OpenSoundLab – A virtual sound laboratory for the arts

Ludwig Zeller
FHNW Academy of Art and Design
ludwig.zeller@fhnw.ch

Hannes Barfuss
FHNW Academy of Music
hannes.barfuss@fhnw.ch

ABSTRACT

How can a virtual sound laboratory allow for new and exciting ways of sonic interaction in the context of the arts? Our project addresses this question by developing the virtual sound lab 'OpenSoundLab' (as an open-source fork of 'SoundStage VR' by Logan Olson) that introduces to the artistic and musical production of sonic media with the help of the VR goggles 'Meta Quest 2'. The aim is to combine the physical experience of working on spatial experimental systems, which is often perceived as positive and productive, with the advantages of digital tools and thus to enable independent learning and experimentation. The virtual lab allows to become familiar with the basics of creative sound generation and processing. Specially produced video tutorials play a central role here, which can be viewed at any time within the virtual environment and thus make it possible to study in individual lab environments independently of time and place. Furthermore, 'OpenSoundLab' may serve as an open-source tool for the professional and academic community of musicians, performers, and artists alike. In our reflection, we develop the notion of 'cooking' sound while 'flowing' in a mixed environment and apply this to experimental work in a virtual sound laboratory.

CCS CONCEPTS

• **Applied computing** → Arts and humanities; Sound and music computing; Media arts; Performing arts.

KEYWORDS

virtual reality, augmented reality, mixed reality, modular synthesis, signal processing, binaural spatialization, open source, educational sound app, live patching

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1 INTRODUCTION

During the 1990s and 2000s, experimental practices in design, the arts and music underwent extensive digitization and thus dematerialization. However, the move towards digital software was repeatedly perceived by artists as a loss of corporeal experience that for instance plugin-based workflows within digital audio workstations (DAW), or patch-based workflows such as 'Pure Data', 'Max/MSP' or 'VCV Rack', simply cannot offer. Often, working with physical tools is valued for its unique immediacy, as it facilitates the achievement of creative 'flow' moments. In this context, material laboratories are to be understood as configurations that condense aesthetic-epistemic actions into experimental systems and in this respect, due to their spatial nature, allow for intuitive immersion in artistic projects.

Some efforts have been made to combine the possibilities of digital audio processing with the haptics and feel of analog hardware. Projects such as 'Elk Audio OS' and 'Elk Retrologue' [16] try to remedy the divide between the analog and digital by developing hardware platforms that can embed VST plugins and offer low latency interfaces to common studio gear. This allows for an intriguing and sophisticated (re-)transfer of the digital into the physical realm by making the complex and vast sound possibilities of software plugins more tangible. Unfortunately, however, the desire for expansive, physical studio setups is somewhat opposed to the increasingly urgent call to save material resources due to the ecological crises of our time. In addition, the Corona pandemic illustrates not least the ubiquitous flexibilization and mobilization of common work modalities, which are thus sometimes also in contradiction with the commitment to material – but immobile – workplaces, studios, and laboratories. The constantly high housing prices in urban agglomerations further aggravate this situation. Finally, the return to analog ways of working is sometimes accompanied by a 'quasi-reactionary' spirit that fundamentally excludes the advantages of digitization.

While virtual reality (VR) does not offer interaction with physical objects, it provides possibilities for strongly embodied experiences through its extensive use of gesture and movement tracking. In the field of music and sound, these possibilities have been explored in different ways. A distinction must be made between *audio games* that use audio as a primary way of interaction (the most popular example is probably 'Beat Saber' [6]), but do not offer any way of creating or altering the sonic content, and applications that enable users to create sound themselves. In the latter category, many apps can be classified as immersive musical *instruments* [1, 3–5, 7–9, 11]. They establish novel ways of interaction and visualization, often sacrificing much of the sonic complexity that traditional DAW or analog studio environments offer. Their main goal is to create an immersive experience. Some apps even focus completely on visualizing existing sound [2, 12]. The level of abstraction regarding audio processing tends to be rather high: While some of these applications do allow for certain kinds of audio manipulation with effects, it is generally not possible to shape and modulate the audio signal on the same level of detail as in Max/MSP, Pure Data or VCV Rack.

The production of sound and music has always been strongly linked to dedicated spaces such as rehearsal rooms, recording studios or

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sound laboratories. The strength of such creative environments not only consists of the tools (instruments, effect racks, microphones) they are equipped with, but also of the atmosphere that inspires and encourages the artist's creativity, without dictating prefabricated ways of interaction. A DAW, on the other hand, renders much of the expensive hardware obsolete and greatly decreases the space requirements, but it usually restricts interaction to a 2-dimensional screen. Hyperbolically speaking, digital audio has gifted artists with hundreds of virtual instruments, but at the same time deprived them of the experience of being physically *inside* the creative environment. With the arrival of VR on the consumer market, virtual audio laboratories that transfer the capabilities of digital audio production tools back into a 3-dimensional space have become possible. From this perspective, it is somewhat ironic that so many existing VR audio applications are developed and marketed as immersive *instruments* as mentioned above, and only few take up the idea of creative *laboratories*. Some of the applications that place the user in a virtual laboratory include MuX [10], SynthSpace [17], SynthVR [18] and the original SoundStage VR [19]. Their graphical presentation enables the users to experiment with various forms of audio synthesis through modular patching. In summary, VR *instruments* tend to put a strong emphasis on playful and immersive performance experiences, whereas creative VR *laboratories* additionally seek to recreate the sonic complexity that is offered by DAW studios, audio plugins and modular synthesis. Against the backdrop of SynthSpace and SynthVR, already the original SoundStage VR stood out with its open-source licensing and its focus on three-dimensional ways of patching beyond skeuomorphic reconstructions of the EuroRack paradigm. Additionally, OpenSoundLab departs from SoundStage VR's game-like experience in order to bring this approach into the more professional and academic domain as an untethered, standalone mixed reality experience with a passthrough view of the user's existing surroundings.

Our project experimentally explores the thesis that virtual laboratories can meaningfully combine the advantages of analog and digital ways of working, potentially bringing the spatio-corporeal to the digital. The advantages of digital design tools such as free duplication, non-linear arrangement by copy & paste and algorithmic composition as well as the storability and later reproducibility of project situations are thus combined with the positively perceived immersion in spatial experimental setups.

2 OPENSOUNDLAB

A virtual sound lab allowing for the creation of modular synthesis patches has been developed at the Academy of Art and Design FHNW and Academy of Music FHNW based on the existing open-source application 'SoundStage VR'. 'SoundStage VR' was originally conceived and marketed by Logan Olson before the developer decided to release the Unity-based project as open source for adaptations and redistributions. A central aim of our project is to make the software, which was initially designed as a kind of video game experience, usable for professional and academic work in sonic research, sound design as well as music. For example, many functionalities that are traditionally expected in creative-artistic modular synthesis (e.g. atomic utilities such as VCA, Sample & Hold or a versatile delay line, as well as the exponential 'V/Oct' pitch tracking specification known from Eurorack) were not sufficiently implemented and had to be added by us. In addition, 'SoundStage VR' was originally developed for Microsoft Windows, so that a significantly optimized ARM-based Android port for the standalone VR goggles 'Meta Quest 2' had to be carried out.

The introduction to sound generation and processing in the context of design, art and music takes place directly in the mixed environment. For this purpose, video tutorials have been produced, which are displayed next to the virtual modules and present technical and artistic strategies of working with digital sound synthesis and processing step by step.

2.1 'Cooking' sound while 'flowing' in a mixed environment

Koskela and Tuuri [13] offered a helpful overview article of the most common and well-known concepts and metaphors for describing the experience of musical involvement: immersion, flow, presence and incorporation. According to the authors, immersion usually describes being embedded within a virtual or physical environment, or in a more abstract notion, being embedded within a structure of imaginary thought entities. Presence refers to having contact with something e.g. by sharing an environment with another entity. Interaction is associated with "doing something with something", often with a strong emphasis on the shared, entangled agency of both sides of the interaction. The term 'flow' is traditionally used to describe high degrees of concentration where someone is close to losing oneself in their activity. This is often associated with the ease of focusing on one area of action as opposed to mind-wandering, as well as decreased self-skepticism and a displaced perception of time. And finally, incorporation describes the phenomena of tools becoming second nature in the classic Heideggerian sense, which has consequences on how we perceive the world, act in it and make sense of it.

It seems obvious that these terms can be applied easily for well-known areas of music such as virtuous instrumentalist performances or dance related musical genres. But what would be concrete examples and manifestations of these concepts for the experience within OpenSoundLab?

First of all, OpenSoundLab is about experimental sound work, during which corporeal intensities could be metaphorically transferred from the acts of mixing or even 'cooking' within experimental chemistry or alchemy setups. From that perspective, a sonic researcher is blending various sonic ingredients in order to synthesize rich and surprising auditive phenomena and experiences. Such 'sonic alchemists' experience flow conditions if they can immerse their cognition in experimental setups where all tools and ingredients are ready to hand for being used in a meaningful and effortless way. Adhering to modules that are mostly atomic and foundational in their function, but allow for creating more complex behaviors and phenomena, increases both the pedagogical value and the artistic expressivity of such an environment. This reminds us that flow also is heavily dependent on advanced skill levels – or in the case of a lack thereof – in the ability to find help and insights easily.

OpenSoundLab takes these aspects into consideration by offering highly atomic building blocks that have video tutorials attached.

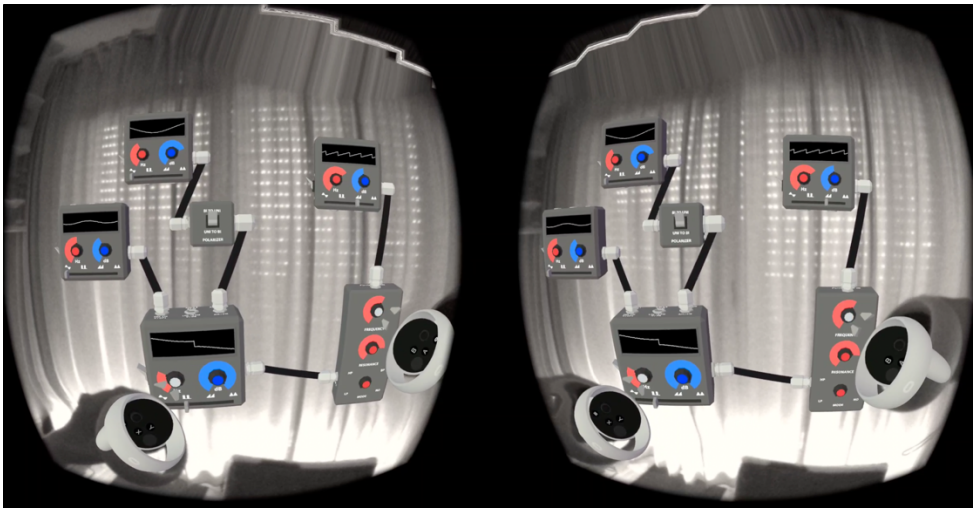

Figure 1: Stereoscopic frame buffer (recorded with 'scrcpy') of a simple patch featuring frequency and amplitude modulation using four oscillators, a polarizer and a lowpass filter.

The laboratory takes place as a mixed environment with the physical surroundings of the user being shown as a black and white passthrough using Meta Quest's 'Passthrough API'. 6-DOF tracking is used to anchor the stereoscopic renditions of the virtual laboratory quite stably to the physical space. From an interactionist perspective, the presence of the virtual laboratory is strengthened by allowing the translation, rotation, scaling, patching and modification of all modules and their according control elements, while offering visual and haptic feedback on every select and grab event.

2.2 Spatializing modular synthesis

In the case of standard Eurorack modules, the dials and jacks must be placed on the front panel of each module – a circumstance that essentially reduces such modular synthesizer setups to a rather two-dimensional experience. In contrast to this, the modules of OpenSoundLab – as well as of the original SoundStage VR – are structured more like effects pedals that can carry jacks on all sides. As a convention, the modules of OpenSoundLab have their audio input jacks on the left, modulation inputs on the top and bottom, resulting outputs on the right, control and visualization elements on the front and in some cases auxiliary configuration dials on the rear. In contrast to front patching, this leads to less cable clutter that would obfuscate the control and visualization elements on the front panel.

Like any modular environment, OpenSoundLab enables people to create sonic micro and macro architectures by organizing signal flows according to established paradigms such as subtractive and FM synthesis or explore more unusual uses and abuses of atomic modules. Given the mental images for the right signal flow – or a sufficiently driven motivation for exploration – creative sound architectures can be realized.

In addition to this, OpenSoundLab aims to add the specific benefits of the virtual spatiality of the digital domain. The modules and patch cables can be arranged without dropping to the floor, without need for stands, mountings or other grip. Everything can be instantiated immediately from the menu or via copy and paste. Modules that are relevant for a certain performative idea can be scaled up in size to make them more easily reachable and controllable. If scaled up to room filling sizes, they appear as sculptural plastics in an interactive sonic scenography of sorts. Additionally, cascading less important modules such as minor modulation sources behind more important ones allows to create machine like structures that can easily – and meaningfully – reach room filling sizes. It must be emphasized that besides working on mono and stereo renditions, binaural spatialization modes are also available via the HRTF-based Oculus spatializer plugin for Unity. This allows for working interactively in spatialized sounds either by placing and patching dedicated speakers or by activating binaural renditions for all modules, essentially enabling the creation of walkable, generative sound gardens and similar sonic architectures. Effectively, the in-situ nature of this spatialization approach eliminates the need for translating from 2D plugin interfaces and controller mappings into the 3D space.

2.3 Mixed realities that make sense

Recently, Walther-Hansen and Grimshaw-Aagaard [14] problematized popular tech ideologies of endlessly augmenting the world through virtual elements and promising higher degrees of immersion through technological progress, arguing for a 'less is more' approach coined "Reduced Reality" instead. While the authors specifically list the auditory and visual reduction of distracting elements as examples, we think that this thought can be expanded to all kinds of annoying things, including getting rid of some of the experiences that are actually disliked when working in material studio setups.

For instance, removing the emergence of cable clutter, the necessity of having to rebuild modular synthesizers every time new modules are added or the requirement of having to buy physical things altogether instead of just downloading (free, open source) alternatives to them. Or being stuck to a physical location in a space simply because gravity and cable lengths demand so, instead of

just grabbing everything and moving things along to other areas of a space and switching between standing and sitting on different chairs for instance.

On a more general note, the user's reality – in the sense of the perception of one's physical environment – is necessarily reduced to a low-res black and white rendition of it, given Meta Quest's current mixed reality implementation. Additionally, OpenSoundLab allows to further diminish the actual reality by blending the surroundings completely to white in order to fully focus on the sound work.

3 CONCLUSIONS AND OUTLOOK

By using OpenSoundLab, our students are given the opportunity to explore the potentials of the spatial virtualization of sound laboratories in a playful way and to discuss future changes in their working world. This also enables them to critically reflect on their own expectations of the phantasm of analog traditions in the age of digitalization.

Through the portability and relative affordability of the current generation of VR glasses, which can be operated as standalone devices without external PC, it is possible for the students and other users to work in sound labs as virtual environments at more or less any place. The students can thus learn independently of time and place and still benefit from the advantages of working in spatial laboratory setups, which promises a high motivation and learning potential.

Nonetheless, some restrictions apply in regard to the optical requirements the tracking system needs to operate in. E.g. bright sunlight, darkness or lack of detectable patterns in the environment usually restrict the use of such headsets. Additionally, due to the novelty of the approach of completely transferring creative-artistic media work into a mixed environment, certain complexities do arise, which can, however, be countered by appropriate measures. For example, it is not apparent to outsiders what the users of the VR glasses are currently hearing and seeing in their virtual sound labs, which, in educational settings, obviously makes it more difficult for the lecturers to supervise them. However, this problem can be countered by video mirroring, which is already provided by default in the operating system of the 'Meta Quest 2' glasses or can be achieved by third-party tools such as 'scrcpy' [15].

For future iterations of the project, we have plans to add a multi-user feature that would allow for either sharing a spatially synchronized local space with other performers, or to interact with other people over the internet. Furthermore, porting a 'spectator' version of OpenSoundLab to mobile phones would make it possible to watch, record and broadcast an ongoing performance or jam from a third-person perspective – again possibly over the internet. Another aspect of consideration is the integration with existing studio gear via Wireless MIDI, OSC and Ableton Link, or adding virtual representations of physical instruments through additional tracking markers. Nonetheless, it is possible already today to move around in a physical studio, play physical instruments and sample their sound through the headset's included microphone. Additionally, the ability to interactively generate spatialized compositions while standing inside them could be enhanced by the addition of a virtual dummy head microphone that would allow the recording of binaural or higher-order Ambisonics renditions from a fixed location in the scene. Eventually, it will soon become necessary from a research perspective to conduct scholarly evaluations to validate or readjust our assumptions regarding the various aspects we propose in this short paper. The source code of OpenSoundLab is available on GitHub [20].

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