performance, but its tape copies soon hit the shelves of museums and bookstores. With the advent of the Internet, this performance was soon incorporated into multiple Youtube and website collections of early media art, prolonging the life of the performance again. The only difference lies in resolution, accessibility, and how the audience and artists interact. Most importantly, the archiving technology was also unsatisfactory, making the TV show almost a singular event, and all the latter renditions had to follow its singularity. Accordingly, there remained a time limit and quality compromise, which were inevitable. We can access Paik's magnificent sounds through YouTube or other streaming platforms. However, these platforms, with or without licenses, still acquired the video from the original tape the TV station kept, as how an accountant would archive his/her ledgers. This method was still confined to the materiality of the tape itself and sometimes the original quality of the recording when the sound occurred and, presumably, the soft and hard system of the TV station, the institution itself, always a centralized and hierarchical structure susceptible to a multitude of capriciousness and human factors.

Throughout art history, we also realize that the performing and archiving of sound art are always profoundly connected and intended to be studied together. Harking back to even earlier examples of sound art, such as the vinyl players, the soundtrack in a movie, or even the laser-cut DVDs, they are all at the mercy of the elements and, without doubt, subject to the institutions behind the performing and, archiving process, in which the emphasis was often put on the former. The situation will become more desperate when we consider other examples, such as the sound in a theater play or Shakespeare's reading. While some would also argue that art is born to be brief and singular (and that's where the aesthetics lie), they still cannot deny that by relocating the temporal-spatial happening (as in the beginning, duration, ending, and archiving) of these events to alternative spaces such as metaverse or a virtual platform, we usher in other possibilities such as us today ruminating Paik's art almost four decades later in a room thousands of miles away from the original New York or Paris showroom. . . . . on YouTube, a platform which only takes a smartphone, electricity and the Internet. Overall, art history would make us wonder how to classify and archive sound if materials became a minimal issue and only the performance quality mattered. Additionally, the new media has marked many watershed departures from its predecessors; the How question of archiving still revolves around power, especially the power behind the algorithms, which are inescapable from human aesthetics and decisions. One might ask who would decide what and how to archive beyond the engineers, given that the material problem of archiving has become obsolete. This question pushes us to look deeper into the details of a metaverse.

Technologies that can be supported at the current stage

Following the trail above, we must also understand what makes a metaverse and how sound works in such a space. Only with this background can we apprehend how archiving works differently in the metaverse. Quintessentially, a metaverse is a network of 3D virtual worlds focused on social connection, which is often represented in the form of VR (Virtual Reality) and AR (Augmented Reality). From the currently available literature, researchers have conducted research in several sub-fields on music in VR and AR, including audio rendering, music visualization in VR, VR music video, music performance and virtual instrument, etc., which sheds light on how we can use currently available technologies, especially during the archiving process.

Audio Rendering

Ambisonics is a full-sphere surround sound format [23]. It can be decoded into binaural rendering that users can listen to in stereo earphones, providing an immersive experience by closely matching the natural sensorium. F. Grani et al. conducted an experiment to compare user preferences towards stereo and binaural rendering with visual and the result showed that participants preferred binaural sound congruent with visual, followed by stereo [7]. Moreover, A. R. Bargum et al. made a virtual reconstruction of the ambisonic concert hall of the Royal Danish Academy of Music in VR, which indicated that the simulated room matched its real one in terms of efficacy [3]. J. Janer et al. conducted another experiment, which tested the auralization of sound sources of recorded live content [10]. Based on the angle and distance between the listener and the source instrument, the listener would perceive the sound with varying intensities and at different times in both ears. When pointing at a specific instrument, users could listen to the augmented sound of the particular instrument. Though major differences remain be-

tween actual and virtual situations, the research above shows the practical realization of mapping real-world acoustic experience into virtual reality with some promising directions.

In an ambisonic metaverse, if the audience could engage the live performance with minimal and natural gestures as close as it would be to an actual happening, its archiving would mirror this mechanism. The recording of the event would happen simultaneously and work to remember not only the event's details but also the audience's interactions, thus forming a pattern for the future audience and performance. Moving forward, the next audience would follow similar interactive patterns as in the previous happening while being archived again in the database. On the one hand, real-time interaction preserves the fidelity of the original or actual performance without deterioration. On the other hand, the accruing process compliments archiving and performance, and the entire process is self-learning to produce a better experience.

Music Visualization

Another element to be considered in archiving is music visualization. There are some existing experiments in VR. For example, B. I. Outram adopted an "orbital mode" interaction technique which allows unprecedented hands-free user observation and navigation control. The image-based visualizations for several tracks were also utilized [20]. Jonathan Weinel created several synaesthetic audio-visual toys in virtual reality through symbolic representation and switch-based music genres or other stimuli to enhance the experience [22]. There are also examples of visualizing music in AR. For instance, Markerless AR music visualizer animates music spectrograms in AR[1]. Another example Beatsy is an augmented reality music visualizer for iOS that uses your music or voice to modify the world around you [2].

Similarly, this practice can also be incorporated into the archiving process, realizing its creative potential. For instance, the audio-visual toys in the archiving could adopt a dynamic mode of changing forms responding to the new audience, different from its previous appearance in the live performance. In the actual performance, the visual presentation must follow the designer's or artist's plan (or agenda, at least) as meticulously drafted beforehand. In contrast, instead of remaining in the original forms, the VR and AR visualizations can also be played with in terms of order and content. While the original copy is saved, the archiving can take creative routes as if a curator selected the gallery for the old collection. Meanwhile, the question "if the archive can become an editable open source artwork" will become a possibility to consider: Can the archivist and audience change the visualizations? What is the agency of the artist and the metaverse community?

Music Video

As a three-dimensional development of music/audio visualization usually based on symbolic patterns and audio analysis, VR music videos for customized content are also found in existing works, showing how one can perform and archive VR performances. According to the research of G. W. Young et al., [27], compared to 2D images, VR MV, as a new format that utilizes cutting-edge technology, provides users with a higher sense of immersiveness and presence, which will possibly encourage new positions and skills in the music industry. "What do we care 4" is a VR music video nominated for the UK Music Video Awards 2015 in the category Best Interactive and innovative Video [19]. The work features a live performance recording in a VR music video. "Echoes of Murlough" is another VR MV with an electroacoustic composition presented in VR [17]. This piece highlights the ambisonic composition of the recorded natural sounds and instruments within the environment of Murlough Beach, Co. Down, in Northern Ireland. The same artist, Gareth W. Young et al., recorded another VR MV featuring new pagans, which utilized volumetric video capture and 3D modeled world building (see Figure 3.) [26]. The session was captured simultaneously across twelve video cameras. Beyond artworks found in academic literature, there are also commercial cases. For example, Björk released an album, "Vulnicura", which allows users to explore the Icelandic locations which inspired Björk's songs (see Figure 4.) [3]. If the above examples are all somewhat based on the real life recording, "Squarepusher Stor Eiglass" is a VR MV that mixes electronic music with imaginative animated 3D dynamic scenes [4].

What the works above show in common is the virtual archiving of video relatively independent of its original environment or source. If the live performance is predicated upon virtual modeling, the archiving will follow the nature of this virtuality. The recording no longer needs to happen in the real world and is later transferred to the virtual. Still, it becomes an entirely virtual process – a virtual recording of the virtual, which maximizes the traceability and capturing capacity of the camera. The second VR videos start playing, and the performance becomes the evolving archive per se, a plural event connecting Björk's Iceland, the engineers' studio, and your laptop. When the performance ends, the preliminary archiving has been completed – the two actions are now synchronized and inseparable. Furthermore, the VR music video also questions the originality of the environment if originality itself has become plural: the originality of the modeling, the music, and the presentation (performance and archiving). This archiving has allowed universal participation in deconstructing the original work. With the rise of auto-tune remix-themed content wryly related to original videos, the action of archiving, as in what should be archived, how, and why, has become a social question.

[1] https://www.youtube.com/watch?v=sNnIczmsr2Qab$_{c}hannel = Designium$

[2] https://www.youtube.com/watch?v=duil2n6jZAAab$_{c}hannel = MattBierner$

[3] https://en.wikipedia.org/wiki/Vulnicura

[4] https://www.youtube.com/watch?v=6Olt-ZtV$_{C}Eab_{c}hannel = WarpRecords$

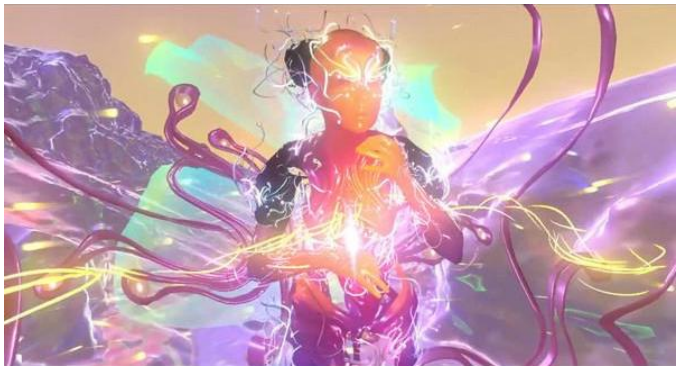

Figure 3: Featuring New Pegans

Figure 4: 'Vulnicura'.

Social Experience

Social analysis of live performance also pertains to archiving. From Charron, J. P.'s analysis [5], he concluded that virtual reality concerts could improve virtual participants' perception of being there, which is an essential factor for concert-goers. He also raised two essential questions requiring further research near the end of the article. One is how to increase participants' engagement and improve the virtual concert experience in the physical absence of others. The other is how future developments in immersive technology will affect the virtual concert experience and the demand for live performances. T. Kaneko et al. conducted related research exploring the sense of unity in VR concerts, echoing the first question (see Figure 5.) [11]. The results showed that exchanging nonverbal communication with body actions [pushing up a fist, rhythmically shaking a hand, waving a hand, clapping, jumping, moving (moshing), and holding a chemical light] between audiences in a VR environment helps elevate the sense of unity for participants. From the performer's perspective, R. Hamilton performed a virtual reality string quartet, where four players played Coretet (a virtual instrument) together wearing VR glasses [8]. Though it pioneered how performers can perform together within VR in a networked environment, it did not incorporate audiences as VR users.Audience participation is likely to become the next element for consideration.

Beyond this perspective, we can safely extend the social implications to archiving. If virtual live performances promote unity and presence, how can archivists preserve or develop this potentiality after the performance? Returning to the research above, we can spotlight a few directions. For example, archivists ought to pay continuous attention to body actions even in the archiving process because it elevates the sense of unity conceivably through somatic engagements and synchronized actions. If the body is the key to social experience in both performance and archiving, the archivists should consider incorporating his/her body in the process. Another highlight is the presence of others. On the one hand, the presence of others provides engagement in a real-world setting. Thus, VR would have to consider this social aspect seriously without blindly repeating the real-world experience. On the other hand, the archivists should determine if this social aspect is necessary for the archiving process: is the concert archived in a way that it would be open to the ensuing scrutiny of others? Should the archiving retain the social presence and sense of unity as in the live performance? If so, how can the archivists ensure a comparable level of social experience in the second and third.....replay after the archiving? Should the social reactions in the first performance be recorded and incorporated into the archiving? These questions would be both technical and social to ponder.

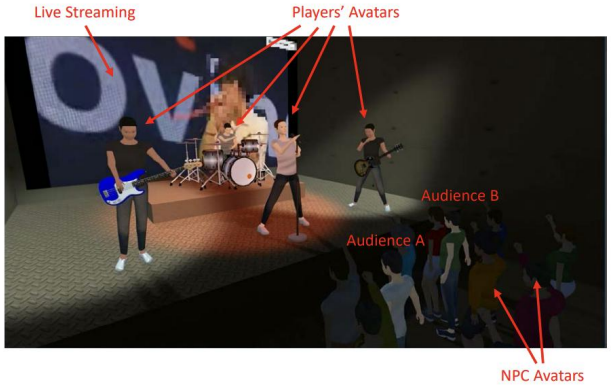

Figure 5: Supporting the Sense of Unity between Remote Audiences in VR-Based Remote-Live Music Support System KSA2

Virtual Instruments

Performing in VR using virtual instruments shows another angle in studying archiving. Serafin, Stefania, et al. presented nine virtual instrument design principles, which are, 1. design for feedback and mapping between sound, visual, touch, and proprioception, 2. reduce latency. 3. prevent cybersickness, 4. use existing skills to extend the possibilities of VR instruments, 5. consider both natural and "magical"

interaction, 6. consider display ergonomics, 7. create a sense of presence, 8. represent the player's body, 9. make the experience social [21]. And the authors further analyzed several existing VR musical instruments. After the year of publication (2016), other creative VR musical instruments were developed. Annie Kelly and Kristofer Klipfel developed Audiovisual Playground (see Figure 6.), which follows most of the design principles and is a sequencer in virtual reality [12]. Coretet is another VR musical instrument developed by R. Hamilton, which implemented the core gestural and interaction modalities that generate musical sound in the violin, viola, and cello [8].

It would also be challenging but worthwhile to investigate further how to archive these instruments in correspondence to the nine principles above. In the actual process, the archiving of the instruments would entail "existing kills to extend the possibilities of VR instruments". Conceivably, one would first archive them utilizing the skills already applicable to the instruments. Still, one should not forget their differences from the virtual ones, including their ergonomics, latency, interactivity, and sense of presence. The archiving, in this fashion, should not be passive documentation of the virtual performance but an intimate engagement with all the nine principles above. In addition to following the digital mechanisms already embedded for archiving the music, the archivists should play an active role in considering "both natural and 'magical' interactions" and differentiating and curating both.

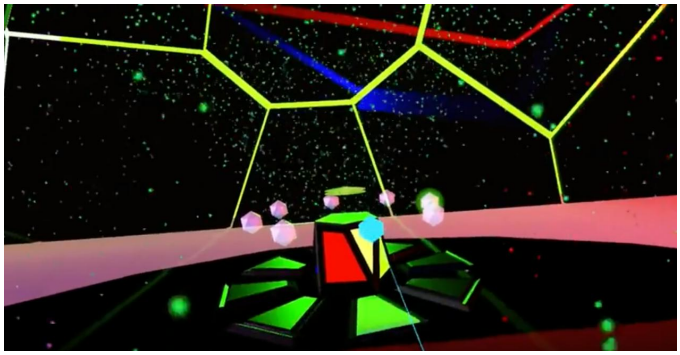

Figure 6: Audiovisual Playground

Applications of Live Performance

There are also some commercial applications for VR live performance. Considering their commodity nature, these applications would pay special attention to archiving. For example, Epic Games held the Astronomical Fortnite Concert in VR live in its game "Fortnite", attracting more than 12 million audiences to watch in 2020 (see Figure 7.). It combines motion capturing, live music performance, 3D modeling, animated live music video, and real-time interactions, which gives its audience a highly immersive and engaging VR experience of live music events. However, archiving is more critical for whoever missed out on the performance. It is always a challenge to archive the performance so that the end product would look as close to the live performance, thus making immersiveness a requirement even after the actual happening. Mobilizing all the available technologies, the archiving would appear encompassing and dynamic, responding to a diversified pool of audiences separated by time and space. As a commodity, the archiving would also respond to market demands and make the process a customer-driven marathon. For example, what platforms and which shots should be considered? Are the advertisements being included, and how much of them? Should the social reactions, including the chat boxes and commentators, be incorporated? Although all these considerations can be easily realized in the metaverse by adopting a thorough strategy, market-driven archiving would require more accuracy and efficiency in targeting such an audience.

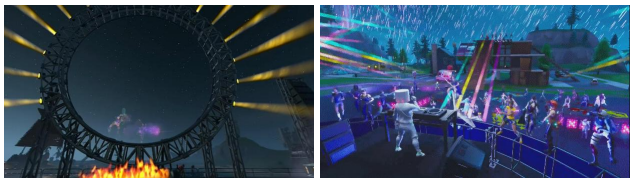

Figure 7: Fortnite Concert in VR

Possibilities

Beyond the onsite sound art of live performances, we could foresee those live performances will occur in the metaverse in the future. Another critical issue underlying these events is not the performing aspect but the archiving one because the metaverse indicates another possibility for the "live" and what it means to be "live". The action of archiving takes on the double meaning of performance as well. Accordingly, we should explore some current examples in the metaverse by comparing their methods and results.

Based on our review of current research and applications of sound art, we summarize some possibilities that would support the archiving of sound art in live performances from different perspectives.

Archiving onsite live performances in the metaverse

Recording is the most widely used method for archiving onsite live performances for the 2D screen, which utilizes video cameras and microphones as the primary devices for capturing the live event. However, since the metaverse is a 3D space, the way of archiving should be accordingly different, which challenges the dimensionality in traditional archiving. This issue brings us to the updated methods of recording.

Audio Rendering Binaural rendering with ambisonics is currently widely used in the metaverse in the industry. However, recording ambisonic sounds in the real world require specific devices that can be used for real-world sound capturing and archiving in XR. In this way, we could let the audience hear the sound in sync with the position of the sound sources/performers at a live VR music event. This method

can provide a more vivid auditory experience that comprehensively simulates the real world. Besides recording using 3D devices, we can also employ post-production algorithms, particular software, or plugins in 3D game engines to remix the sounds recorded in mono/stereo into binaural representations. In that way, we could recover the original soundscape in the process of archiving.

Visualization Real-time volumetric video/motion capturing is commonly used for making 3D music videos, which could also be applied to live performances. It is fully applicable for a live sound event, though special equipment and room setup are required. Besides replicating the real-world live performance, 3D animation modeling can also be added to allow more creative maneuvering.

Archiving live performances which happen in the metaverse

Though there has been a paucity of applications for live performances in the metaverse, live performances in the metaverse can be delivered via 3D modeling of the stage/environment, motion capturing with 3D-modeled interactive instruments, real-time volumetric performance recording, and avatar audience.

Following the performances, archiving can be simultaneously exercised by 360-degree video capturing in XR and the delivered format is video. Alternatively, it can be completed programmatically by logging all the scenes and parameters. In this way, the archiving and performing are synthesized into one virtual act, which would also bring about technical and aesthetic values that would not be possible in the independent act of either.

Audio rendering and instrument Since it is a real-time event that happens in the metaverse, the sound is in its digital format originally. 3D audio with ambisonics can still be utilized and controlled more flexibly with programmable parameters. Building instruments in the metaverse can also be inventive with such flexibility, which can also be deployed and recycled in the archiving process.

Visualization Unlike recording scenes of onsite live performances, visualization is directly done in the metaverse, providing a more native space-driven archiving with higher replication. Music/audio visualization based on symbolic data or audio itself through audio analysis can be adapted to reflect the music changes visually. 3D modeling and animation can also provide a more immersive and creative experience. All the synchronistic elements will be reflected by the archiving as well.

Social Being present with others when attending a live performance elevates the sense of unity. For archiving, even if it's not live, it is critical to ask who would have access to the same archive, or how should it be while a large society as its potential audience is involved? We also expect that there will be future applications for performers and audiences in VR to answer the two questions further. Meanwhile, if the performance emphasizes a sense of unity, then the archiving should also consider this social element if other audiences will experience the event from the archive, not live.

Platform-based archiving

Design Design principles should be developed to build a platform that accommodates live performances. Lurk, T., Enge, J. presented the idea of FAIR (Findability, Accessibility, Interoperability, Reusability) for archiving cultural collections [14]. Due to the possible diversity and complexity of the live performance, to support a general use case, the metadata design should consider various factors. Some obvious common ones can be the artists/authors, the place, the time, and the content. Based on the discussion, if not only 3D videos are preserved, but also applications/audio rendering parameters/instruments/social data, it remains a question of what other metadata info should be included and how the design responds to this inclusion to make the platform user-friendly and aesthetically appealing.

Blockchain While considering the metaverse, we could easily form an association with the potential of other accompanying technologies, for example, the blockchain. A blockchain is a distributed ledger technology that stores securely linked blocks using cryptography [24]. A non-fungible token (NFT) is a unique digital identifier that cannot be copied, substituted, or subdivided in a blockchain, which is used to certify authenticity and ownership [25]. IPFS is a protocol, hypermedia, and file-sharing peer-to-peer network for storing and sharing data in a distributed file system[5]. Regarding the nature of sound art, such technology can be utilized to record and identify the authenticity and ownership of the performance when ownership increasingly becomes an issue in contemporary art and the market. VR music event tickets/social tokens can also be minted as NFTs to ensure their authenticity and be recorded as memory vouchers.Likewise, access to the archive can also utilize this apparatus to ensure the safety and sustainability of the process. The roles of the artist, archivists, and audiences would be further systematized while connected in a reliable way. Additionally, blockchain technology would also promote the circulation of the archive and track its network for market or research purposes. Yet there are also some challenges for utilizing this technology, e.g. limited storage, dependence on crypto currency value, etc.

Therapeutic and Mental Music or sound is sometimes believed to have unique mental or even therapeutic effects. However, some effective sounds are ephemeral or socially demanding. In such a situation, the virtual space would help customize the experience without compromising the demands of others, including those that would prefer different modes of social presence. The application of sound in the metaverse also has a psychiatric function and a safe and immersive space can only elaborate this faculty. Therapeutic approaches can be developed from this experience and help understand the human mentality in a virtual setting, serving as references for technological, psychological, and social research and applications. Throughout art history, the actual archives of photos, texts, and paintings have proved to bear enormous effects on the audience especially in treating many neurotic and mental diseases such as amnesia. Future

[5] https://ipfs.tech/

archiving should also incorporate this therapeutic aspect into its programming and continue to develop this connection.

Accessibility for blind people Through the "Be my eyes" app, volunteers can assist patients who are blind or visually handicapped by observing them on camera and directing them with sound. This demonstrates how significant the audial is among the community of the blind, which kindles a new way for sound archives to affect vulnerable communities.

Non-visual photography is a technique that enables blind people to take and perceive images through the height of sound. When the visually impaired get introduced to non-visual photography, they usually put their ears into the camera and take pictures based on the sounds and smells emitted by the subject to determine their orientation. Listening to sound to identify orientation is one of the more essential skills in non-visual photography. Sound training is also necessary for visually impaired people before taking non-visual photographs. For example, ping pong balls with sand and guides are suitable sound training devices, which can be used to train visually impaired people to distinguish their orientation through the difference of sound volume from different directions in the air. A visual field acquisition module, a central processor, and a 3D stereo sound module are all disclosed by Vivolight Medical Device Technology Co Ltd as an auditory-based device for communicating information about the environment to a visually impaired person[6]; visual field acquisition module is used to acquire stereo information about an obstacle surrounding a visually impaired person; The stereo information is transformed into planar information in the form of a two-dimensional matrix by the central processor, which then builds a 3D sound field signal based on the planar information and sends it to the 3D stereo module. In this signal, the position of the sound represents the orientation of the obstacle, and the sound's pitch, loudness, or timbre represents the distance from the obstacle. To help visually impaired people determine the orientation and proximity of nearby obstacles, the 3D stereo module's left and right ear speakers receive the 3D sound field signal from the central processor and output appropriate sound.

This technology has important ramifications for sound archiving. Based on the distance, height, and cue guiding of the sounds in the metaverse virtual environment, bodily impaired users can now transcend the limits of the visual and extend the possibility of the audial by taking photos through the ears, an action that would sound absurd before the advent of visual field acquisition module. It is no stretch to suggest that this technology can now enable the visually impaired to access the archiving process if vision has been rendered unnecessary. Accordingly, as in many other infrastructure designs, archivists should now consider the demands of the visually or other bodily impaired people to make sure that the archived experience also includes the vulnerable communities who share equal rights and needs to enjoy both the performance and archive.

[6]https://patents.google.com/patent/CN204744865U/

Pros and Cons

The aforementioned examples demonstrate how archiving a live performance of sound art in a metaverse can circumvent some of the restrictions associated with actual locations. Still, there are also certain drawbacks associated with most new technologies. More importantly, traditional live performance can be easily incorporated into a metaverse and vice versa, which does not disfranchise the unique charm of the actual performance but proffers new hybridity and alternative to consider, which sometimes also give rise to progressive forms and changes.

In summary, the intriguing potential of the metaverse for delivering and archiving the sound art of live performance and more is as follows:

- Metaverse-archived performing arts can accurately and comprehensively capture the details of a performance.
- Moreover, Location doesn't matter. Audience members can participate and view the performance archive from any location using a headset or a computer screen if the user does not have a VR headset.
- As there will be differences in proximity to the stage in the physical space of the performance site, the perceived stage and sound effects will also be very different. The metaverse is not subject to these limitations in the digital archive. The user's digital twin can be teleported to any location in the virtual space to obtain a freer movement and greater agency in audiences.
- Metaverse archives can accommodate a huge volume of performances and provide enough space to accommodate the growing volume of archival content while retaining the original order and quality.
- Developments in the metaverse technology allow us to experience a fuller spectrum of physical interactions, such as pain [4], heat, and cold [16]. Further developments enable us to expand beyond vision and hearing and to integrate other sensory faculties, thus enhancing our bodily and mental engagements.
- New breakthroughs in sound technology can apply to archiving sound art in the metaverse. For example, the spatial audio technology released by apple 2022 for AirPods. It uses computational audio technology to enable adaptive equalization capabilities and support dynamic head tracking of sound. They are specially adapted to spatial audio in this virtual environment.
- Sound archiving in the metaverse offers additional potential for education, performing arts and therapy.
- In the metaverse, the action of archiving and performing could be synchronized and synthesized to express new aesthetics with higher efficiency. This shift could also redefine the real-time quality of music or sound performances, revealing an open boundary between the moments of singularity and plurality.

VR applications in archives also present challenges:

- Despite the popularity of digital devices, only a minority of people will have access to the content archived using a metaverse device in the initial stages. The rest of the

audience may be limited by the number of headsets. As a result, the spatial immersiveness in sound art may be compromised.

- It is unfriendly to special populations. For example, people with eye injuries or low vision could have difficulty accessing the currently visually-based metaverse.
- Building a metaverse space for archiving sound art is labor- and cost-intensive, especially at the beginning. It could also be more challenging if we hope to program the performing and archiving faculties together.
- The maintenance of archived data can be costly, and virtual archiving still takes materials seen in smartphones and laptops like silicons, which are not necessarily environmentally friendly.
- Copyright issues for archived sound art need to be resolved. Accordingly, the current legal framework must be expanded to accommodate the new situations affecting artistic authenticity and intellectual properties.
- How to realize the decentralization of users and developers relatively independent from the big-tech capitals would remain a social and conceptual challenge to be confronted.

In addition, we should not avoid the next question: Is a digital collection of real-time sound art performances that uses the metaverse as a platform genuinely immersive? Can experiencing sound art live and in person be more moving than experiencing it virtually through a metaverse? It is essential to understand that this metaverse archiving of sound art performances does not seek to replace live performances entirely. The metaverse is meant to sustain, preserve, and recycle information instead. Similarly, customers and artists will continue to enjoy the existence of vinyl records as the traditional medium for archiving sound and music. As insightfully put by Marshal McLuhan, "the medium is the message [18]" and sometimes archiving is not only a technical act but a multifaceted engagement with the individual and society.

What is certain is the creation of realistic virtual settings thanks to the advances in 3D reconstruction technology. According to specific authors and researchers, future policy decisions may use simulations as a testing ground. Therefore, future research will entail a more significant investigation of the interactive sensory experience of digital simulations and actual situations, along with the social considerations of these technologies.

Conclusions and Recommendations

Many artists and academics, including Ryuichi, have been able to experiment with more and more facets of sound and ambient space in general, thanks to the exciting growth of virtual technology. Following the historical trend toward immersiveness, virtual performances of sound art and other types offer the audience a unique experience that empowers both the audience and the performer to strike a better balance between physical vividness and virtual closeness, as well as between the pressures of social interaction and the desire for personal freedom, presenting a range of intriguing possibilities. These initiatives will ignite the future of the creative and commercial arts, transforming the way aesthetic scholars think so that art will speak faster and better than words.

While the performing aspect of the virtual sound experience is often emphasized, the archiving aspect is equally crucial. The latest technology has also made it possible to recycle the performed resources better and efficiently, including sound and video art. They could be rewatched and re-experienced infinite times in theory. The key lies in how virtual technology replaces the conventional material-based archiving method. More examples clarify the advantages and challenges of this shift. Another question is valid: Who and what would decide what and how to document which works of art in which algorithm? Would such an archiving mechanism inevitably result in the democratization of art history, which was intended to be exclusively historical, temporary, and traceable only through the materials and eyes of certain people? What would art history look like if it was widely possible and acceptable to archive and access a whole art experience? We must carefully consider the aforementioned issues as we advance toward an increasingly virtual future that is both live and historical. This process also pertains to the epistemological efforts to synthesize technology and humanities in research and beyond because our reality is complicated by this entwining of various temporal-spatial locales and experiences which challenge artists and audiences alike in a way they were not accustomed to or prepared for.

The ultimate question falls back on the boundary between the virtual and real. Although it is widely accepted that this boundary has been increasingly ambiguous by experience, it still exists by nature for many. It also exists for some well-sought reasons: the audience would prefer the virtual under some circumstances, while the unique experience of watching a live concert of Micheal Jackson remains irreplaceable for many reasons. In such a "transcoding" blend, we would also wonder how the virtual performance and archiving would change the real or even help make the real more exciting and productive instead of competing with it. Many sound artists such as Mei Tei are already attempting to solve this challenge by engaging both the real and virtual, and by solving it, making live sound art a new form to bridge the two realms that are often unbridgeable but deeply connected. However, with new tools, has not art been a noble course to bridge the unfathomable throughout humanity?

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