Poème Numérique: Technology-Mediated Audience Participation (TMAP) Using Smartphones and High-Frequency Sound IDs

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Abstract. In this paper we discuss a setup for technology-mediated audience participation using smartphones and high-frequency sound IDs. Drawing from the insights of a research project on audience participation in live music we describe a setup for playful music interaction composed of smartphones. In this setup the audience needs to install a smartphone app. Using high-frequency sound IDs music samples and colors can be triggered on the audience's smartphones without the need to have an internet connection. The resulting soundscape is determined by the samples and parameters selected by the artist as well as by the location audience members choose in the performance space.

Keywords: Technology-mediated audience participation · TMAP · Live music · Smartphones · High-frequency sound Ids

1 Introduction

This article presents a specific method for technology-mediated audience participation (TMAP) using smartphones. Audience members can use their own smartphones to join in a performance. Music samples and different color schemes can be triggered by the performing artist on all participating smartphones. The resulting soundscape consists of shifted and overlapping samples, which create new rhythmic and melodic patterns dependent on how participants group themselves in the performance space. The presented approach does not require the phones to have an internet connection as control signals are sent from the artist using high-frequency Sound IDs. The music for the proposed demo has been composed by Austrian electronic music artist Electric Indigo [1]. The performance that will build on the described technology is part of the art-based research project Breaking The Wall [2], which discusses audience participation from

the perspective of the involved creative processes. The presented technical development was part of a master thesis at the Vienna University of Technology [3].

Audience participation goes back to as far as Mozart (1756-1791), who allegedly composed the parts of the "*Musikalisches Würfelspiel*" [4] (musical dice game minuet). He made a quite conscious game design decision. He recognized chamber music as a participatory musical form in the need for an interactive diversion for the audience. Thus he introduced two dice, thrown to determine one of many possible combinations of musical segments of waltz music played afterwards. It's a minuet with 16 measures with the choice of one of eleven possible variations (11^{16}), each possibility selected by a roll of two dice, with literally trillions of possible mirror combinations.

One of the core challenges in designing musical gameplay for entertainment was – also due to marketing reasons - to make music accessible to people who do not necessarily play an instrument or are literate in musical notion. This gaming approach seemed to represent the very antithesis of compositional strategies [5].

In Mozart's case he succeeded to make music more varied and introduced a participative mechanic. While this game mechanic is purely based on luck it still involves the audience and makes the musical result feel more personal and unique. For this purpose Mozart abstracted waltz music from continuous pieces of music to smaller segments, which can be rearranged freely. The common denominator of many works in the field of sound art and music-based games [6], is that they make aspects of playing music and composition accessible to the audience by abstracting from its original complexity. In the case of technology-mediated audience participation the process of abstraction is even more delicate. On the one hand there is a need to reduce and abstract complexity to make music easily accessible to the audience, on the other hand the complexities and intricacies of musical play must not be lost. Mazzini also presents metrics to describe and evaluate the characteristics of participatory performances [7].

The presented technology allows an audience to participate seamlessly using their own smartphones. A lot of control remains with the artist, who is able to trigger the samples played back on the smartphones and the colors of their screens. The audience can shape the resulting soundscape and their own experience by moving around in the performance space.

2   Project Context: Breaking the Wall

The field of audience participation has a rich history of custom-built instruments and devices, and ways to facilitate collaborative performances. The artistic potential of audience participation both for musicians as well as their audiences is very high. Recent advancements in sensor and interface technology have further increased this potential. While research on audience participation shows both practical as well as theoretical perspectives, a structured creative and evaluated approach to fully explore the artistic potential is missing so far. Thus the art-based research project Breaking The Wall addresses the central research question "Which new ways of artistic expression emerge in a popular form of music performance when using playful interfaces for audience participation to facilitate interactivity among everybody involved?"

To answer this important question and to shed light on the artists' creative practice we develop, document and evaluate a series of interfaces and musical performances together with popular music artists. The focus is on providing playful game-like interaction, facilitating collaborative improvisation and giving clear feedback as well as traceable results. The interfaces will be deployed in three popular music live performances at one event. The art-based research approach uses mixed methods, including a focus group and surveys as well as quantitative data logging and video analysis to identify parameters of acceptance, new ways of artistic expression, composition and musical experience. The evaluation will allow to present structured guidelines for designing and applying systems for audience participation.

The project team is comprised of popular music artists, and researchers covering diverse areas such as media arts, computer science, human-computer-interaction, game design, musicology, ethnomusicology, technology and interface design.

The results of the project will be situated at the interdisciplinary intersection of art, music and technology. It will present structured and evaluated insights into the unique relation between performers and audience leading to tested and documented new artistic ways of musical expression future performances can build on. It will further deliver a tool-set with new interfaces and collaborative digital instruments.

3   Implementation

The technical basis of Poem Numérique is the use of high-frequency sound IDs to trigger events on the audience's smartphones. The use of high-frequency sound or "Ultra Sound Communication" for audience participation has first been documented in [8]. In this approach frequencies above the average human hearing spectrum are transmitted by dedicated speakers and are used to quasi silently trigger events. An app that has to be downloaded before the performance listens for these sound IDs using the smartphone's microphone. Figure 1 shows the full setup with a computer used to send the sound triggers to a sound system and the audience's smartphones, which listen for these triggers using a cross-platform Android/iOS app. The cross-platform app has been implemented using Xamarin Forms [9].

Each Sound ID is composed of two distinct frequencies between 18 kHz and 20,7 kHz. Two speakers are used to transmit the two frequencies simultaneously. The IDs always are played back for three seconds. Much smaller playback timeframes are theoretically possible, but our application does not need to allow for fast sequences of triggers. Within the above frequency range we managed to implement 15 unique IDs. To reduce false positives and faulty recognition we used one of these for a Sync ID sent before an actual Sound ID. This Sync ID prompts the phone to listen for a Sound ID for nine seconds. After the Sync ID we introduced the option of sending what we called a Change ID used to allow a second bank of triggers. After that the actual Sound ID is transmitted. By this means the system at present supports 26 unique Sound IDs. A PD (Pure Data) [9] patch is used to play back the high-frequency Sound IDs and thus is the central hub for controlling the distributed performance. The PD patch can itself be controlled through any network protocol including MIDI or OSC.
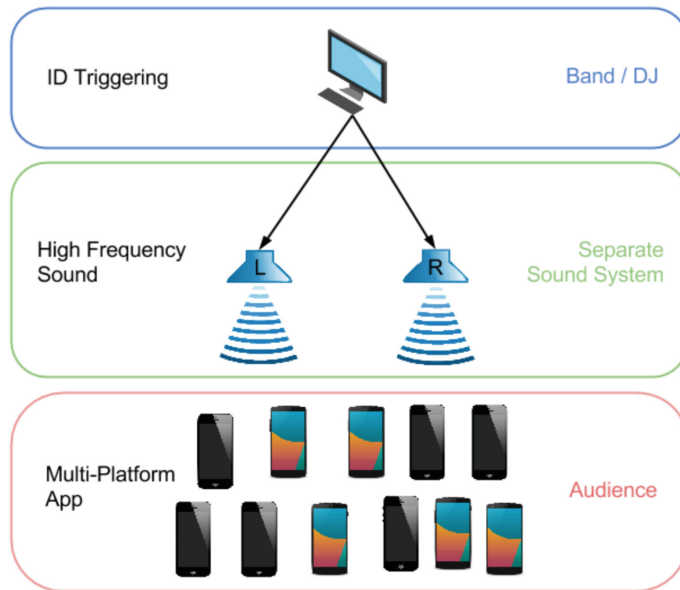
Fig. 1. The technical setup of using high-frequency sound IDs.

4   Setup and Outlook

To demo the setup at the conference little infrastructure and no dedicated performance space is needed. The technical and creative aspects can be demoed in an ado setting where visitors pass by a small performance hub and either just listen to the soundscape or take part using a provided or their own smartphone. The authors will provide a laptop and a minimum of ten smartphones. The app also is available for download for free for both Android and iOS platforms. The authors will also bring speakers, which

Fig. 2. A test of the system with students during a lecture.

are able to emit the frequencies needed to control the smartphones. One consideration when demoing Poème Numérique is that it produces a certain (but not very high) level of noise, which might disturb other exhibitors.

Figure 2 shows a test performance using the system at a lecture at the Vienna University of Technology with informatics students. The test performance showed that the transmission of high-frequency sound IDs is mostly robust, but that recognition problems might occur with untested smartphones and with increasing distance from the sound source. Also some Android mods (e.g. Cyanogen) block microphone access due to privacy settings. Further tests will determine the acceptance and creative possibilities of such a system from an artist and an audience perspective. Poème Numérique has been designed building on a series of workshops with the performing artist Electric Indigo. The design of the system will be refined iteratively based on the evaluation of the test performance and on future tests in a live setting.

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