Interaction Models for Real-time Participatory Musical Performance using Mobile Devices

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ABSTRACT

With the availability of mobile devices, numerous works have emerged that invite the audience to participate in musical performances in real time. In this paper we review a number of different works with the intention to formulate and analyse interaction models used in real-time participatory musical performances. We identify audience participation forms and performance models as two main viewpoints for discussing interaction models. Furthermore we indicate several potential directions for an engaging and ongoing interactive dialogue. We conclude with an interest in the audience’s direct involvement in combination with a responsive form of interaction, for further research and development in the field of participatory musical performance using mobile devices.

1. INTRODUCTION

Participatory musical performance is a form of music that invites the audience to be a part of, or influence the performance in real time. The current ubiquity of mobile devices makes it possible for large numbers of participants to interact with the performance in real time. The participants in such performances could be either just audience members or audience members combined with performers. We have excluded works that were designed for professional performers, required substantial practice or extensive prior musical knowledge. Besides the traditional western concert performance practice, the participation of audience in performances is becoming an emerging field. The audience plays different roles from performars, to composers, to editors, etc., varying from work to work.

In this paper, we review documentation and publications of a series of real-time participatory musical performances using mobile devices. In Section 2, we reflect upon the descriptions and definitions around the question: who are the participants? Subsequently, the analysis of audience’s role is given in Section 3. We discuss several forms of participation mainly in three aspects: active or passive, direct or indirect, within or without limitations. In Section 4, we introduce the term ‘performance model’, following the explanation of unidirectional and responsive interaction.

Lastly, in Section 5, we propose possible directions of efficient interaction design for further research.

2. PARTICIPANTS

In some existing participatory musical performances, the participants could be divided into two groups, novices and masters [1, 2]. Mileto et al. considered a novice a music beginner, a person who lacks musical knowledge or who is learning the rudiments of music [3]. The works we review in this paper were not aimed at master musicians, but attempt to engage the audience in the performances. We characterise the performance forms as 1) audience and performers or 2) audience only. Performers may play a leading role or a collaborative role in a performance.

2.1 Audience & Performers

There has been a clear separation between audience and performers in traditional western concert performances. We are interested in blurring this line and inviting the audience to participate and interact with performers using mobile devices. In Dialtones [4], the audience was asked to register their phone numbers at web terminals, and ringtones were installed on their phones. During the performance, the phones were dialled by the performers via software that allowed 60 phones to ring together, this way the ringtones could be choreographed as a musical performance. The audience’s mobile phone became the performance medium, although they played a passive role in the performance itself.

Since then, performances have been developed to invite the audience to participate in a more active way. massMobile [5, 6] is an audience participation framework developed by Freeman et al., it provides an interface for the audience to shape an onstage live performance. In Saxophone Etudes [7], an application developed within massMobile was used to collect votes from the audience, and to display musical factors including tempo, dynamics, note duration, articulations and measures of the music to the saxophonist for improvisation.

Both works combine audience participation with performers and construct different collaborations between the audience and the performers. While the performers directed the performance in Dialtones, the audience influenced the way the performance developed in Saxophone Etudes.
2.2 Audience Only

In some participatory performances, there are no professional performers, and the audience is instructed to create or join a performance individually or form a group. In Tactical Sound Garden [8], users can choose a sound from a pre-designed sound library and plant it at a certain location by adding a GPS location. Furthermore, they can modify the sounds planted by others and modify their volume and repetition time. All the sounds are mixed at the server-side and streamed to the mobile devices used by the participants. As soon as someone walks into the garden, the sounds planted around them would be played in real time. When one plants or modifies a sound based on the mixture of former sounds in the garden, communication amongst the audience members emerges through the sounds. Each audience member contributes sounds independently, and one audience member can be seen as the contributor in the others’ view.

Swarmed [9] is another case of audience only participation. It applies a captive-wifi-portal allowing participants to generate audio via an HTML5 web page used on multiple mobile devices simultaneously. There are several predefined instruments to choose from, and which produced synthesised sounds based on gestures. The audience is able to hear the sounds they are playing on their phones independently, as well as the combination of all of the other audience’s contributions from onstage speakers.

SoundBounce [10] shows the possibility that the audience could perform and interact with a sound in a group. In SoundBounce a sound is regarded as a ball. Pre-defined gestures allowed the players to throw and bounce the virtual ball to each other according to compass data using their mobile devices. The movement of the ball (or sound) is sonified with FM synthesis. Although the premiere of SoundBounce was performed by several professional performers, we still included it in our audience category. SoundBounce utilises a physical metaphor to develop the mobile interaction and designed an intuitive way for a group of participants to perform and interact with each other. We see this as an equally meaningful approach in an audience only context.

All of the three works discussed above are examples of audience only participation performance. Tactical Sound Garden is not a performance with a beginning and an end and can therefore be seen as an installation format. Tactical Sound Garden and Swarmed have a similar approach in the sense that the participants make their own contributions and are not ‘forced’ to interact with each other. Interaction between the participants is an inherent requirement of SoundBounce since the ball has to be thrown and caught. In all cases the performers can take a pause and just listen to what is going on.

3. AUDIENCE PARTICIPATION FORMS

The development of mobile devices and wireless technology has opened doors for new ways to engage and make the audience interact with performances, and created the possibility to make the audience a part of the creation of a performance. In order to describe different forms of audience participation, we analyse the audience’s role in various performances.

3.1 Passive Participation

We define passive participation as a form in which the audience does not influence the result of a performance, but are nevertheless aware of participation. Like in Di-altones [4], the audience did not need to take any action but only brought their phones along. This innovative way of performing sounds tried to get participants involved in the performance, still the passive role might make the participants feel surprised more than engaged.

In Net_Dérive [11], the participants had more choices to take action. There were several paths for participants to follow around the outside the gallery. While the participants were walking, ambient sounds were recorded automatically by the participants’ phones at regular intervals. These recordings were mixed at the server-side and played in the gallery. In this case, the participants could choose different routes around the gallery though, the process of recording was automatic.

Compared to Di-altones, the participants in Net_Dérive were more active. But they did not have the opportunities to fully decide the recording materials. The two works require the audience to be there and participate but the audience has little or no influence on the sounding result itself.

In Figure 1, we will make a distinction between direct and indirect forms of active participation.

3.2 Active Participation

Active participation signifies that the audience makes choices to affect and construct a performance. In this section we will make a distinction between direct and indirect forms of active participation.

3.2.1 Direct Contribution

The term ‘direct contribution’ indicates the condition in which the audience produces or controls sound directly. For instance, their actions might be utilised as the input of sound generation or to trigger audible events. The audience
is likely to become aware of how everything functions in
the aforementioned conditions. In Dial the signals! [12], a
matrix of mobile phones was exhibited as an installation,
and the numbers of the mobile phones were passed to
the audience to dial. Every tone the phones played was
broadcasted by several radio stations and available as a
live stream on the internet. The audience had full control
of deciding which phone to dial, and their involvement
was direct. Furthermore each of the phones corresponded
to a specific sound. It is impossible for the designers of
this work to predict which phone would be dialled first or
in which order a series of phones would be dialled. The
audience gets complete freedom and there are no specific
choices made regarding the compositional or interactive
development over time.

In some other works, specific interaction rules are used to
limit the audience’s direct contribution. In Echobo [1], an
eight-key keyboard was displayed on the individual mobile
phone as an instrument. The audience was instructed to
play the notes of the chord selected by the composer or
a master musician. But the sequence of playing the notes
was not fixed. The corresponding keys were marked with a
black arrow, and an electronic piano sound was generated
directly from the phone as the harmonic backdrop of the
performance. The harmonic structure was controlled by
providing limited keys for the audience to play. Ac-
cordingly, the audience collaborated with the performer
harmoniously, while having partial freedom to play the
instrument.

In SoundBounce [10], the audience performed with cer-
tain mapping rules pre-defined by composers and deve-
lopers. The movement of the virtual ball was sonified
with frequency modulation synthesis. The melodic pitch
got higher, and the sound became louder as the ball rose.
Additionally, the sound cross-faded from the thrower’s
phone to the receiver’s phone. Limitations were set up to
to control the randomness and unpredictability in Echobo and
SoundBounce, to improve the structure of auditory results.

3.2.2 Indirect Contribution

Participatory performance using, for example, interpreta-
tion or manipulation of the audience’s contribution might
have a more indirect nature. In TweetDreams [13], the
audience was asked to tweet during the performance.
Tweets with a certain hashtag were able to be searched and
collected. The specific hashtag and the rate of appearance
of each tweet were determined by the performer, further-
more the tweets were used as an input for algorithmic com-
position. In this case, the audience’s active participation
had been passed through a selective and translated process,
and the audience themselves did not control or produce
sound directly or instantaneously. While being indirect,
the audience plays a crucial role in the performance.

In The Open Symphony [14], four professional musi-
cians improvised in accordance to the score resulting
from the audience’s votes. The audience could vote
different playing modes for different players through a web
page, including single notes, melodies, free improvisation,
silence, etc. The result was displayed as graphic notations
on a big screen from left to right. With limited features to
vote, the audience contributed compositional resources to
the performers to improvise.

4. PERFORMANCE MODEL

By participating in an interactive system, an audience
member can control or influence the outcome of a per-
formance step by step. The interactive experience is
constructed through such form of interaction. In this
section, we introduce the term ‘performance model’. It
describes the connections among audience members, and
between the audience and the performance system. The
performance consists of the audience’s actions and interac-
tive system’s reactions. Schraffenberger and van der Heide
considered mutual influence between audience and art-
work an important underlying principle of interaction [15].
Some performances might have an evolving interactive
dialogue, whereas the interaction model could be static in
other performances.

4.1 Inherent Performance Model

In Dial the signals! [12], the participants were free to
dial the mobile phones exhibited in the installation, and
the corresponding phone rang immediately. Each phone
corresponded to a specific ringtones. The participants can
learn the mapping between ringtones and phone numbers,
and choreograph the combination of ringtones to create
a larger composition. In Dial the signals! [12] there is
no varying interactive dialogue taking place between the
actions of the audience and the reactions of the system.
The system does not interpret and react to the actions of
the audience. There are simply fixed relations between the
actions of the audience and the sounds being played. Dial
the signals! does facilitate an interactive dialogue between
the participants.

![Figure 2. Diagram of Inherent Performance Model.](image)

Tweets were used as input for an algorithmic composition
in TweetDreams [13]. The program analysed selected
tweets and checked whether one was new as the root or was
familiar to an existing root. If a tweet starts a new root, a
new melody will be chosen from pre-composed melodies,
otherwise the melody will be mutated from its parent’s
melody. The visualisation of tweets gave the audience
feedback to track and locate their own contribution, while
the musical translation may not be clear enough for a true
interactive dialogue. Similarly, the audience responded to
guided questions sent by the performer to form a story in Moorri [16]. The text messages then were spoken with text to speech software. Despite the questions that were designed like a narrative script to keep the audience answering the questions, the interaction ended when one answer was spoken. Therefor there was no real opportunity for an interactive dialogue.

In Echobo [1], there was one musician controlling the chord progression, and an acoustic instrument player performing melodic material. The audience can play only with the harmony defined by the musician. Still, the audience was free to decide the order of notes they played. The performer would probably affect the audience’s decision about the order. The unidirectional interaction started with the chord selection and ended when the audience finished playing the notes from the chord without any further dialogue.

We use the term inherent performance for forms of interaction that don’t lead to a substantial interactive dialogue between the audience and the interactive system. From the diagram (see Figure 2), it can be observed that the interaction in the inherent performance model is often one directional.

### 4.2 Responsive Performance Model

The form of the performers’ improvisation could give a clear feedback to the audience, and create a continuous interactive dialogue. It may also make the audience feel that they were engaged and influencing the performance. Because the audience might be curious about, or anticipate on how their contribution is being translated or performed. In Sketching [2], the audience could draw different shapes through a web page developed within massMobile. Each shape was assigned to an instrument. Other features such as colour, size, opacity, border were mapped to different musical factors. Performers from a jazz band would pick and play a jazz standard and improvise based on the drawings from the audience, or entirely improvise with the drawings. The audience might draw a new shape or adjust the features according to the previous performance, and try to develop the performance further. We call this the responsive performance model.

1) The Open Symphony

![Diagram of Responsive Performance Model](Image)

In The Open Symphony [14], the graphic notation presented the individual and collective feedback for both the audience and the performers. An audience member’s decision may be influenced by the other audience members as well as the performers. Differently, although the points selected by the other audience members were presented on each audience mobile client, the audience did not know the results of voting for each musical factor, such as speed, dynamics, etc., in Saxophone Etudes [6].

In Tactical Sound Garden [8], the audience was not only able to plant a sound, but also modify the sounds played by others. Influenced by the mixture of the sounds in the garden, one audience member may come up with various ideas about planting and modifying sounds. Such interaction remained among the audience, and the combination of the audience and the results of the sound mixture. In addition, it extended the audience’s experience beyond the time that the audience is interacting themselves.

5. DISCUSSIONS & FUTURE POSSIBILITIES

In contrast with visual feedback, the auditory result might be less noticeable and understandable when the audience’s involvement is indirect. This depends on whether the audience is capable of associating the musical outcome with their actions or contributions. In part of the performances that we have reviewed in this paper visual feedback is used to create insight in the performance and make the interaction more engaging. On the other hand, the visual feedback might also distract the audience from the actual auditory result.

Our interest focuses on musical performance and therefore we concentrate more on the sound and music than the visuals. In this context, we prefer a form of interaction in which the audience’s musical contribution can be clearly perceived. For example, they trigger pre-composed files or audio events, apply diverse forms of audio synthesis or utilise live recordings. The limitations created by the composers and developers could help to create the right balance between a feeling of control and unpredictability and thereby improve the quality of real-time performance. We are aware that this would demand a further discussion about the balance between control, predictability and unpredictability in a performance. As for indirect involvement, proper visual feedback can assist the audience to understand the interactive system and the performance structure. We believe that it is important to give the audience a feeling of control when they contribute in a bigger process or systems that use sever-based approach.

![Possible Model for Future Research](Image)
ongoing form of interaction Although efforts have been made to maintain the audience participating longer by elicitation, for instance, questioning [16] or instructing them continuously [1]. The feeling of participating could be broken at any time during the performance since the audience does not get enough hints of participation from the result. Furthermore a static form of interaction could be in the way of developing a dialogue between the audience and the performance system. In most of the discussed works in section 4.2 the participation form has an indirect nature. It is worth a try to combine the approaches used for direct contribution in the context of a responsive performance model.

6. SUMMARY

Participatory musical performance is still in its developmental stage. The mobile device is a widely available medium for the audience to participate in a performance in real time. For sure, the evolution of mobile and wireless technology could offer endless possibilities for participation. We have chosen not to focus on the technology itself but on the possible forms of interaction.

In the course of our review, we have presented the term participants. The audience members become participants when they take part in an interactive system. Performers could be included to lead or collaborate with the audience in a performance but are not a requirement. We have derived and categorised multiple audience participation forms from the audience’s roles and behaviours. There is little interaction existing in passive participation. Differently, active participation supports a wider range of interaction. Participants can be aware that their decisions are shaping and influencing the performance when they perceive direct contribution. In some of the discussed works, certain rules were set up to limit the possible input and create more control over the performance. Indirect contribution employs a system to collect the participants’ choices, and translate those materials into compositional resources to create a performance. Participants often experience less clear feedback of interaction in this form.

We have distinguished two performance models. We have analysed the interactions among audience members, and between the audience and the performance. Subsequently, we have categorised existing works as works with an inherent or responsive performance model. Aspects such as interaction, feedback, (un)predictability and control have been discussed. We have highlighted the need for future research and made several recommendations for formulating new interaction models. We concluded that we are particularly interested in exploring the potential direct contributions by the audience in combination with a responsive performance model in order to create engaging interactive dialogues.

7. REFERENCES


