Concerts of the Future: Designing an interactive musical experience in VR

Ciaran Frame
SensiLab, Monash University
Melbourne, Australia
ciaran.frame@monash.edu

ABSTRACT

This paper examines the creation and development of *Concerts of the Future*, a Virtual Reality music experience that bridges the gap between music listening and active participation. Collaboratively developed with a chamber ensemble over eight months, the narrative-driven experience places participants alongside a live ensemble, enabling them to perform with a unique gestural instrument in a VR concert setting regardless of musical experience. Reflecting on previous work in the VR and interactive music field, the paper outlines key design decisions that were made in the development of the work over a period of 8 months, including a pilot presentation with participants. The paper discusses the implications of stylised VR design and the use of theatrical elements outside the digital environment to make music more accessible. It highlights the potential of VR in transforming the traditional roles of composer, performer, and listener, thus expanding the scope of participatory musical experiences.

Author Keywords

VR, musicking, Digital Musical Instruments, audience participation

CCS Concepts

•**Applied computing** → **Sound and music computing;** *Performing arts;* •**Human-centered computing** → Participatory design;

1. MOTIVATION

In 2022, 91% of the population of Australia aged 15 and over listened to recorded music, leading the National Arts Participation Survey to conclude that music was "...the most accessed, and potentially most accessible, art form..." [7] in Australia. Implied but not stated in this conclusion was that the term 'music' was actually referring to music listening. In reality, only 14% of the population of Australia aged 15 and over played or created music [7].

NIME'24, 4–6 September, Utrecht, The Netherlands.

In contemporary Western music, while a vast majority of people regularly partake in music listening, a smaller percentage are involved in its active creation. This distinction between listening to music and music-making has been explored by the likes of Sessions, particularly in the context of traditional roles, where "the composer writes, the performer plays, and the listener claps" [17].

An excellent illustration of this lies in the activities of a concert hall – as Small points out, audiences are "... excluded from the magic world of the musicians, whose separateness is symbolised so lucidly ... by the division of the concert hall into two" [19].

These observations around the social aspects of musical form and participation suggest interesting creative material for artists and composers to explore, discussed in the next section.

2. RELATED WORK

2.1 Audience participation and music

Active audience participation has blossomed alongside the evolution of Western contemporary classical and popular music, marking a trend away from the traditional structures present in the concert hall in both audience preference and artistic intent from composers and musicians [6]. Sloboda and Melissa observe that the activity of "attending concerts and sitting quietly as a live performance unfolds..." is "...an increasingly incongruous activity in our data-rich, fast-paced world" [18] in [20].

Musical works have a rich history of allowing participants to play more active roles, particularly in the case of audiences or non-performers. Of course, listening to music can in itself be an 'active role', and can certainly amount to audience participation in some contexts [10], so here I refer use the term 'audience participation' based on Toelle and Sloboda's proposition that it involves some form of "creative expression on the part of the audience member" [20].

Pauline Oliveros' *Lunar Opera* [15] uses audiences to shape the structure of the work, using breathing exercises and crowd movements to alter the sound world. Audience members do not need to play an instrument, "...the only requirements for participation are that you enjoy listening and walking/moving with awareness"[15] – a clear compositional technique that creates a more active experience for participants.

More recently, digital technologies have begun to change the role of the audience even more dramatically. The growing popularity of music technology and sensor-based gestural instruments has meant that traditional musical roles and modes of participation are more fluid and interchangeable, particularly in the context of Digital Musical Instruments (DMIs) [13]. Examples of audience participation in this con-

text include works that use audiences' locations [9], posting on Twitter [8], using mobile phones [11], or even perhaps the act of dancing in front of a DJ set [12].

These examples illustrate a new environment for music interaction, which Lansky says leads to an "increased potential for complex social interactions in this expanded network where the most promising musical opportunities emerge" [14].

2.1.1 Virtual reality and music

The use of Virtual Realities in the field of music is diverse. Here I use the term Virtual Reality (VR) to mean an immersive experience that transports the participant to a new reality through technology like VR headsets.

There are comparisons to be made with immersive music projects outside the headset space that use different forms of mixed and virtual realities, such as Laurie Anderson's *Puppet Motel* [1] (an interative CD-ROM), Pauline Oliveros' *Rotating Brains / Beating Heart* [2] (a mixed reality performance) and Juan Carlos Vasquez's *Ecstasy / Light / Inertia* [22] (an interactive gamified musical experience).

In terms of works that use VR headsets, there has been significant growth in the field of music training and education, in areas such as conducting training [5], or in piano practice [16]. Virtual Reality headsets have also been a place for artistic exploration, particularly in the field of new instruments and generative systems, like augmented instruments [16] or entirely virtual instruments [23]. These trends reflect Bailenson's observations around VR as a medium that allows for tangible experiences [4] that allow for on-demand access to environments or contexts that may otherwise not be practicable or even physically possible.

Notably, however, these VR systems have typically reinforced the traditional roles of composer, performer and listener proposed by Sessions [17]. For instance, new instruments or training tools are typically used by performers or those aspiring to be one. There are very few instances where the traditional role of 'audience member' produces the music themselves within VR experiences – instead the role of audience is often reinforced from a different perspective (such as the field of view in a performance) [21].

This presents an interesting opportunity to explore the medium of VR through an artistic lens in order to extend the audience experience. VR is an ideal medium to explore this kind of immersive musical participation in a safe, controlled environment that might not otherwise be practical or desirable.

A natural evolution of participatory musical experiences, discussed in the previous section, and the opportunity for new participatory VR works discussed in this section, forms the basis of the new work "Concerts of the Future."

3. CONCERTS OF THE FUTURE

Concerts of the Future is a novel VR music experience created to address the disparity between music listenership and active participation in a creative way. The project leverages wireless gestural instrument technology and high-definition 360 degree video recording to offer an immersive experience where participants with no required previous musical experience find themselves centre-stage in a virtual concert setting.

The work invites participants onto the concert hall stage through a VR Headset, sitting on the stage next to performing members of a real ensemble, with the ability to play, listen and absorb music in 3D space.

Virtual Reality was chosen as the means of placing participants in a virtual concert hall because it provided a practical platform for anyone to play with musicians on a more intimate level. As Wang and Atherton point out, VR is ideal for "Making things that would be impossible in the physical world" [3] – it makes an impractical scenario (having a chamber ensemble on call for individual experiences of the same piece for extended periods of time) a (virtual) reality.

3.1 Audience experience

Participants interact with the performance by sitting alongside members of a chamber ensemble in a 3D virtual space. The chamber ensemble, *Rubiks Collective*, is a real ensemble based in Melbourne, Australia consisting of four players (flute, cello, percussion and piano). The participant replaces one of these players at random, playing their own unique digital musical instrument, the 'AirStick', a wireless gestural controller that allows for the translation of movement into sound (shown in Figure 1).

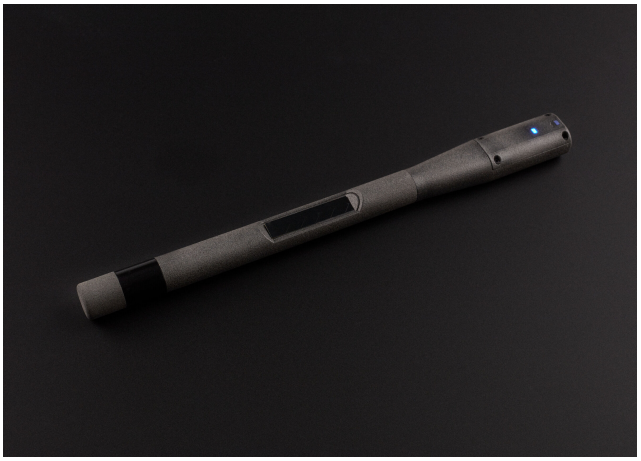

Figure 1: The AirStick.

The experience commences outside of VR, in a real, physical green room where participants familiarise themselves with the 'AirStick' instrument. They are shown a fake live-feed of the concert hall they will soon enter, and given a program that has their name in it. The program outlines the scenario participants will be placed in:

> *Name* is a performer based in Melbourne. This is their first collaboration with *Rubiks Collective*, and their first performance on the AirSticks. The AirSticks technology will follow their movements throughout the piece, as arm and hand movements are transformed into virtuosic musical lines.

Participants receive a knock on the door of the green room, and are escorted to the 'concert hall' – an empty, dimly-lit room filled with a piano, empty spotlit stools, speakers, and the sounds of pre-concert chatter as if an audience were in their seats in the darkness just beyond the light awaiting the performance. Upon donning the VR headset, they are transported to a similarly empty concert hall, but the performers shuffle in to take their places and greet their fellow participant (see figure 2).

The lights come up, and the piece begins, with participant and ensemble playing together. Members of *Rubiks* provide eye contact and smiles while playing, and the integration of spatial audio and stereoscopic imaging enhances the realism, culminating in a performance where participants play by

Figure 2: A participant interacts with the VR experience.

moving their arms, simulating the thrill of a live concert performance, as seen in Figure 3.

Figure 3: A screenshot of what a participant observes within the 360 degree experience.

3.2 Technology

The performance that the participant plays in is a previously recorded video that is played back in VR. Recordings were made with the Nokia OZO 360 camera, recorded in full stereoscopic takes with close microphones (seen in Figure 4). These recordings were then rendered into a polished edit, and audio tracks split out into individual speakers placed in the same discrete positions where the performers sat relative to the OZO camera. Through this static speaker placement, and the fact that the participant remains stationary throughout the VR experience, a sense of realism is achieved by creating a spatialised sound environment that reflects what participants are seeing in the video. This technique was chosen because the recordings were made in the same space the VR experience takes place in, thus achieving acoustic realism without the use of headphones.

The VR experience is run through a Oculus Rift S VR headset, with the video content coming from a Unity runtime file. Audio is run from a separate computer due to operating system constraints – the Unity session runs on Windows, and the audio session runs on MacOS. Sensor data from the AirStick is sent to a MacBook Pro via custom AirStick software, which translates movement into MIDI information and triggers instruments within Logic Pro. Performer tracks from *Rubiks* are also played in the Logic Pro session, allowing for the syncing of participant and *Rubiks* content. The audio computer is linked to the Unity project through OSC, meaning that the video content from Unity, and the audio content from Logic Pro can be triggered at the same time. QLab is used on the audio laptop to select one of four takes, and to send a 'Go' trigger to both Unity and Logic Pro when the participant is comfortable with their headset and position.

Figure 4: Recording a take with the Nokia OZO camera.

The tech layout is shown in Figure 5.

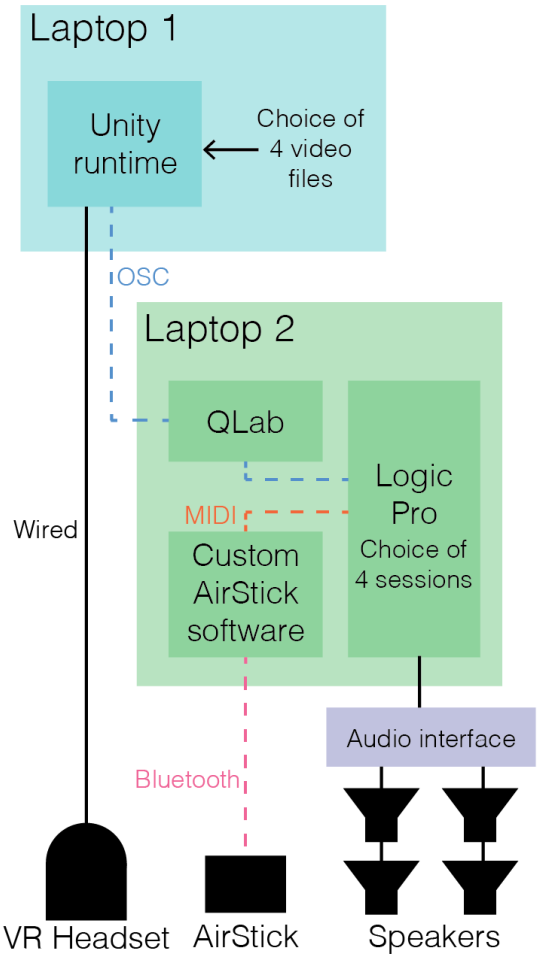

Figure 5: The technical setup for performance.

4. DESIGN DECISIONS

Development of *Concerts of the Future* occurred over a period eight months in collaboration with *Rubiks Collective*, with two design stages and a pilot performance, all of which involved audience participation and semi-structured interviews that collected feedback at each point of development. Based on the collected feedback, we were able to integrate several key learnings and design decisions that led to the creation of a more complete work that utilised the VR medium to a fuller extent.

These learnings are outlined in chronological order below.

4.1 Stage 1

Stage 1 of development covered the narrative context and early discussions around the audience experience. Early ideas were trialled with seven participants with a mix of musical abilities. Participants took part in semi-structured interviews at the end of their sessions, debriefing on their experience of the work post-experience. At the end of this stage, a series of key design decisions were made that addressed perceived needs from the creative team that would be taken into the next stage.

4.1.1 Storytelling

One of the most important areas of Stage 1 development was the participant's journey and their reason for playing. Our creative team was keen on guiding participants, especially those unfamiliar with musical performances, in a way that was independent of external knowledge or practice. In this way, an audience member could simply arrive to the performance without us knowing their level of expertise or ability. The goal was to let the music, and more specifically the narrative of the experience, naturally guide the participants allowing them to intuitively understand their role in the ensemble.

This narrative immersion became central to the composition of the piece, and was a key component we grappled with. There were various scenarios that a participant could take part in: Would the participant step into the VR world as a last-minute replacement for an indisposed member of *Rubiks*? Or would they be recognised as themselves, distinct from the ensemble?

In attempting to create a narrative that audience could invest in, we landed on the story that the participant was an additional musician akin to a soloist performing their own unique instrument alongside *Rubiks*. Importantly, we felt that this soloist scenario provided a clear narrative without creating unnecessary pressure and potential feelings of inadequacy around having to replace a professional musician.

Early discussions with pilot participants confirmed this – one Stage 1 participant noted that the experience was "...giving me the experience of being in an ensemble" and made them "...feel welcome in the group".

4.1.2 Simple musical structure

In creating the narrative, development turned to the content and structure of the 'piece' that participants would play in. Initial discussions settled on a notated piece that had clear structural signposts, and implied sections where the participant was to take centre stage through the use of strong gestures and lighting. However, the ideas piloted with trial participants were clearly overly complicated and didn't seem to support our narrative and goal of making the participant feel comfortable.

For example, the initial piece commenced with a sequence where spotlights illuminated each player in turn, moving in a circular pattern until the light reached the participant. When under the spotlight, *Rubiks* performers executed large, expressive gestures, which were intended to be mirrored by the participant (i.e. a sequence of turns followed by the participant's turn). However, this cue was either misunderstood or perceived as overly intimidating by most participants, with one participant saying, "...I could see there was a pattern, but I wasn't sure if I was a part of that or not", and another noting their hesitation in "...having to do the same thing as [the performers], because I'm not a musician."

Three changes were made to the musical structure to enhance participants' engagement and comfort:

1. Purely major mode with no accidentals: The musical composition was anchored in the key of C major, occasionally integrating elements of the Mixolydian mode. Importantly, participants were restricted to playing exclusively within the C major scale, without any accidentals. This decision was made to ensure harmonic integration of the participant's input with the rest of the ensemble, reducing the likelihood of dissonant or 'incorrect' notes that might create dissonance.

2. Introduction with a flexible and quiet start, featuring a unison note: The piece commenced with a sparse texture, offering no definitive cues for entry, which implied that there was no singular 'correct' point to begin playing. This approach was intended to mirror and validate the likely tentative initial approach of the participants. Additionally, the inclusion of a unison note, shared between the participant and the performers, aimed to foster a sense of unity and belonging. When the participant began playing, their note would harmonise with the rest of the ensemble, reinforcing the feeling of community and collective action.

3. Consistency in form and structure throughout the composition: The overall structure of the piece was designed as a gradual crescendo of texture, akin to a 'wall of sound'. This consistent structure was maintained throughout, deliberately avoiding dramatic shifts or sudden changes. The intent behind this approach was to create a stable and predictable musical environment. This stability aimed to alleviate anxiety about unexpected changes in the music, allowing participants to feel more at ease and focused on the experience of 'jamming' with the professional musicians, rather than being preoccupied with the anticipation of what might come next.

These changes resulted in a more predictable and simple musical structure that more participants felt comfortable participating in, evident in one participant noting the satisfaction of the unison note at the beginning, stating "...everyone was on the same pitch, and I was like, 'I wonder what my pitch will be' – and then I heard the same pitch!"

4.1.3 Predictable instruments

In addition to the structure of the music played by *Rubiks*, we also had to determine what the participant would play (i.e. what sounds the AirStick would be mapped to). In wanting the participants to experience what it might be like to be a performer, our sonic ideas centered around the idea that the performers would perform a virtual representation of the instrument they were replacing in the ensemble. For instance, if Kaylie the vibraphone player was absent, the participant would move to trigger vibraphone sounds.

This idea was almost immediately abandoned for two reasons – acoustic instruments not only have a physical reality that we could not reproduce in the same resolution or realism as the high fidelity stereoscopic video, but they also have a 'right' and 'wrong' way of playing them. By implying that participants were playing instruments analogous to real instruments, our fear was that preconceived notions of these instruments, or a lack thereof, might create a more stressful and rigid environment that participants felt like they had to adhere to. We thus removed the idea that they were playing 'a flute' or 'a vibraphone', and instead reinforced that they were playing 'the AirStick', complete with its own unique soundworld that was clearly distinct from other instruments in the ensemble.

The AirStick was instead programmed to trigger MIDI notes. That is, instead of a strike at various points in space triggering a single note, shaking the AirStick in varying levels of intensity (what we termed AirStick 'energy') would excite different musical textures, as seen in Figure 6.

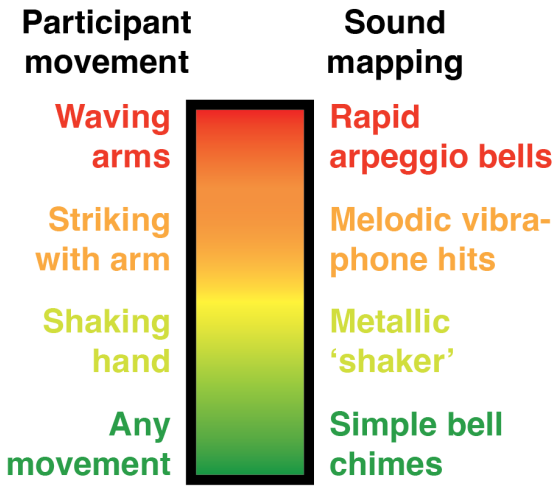

Figure 6: An example mapping for the AirStick in *Concerts of the Future* based on 'energy'.

This concept of 'energy' meant the participant could trigger melodic lines or uncover pre-composed musical textures, depending on how much energy they placed into the AirStick. However, Stage 1 trials with participants revealed that our original AirStick mappings, with their large dynamic range and possible ability to play in a different style, were not the right design decision.

For instance, one participant, upon testing the limits of the mapping, played a series of dissonant, loud notes that could be interpreted as being out of place – they noted "Once I went really loud I was terrified of playing again ... I thought I broke it!" In attempting to increase agency of participants, we had inadvertently increased discomfort, creating an environment of people who Jensenius observes "...want to engage more actively with music, but they are afraid to 'not be good at it.'" [13]

This became a prominent concern for participants. The notion of 'ruining' the music was not rooted in vanity, but rather in a reluctance to disrupt what they perceived as a valuable creation reserved for the realm of professional musicians. Participants expressed a sense of intrusion, with one participant saying it was "...not my place to play..." in an environment dominated by professionals. This sentiment was further compounded by a general nervousness experienced by many participants in the presence of these musicians, even though they were not physically present.

Rather than act as a deterrent, this reaction highlighted the previously mentioned palpable divide between the general public and professional musicians, particularly in the context of performance and active participation in music-making. Even for those accustomed to attending arts events, the act of holding an instrument and the prospect of performing alongside professionals elicited a significant reaction. This insight reinforced our conviction approach and the importance of bridging this gap between the public and professional musicians in the realm of interactive music experiences.

Our solution was to create a far more curated instrument mapping that built in 'musical guard-rails' that meant a participant wouldn't ever go beyond the texture or dynamic level of what members of *Rubiks* were playing. We ensured that the pitch set and rhythm were always quantised to the music coming from the ensemble (i.e. meaning all music was in time), and that it would be impossible to make any "ugly sounds". By using a combination of acoustic instrument samples and in-built Logic Pro X synthesisers, we were able to trigger both previously composed MIDI lines as well as MIDI notes quantised to the performances of performers. Additionally, instead of the fixed energy scale, we introduced a dynamic energy scale that followed *Rubiks* performers, allowing for participant agency over some dynamic and musical content, but only within fixed bounds (seen in Figure 7).

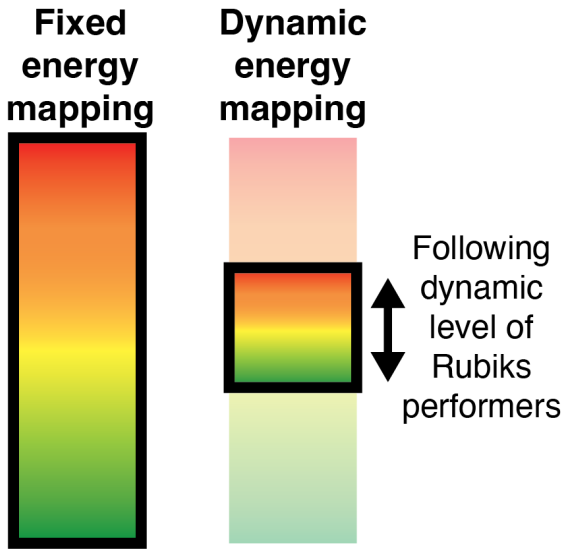

Figure 7: Static vs dynamic mapping for the AirStick.

4.2 Stage 2

Stage 2 of development covered the recording of final performance videos and the addition of theatrical elements around the VR experience itself. These recordings were trialled in a more formal presentation context, with twelve participants taking part in a more formal trial presentation. Feedback was collected using the same method as Stage 1, with semi-structured interviews post-experience. Throughout this stage, a series of key design decisions were made that addressed perceived needs from the creative team that would be taken into the next stage.

4.2.1 Social cues

One of the pivotal design choices made during Stage 2 was re-imagining the traditional seating arrangement of a chamber ensemble. Instead of using the conventional single-file layout facing the participant, we opted for a circular arrangement. This ensured that the VR participant was always facing all members of *Rubiks*, creating an inclusive environment that fostered continuous interaction and eye contact (see layout in Figure 8).

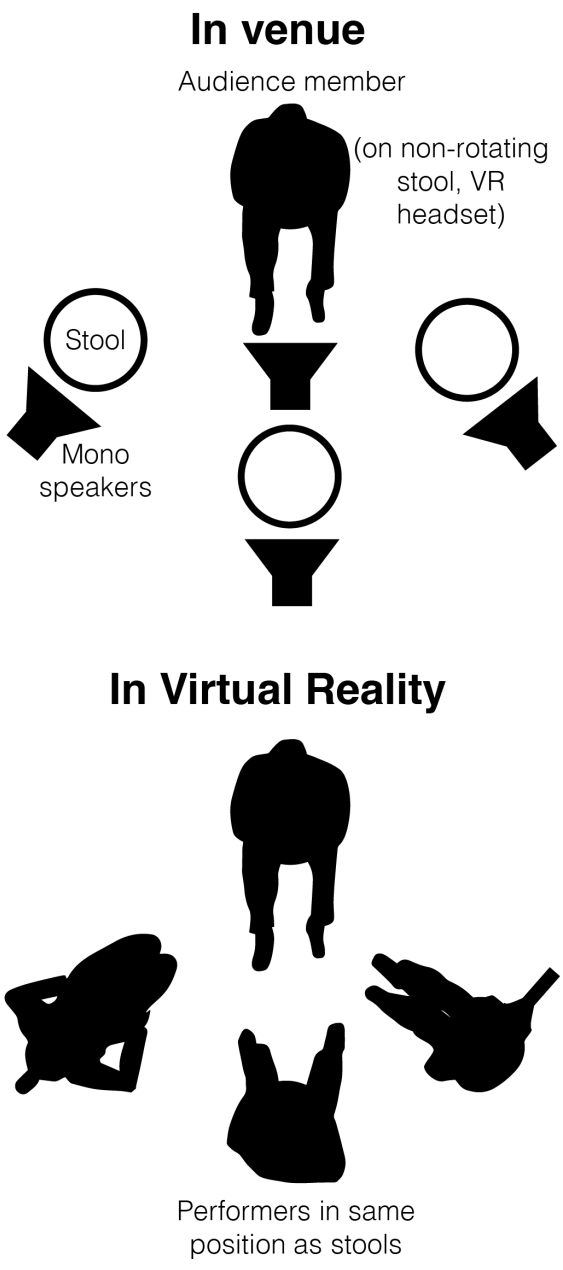

Figure 8: Layouts of the experience in the venue and in VR.

This choice, while unusual for a concert, was deemed the right choice for the immersive VR experience, because it allowed for eye-contact with performers, and meant the participant could receive more subtle continuous feedback in the high-fidelity recordings. Pilot participants noted the layout was warm and inviting, with one participant noting the expressions "...puts you at ease and encourages that connection." Another participant noted "I don't like audience participation at the best of times ... but this didn't feel like that!"

4.2.2 The 'extra-VR' experience

Having trialled the musical elements and layout of the work, Stage 2 development focussed on the refinement of what happened around the performance. We named these layers of theatre built around the VR headset the 'extra-VR' elements, after the term 'extramusical.' These were layers of mise-en-scène that contributed to extra realism around the idea that audience members were participating in a real concert experience. For instance, upon entering the venue, pilot participants were met with a digital poster with their head-shot on it, advertising a recital that was occurring at their booked time slot.

Of particular note was the use of a 'green room,' a preliminary area designed to alleviate nerves related to the playing in an ensemble, and to enhance the overall realism of the concert setting. The room reflected what performers might often experience in a similar place – a 'live feed' (pre-recorded video loop) of the concert hall, some snacks and water, and a space to warm up. A carefully crafted script was employed in the green room to create an ambiance that was both welcoming and informative, without being overly directive. This script aimed to establish basic guidelines and expectations for participants in a gentle manner. Key elements of this script included:

- Encouraging participants to 'play along' with the musicians, emphasising the collaborative nature of the experience.
- Reassuring participants that errors were not possible, fostering an environment free from the fear of making mistakes.
- Introducing the AirStick and physically handing it over to participants. Also conducting a 'calibration' process that, whilst not technically necessary, served to illustrate the connection between physical movement and sound production, guiding participants to explore the instrument's capabilities.
- Exposing participants to sounds similar, but not identical, to those in the main experience, setting auditory expectations.
- Allowing a solitary practice duration of up to five minutes in the green room. This period was intended to facilitate familiarity and comfort with the AirStick in a stress-free setting.

Additionally, the sensitivity of the instrument was deliberately lowered in the green room. This adjustment was designed to encourage more pronounced physical movements, thereby slightly mitigating any potential timid playing that might hinder sound production in the actual VR experience.

One Stage 2 participant noted that they were "...always curious" about what went on behind the scenes of a concert hall, and "...the extra context around the music felt like I was part of what was going on."

5. DISCUSSION

Two elements emerge from the above design conclusions that may be useful as broader conclusions for the creation of musical VR experiences that involve audience participation.

5.1 Stylised Design for VR

The development of *Concerts of the Future* illustrated a pivotal shift from a realistic portrayal of performance to a stylised representation in virtual reality. This approach not only made the experience more accessible but also enriched it by creating an inviting and imaginative rendition of a concert hall setting. The decision to move away from a strict representation of reality allowed for a more robust and welcoming concept that offered participants an 'impression' of performing in a concert hall, a scenario that might not align with the reality of professional performance but nonetheless captured the essence of the experience.

This stylised approach proved to be crucial in reducing performance anxiety among participants, and only came about due to the multiple stages of testing the work with participants in development. As musicians, we were initially too focused on replicating our experiences of performing in the concert hall. By focusing on the impression rather than the exact replication of a concert setting, the experience became less intimidating and more approachable. Participants were able to immerse themselves in a world that felt both grand and accessible, encouraging engagement without the pressure of adhering to the strict realities of professional music performance. The design's success lay in its ability to balance the grandeur of a concert hall with the comfort of an inclusive and participatory environment.

5.2 Immersive design for VR

The project expands on immersive experience discussed in 2 by considering and integrating elements of both the participants digital and real experience. This holistic approach extended beyond the digital realm, encompassing the physical environment and additional mise-en-scène that contributed to the overall narrative and immersion.

The incorporation of additional elements such as the green room and digital posters along with the main VR performance, created a fully-realised narrative. This narrative transcended the boundaries of traditional music performance, blending various art forms and technologies to create a cohesive and immersive experience that challenges the aforementioned 'composer, performer listener' model. The attention to detail in both the digital and real-world components of the project ensured a seamless integration of all elements, enhancing the participant's sense of being part of a larger artistic endeavor.

The success of this endeavor highlighted the potential of VR and interactive technology in creating new forms of immersive musical experiences.

6. CONCLUSION

This paper presented *Concerts of the Future* a novel Virtual Reality music experience designed to bridge the gap between passive music listening and active music participation. By leveraging VR technology and the custom-designed AirStick, participants without any musical background are immersed in an interactive concert environment where they perform alongside an ensemble.

Throughout the development process, the project evolved to focus on stylised design that reduces participants' anxiety and enhances engagement. The experience was enriched with extra-VR elements like a green room, creating a musical narrative that extends beyond the digital performance. The iterative development process led to an immersive musical experience, drawing on diverse forms and technologies to create an immersive musical experience.

The success of the *Concerts of the Future* pilot program indicates future potential, particularly in the expansion of the format to encompass different musical formats and instrumentation. There is also much to be explored in a more adaptive VR experience, in which the structure, musical content and participant's instrument changes live depending on musical preferences and experience.

Overall, the experience hints at the potential of VR in transforming musical experiences, challenging traditional roles within music and fostering a new level of audience engagement and participation.

7. ACKNOWLEDGMENTS

Concerts of the Future would not have been possible without *Rubiks Collective*, consisting of Kaylie Melville, Tamara Kohler, Jacob Abela, Gemma Kneale and Eliza Shephard. The project has been assisted by the Australian Government through Creative Australia, its principal arts investment and advisory body.

8. ETHICAL STANDARDS

This project and associated research obtained full informed consent of all participants involved through the Monash University Human Research Ethics Committee.

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