TOWARDS AN EXPERIMENTAL PLATFORM FOR COLLECTIVE MOBILE MUSIC PERFORMANCE

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ABSTRACT

This paper presents an experimentation of an interactive performance system that enables audience participation in an improvisational computer music performance. The design purports an improvisation tool and a mechanism by involving collective mobile interfaces. It also provides a design of an adaptive control module in parts of the system. Designing a collaborative interface for an easy to use and easy to control everyday-life communication tool allows for an audience to become more familiar with the collaboration process and experience a way of making music with a mobile device. The role of the audience is critical, not only for the design process of the system, but also for the experience of such experimental music.

1 INTRODUCTION

Mobile interfaces aid the participatory augmentation in collaborative computer music performances. They do not only make use of the technology but also provide an opportunity to emphasize the role of social communication and its relationship to interaction in human actions and reactions towards music.

Collaborative music making requires event participation in a musical context and it includes all aspects of human musical interaction - voluntary and involuntary actions [1, 2]. Voluntary actions involve participants consciously forming decisions about musical activity, both in listening and playing modes. Some human actions on the other hand, are performed without conscious comprehension, and it can be argued that it is hard to draw the line between voluntary and involuntary actions, especially in an activity like music making. In music, these actions result in exchanging musical events and gestures, which in turn bring about a shared interaction and experience framework.

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The level of interaction in a music performance can be estimated by whether the voluntary actions take an active role or they are reduced to a passive role of just being a member of the audience. In the context of experience design, interactivity is comprised of many attributes, such as feedback, control, creativity, adaptivity, productivity, communications and conversational experiences [3]. These attributes draw the line from low-level to high-level interaction in the interactivity spectra. Interactive performance systems can enable a high level of interaction by providing new practices for voluntary actions in order to achieve a high level of feedback, communication and audience control in a computer music performance. Creativity and productivity achieved in the moment of participation and the adaptive ability of the interactive system will also increase the level of interaction during the performance. This will result in a shared collective musical experience and enhance musical satisfaction.

This paper introduces the current state of experimentation of the *Control Augmented Adaptive System for Audience Participation (CAASAP)*, which is a part of the strategies developed for a collective mobile music performance. CAASAP is a facilitator of dynamic social interaction, controlling group communication and its relation to the improvisation of music. The core novelty of the system is, that it cumulates the participants' control-data in a centralized network and grounds it as a source to generate overall control parameters for improvised music. Figure I illustrates the ideas for the performance modules and interaction model of the system. In the following sections, the overview of the current work done in developing strategies for system modules is presented and the interface and adaptive module plan of action are introduced in detail. Paper concludes with a presentation of outcomes and indicates the future development of the CAASAP system.

2 BACKGROUND IN COLLECTIVE MOBILE MUSIC PERFORMANCES

CAASAP can be categorized as a small-scale system based on Weinberg's taxonomy [4]. Mobile collective interfaces

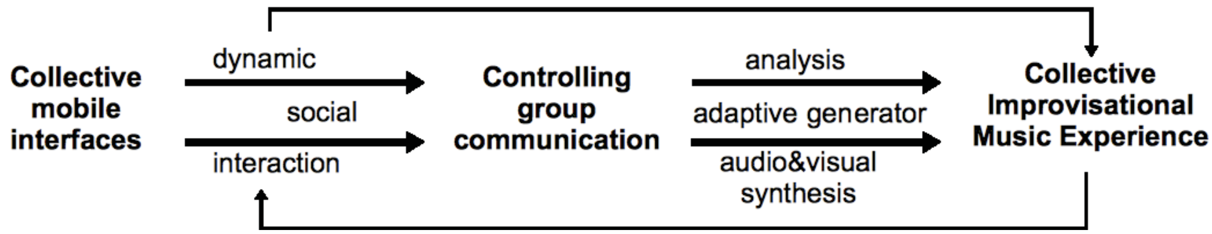

Figure 1. Modular structure of interaction in CAASAP performances.

give more possibilities to increase the amount of participants in collaborative music performances. However, designing such a system to include audience participation requires bringing together different technical platforms and managing the complexity of their integration. In literature, the collaborative, improvisatory and technological aspects of mobile music performances are introduced as alternative approaches for this integration in mobile music systems.

Golan Levin's mobile music piece *Dialtones (A Telesymphony) (2001)* [1] is a large-scale collaborative performance that brings forth a different approach to the performative role of the audience. Low-level interaction achieved in terms of decisions made by the audience; however, using mobile phones as means of musical instruments, by hacking the dialtones of the audience's mobile phones and performing a pre-composed piece by ringing and dialing, is a remarkable event for the use of mobile devices in musical contribution.

A mobile phone, being a significant communication tool for the majority of people, gives the opportunity to interface its everyday-life practice for a collaborative musical experience. *Call in the Dark Noise (2006)* is a performance that provided the audience with a responsive environment for participating in an act of musical improvisation [1]. In this performance, the interactive performance system allowed the audience to use their mobiles phones as a musical instrument by sending SMS messages. The interactive system altered SMS messages into sound structures and created respond text messages. Using an everyday communication medium as a musical instrument can make the audience feel comfortable about participation and improvisation by sending SMS messages can create an exciting framework for collaborative music making. Today, the technology of mobile devices can support more possibilities than only receiving and responding to SMS messages during a live performance.

As the technological aspects are developed further, new capabilities and tools in mobile phone technologies have begun to provide alternative feedback mechanisms. Tapping on a touch screen, tilting the mobile device, multi-touch interfaces change the way we interact with a mobile phone. Moreover, they create a new gestural dictionary within the context of interactive gestures [2]. Nokia N-series phones, Apple iPhone and iPod touch mobile devices are the leading new alternatives that support these types of gestures. Interfacing new mobile functions as expressive musical instrument is an interesting prospect. Mobile devices provide alternative possibilities for experimenting with new music making processes. MoPhO is the Mobile Phone Orchestra of CCRMA using mobile phones as musical instruments in a larger scale performance [5]. They are using not only new feedback mechanisms that come with the new series of mobile phones, but they are also using the advantage of enriched computational possibilities. However, the computational possibilities for audio synthesis in mobile phones are still limited compared to other portable devices.

MoPhO compositions are performed through performers' actions on mobile phones guided by the conductor of the performance. These compositions can be interpreted as freely composed pieces. Conducted improvisation in music or the performance of pre-composed pieces might limit the type of free communication that could be achieved in a free or structured improvisation performance. The overall control structure in CAASAP does not scale down participants' collective activities as the performers of a pre-composed piece, instead, it supports them developing their musical ideas and activities in a real-time performance.

Malleable Mobile Music Engine in a broader scope shows similarities with CAASAP as it serves as a platform for collaborative music making through mobile wireless networks [6]. Malleable Music encourages participatory activity by facilitating a system that detects involuntary gestures and the remote geographic location of the participants. In contrast, CAASAP is a facilitator for audience participation where the improvised music content is generated through the voluntary actions of the participants.

3 OVERVIEW OF CAASAP

CAASAP is based on independently developed modules; their interaction forms the characteristics of the interactive system and its performance. The system consists of interface, registration, adaptive control, and audio & visual syn-

[1] http://www.flong.com/

[2] http://intertactivegestures.com

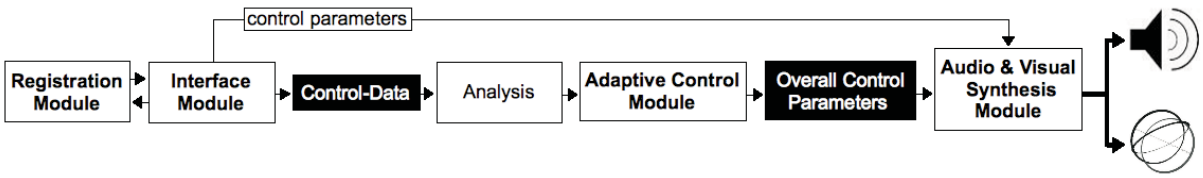

Figure 2. Block diagram of the system modules.

thesis modules. In addition to receiving and collecting control parameters, these modules also analyze control-data and perform audiovisual synthesis allowing these actions to be interfaced within a mobile device.

The modular structure of the system requires sequenced action of particular modules. Figure 2 shows the interconnected system modules. Registration module represents the initial act that alters participation into action. This module is in charge of creating a local network and maintaining the requirements for real-time connections of the participants. It includes assigning the server IP for participants to access and join the local network. When all the participants are connected, then the registration module uploads the interface module to the participants' mobile devices. The current version of the registration and interface modules are enabled by mrmr technology [3]. Mrmr is an ongoing research project to develop a standardized set of protocols and syntax conventions to control live installations and multimedia performances. This technology, based on the Open Sound Control (OSC) and other open standards, makes it possible to use mobile devices as controllers in audio-visual performances.

Interface module is based on the design of a collective mobile interface that enables interactive gestures and sends parameter changes to the audio & visual synthesis module. This module modifies main control parameters, including instrument's ID number, volume level, direction of the audio stream, reverb level, noise level and text messages. Interface module also sends the state changes of participants' interactive gestures to the adaptive control module for further analysis of the control-data.

The adaptive control module will analyze the control-data and it will generate overall control parameters for the audio synthesis module. As a result of the different modes of the participants' musical activities, this module will generate alternative improvisation models during the collective improvisation performance. Section 5 introduces the analysis and generative strategies that will be implemented in adaptive control module in detail.

Audio & visual synthesis module receives control parameters and maps them onto control values of the digital instruments. The changes of the direction of the audio stream will be also used as visualized representation of the participants' location in the performance space. Three-axis (x,y,z) accelerometer's control data will be visualized as three circles for each participant [7]. The rotation speed of each circle will represent the participant's speed of the action on the particular axis.

[3] `http://poly.share.dj/projects/#mrmr`

4 INTERFACES IN CAASAP

In the course of the development of CAASAP, several available technologies have been studied and practiced. Figure 3 illustrates the UI every participant operates on. The interface is made by using mrmr protocol and tools. The four push-buttons on the top enable/disable up to four shared instruments (see section "Audio Synthesis" for more discussion). At this instant, the first instrument is selected and the values for reverb, noise and volume parameters are assigned. The state changes of the interface are sent through OSC protocol. The current version of mrmr technology supports one-way OSC communication, which does not enable the system to send feedback based on state changes to the interface module. On the other hand, this interface module supports text message affordance, which opens up another communication channel for participants and possible sonification strategies for the audio synthesis module.

In the process of developing the interface module, RjDj application [4] has also been experimented with. RjDj is a technology that uses sensory input to generate and process embedded scenes for iPhone and other mobile devices. RjDj technology enables Pure Data [5] for processing live data taken in mobile devices. The overall system architecture of the CAASAP has been developed by using the Pure Data environment; therefore, RjDj gives more possibilities to integrate control-data with other CAASAP modules. Accelerometer and touch screen sensor data of the mobile device is available and can be accessed with RjDj application. Moreover, it takes in the sensory input from microphone device, which makes it possible to process the audio as a sensory data in mobile devices. In order to improve CAASAP performance, some part of the analyzes can be embedded in mobile devices through RjDj application and resulted event data can be transfered for further use in adaptive and audio & visual modules. At the moment RjDj application also only supports one-way OSC data stream; however when

[4] `http://rjdj.me/`
[5] `http://www.puredata.info/`

Figure 3. The interface module enabled on mrmr technology.

RjDj will support OSC stream in both directions, then it will be possible to control audio device features of the mobile devices in more advanced level and implement new features in CAASAP.

5 CONTROL PARAMETERS FOR OVERALL IMPROVISATION

Improvisation practices lead participants to experience a way of music making, which takes form in the act of performing in a collaborative environment. In this participation, exchanged gestures play an important role together with the exchanged musical events and together they form the participant's musical activity. CAASAP will collect these exchanged events similar to the way that the control-data of the interactive gestures will be received. Accelerometer control-data of the participants will be analyzed in order to generate certain improvisation models to negotiate with the participants, moreover to support or provoke them to create new musical ideas within the group dynamics of the collective improvisation process. The overall improvisation parameters will be generated in this process to control the group communication, aiming to balance the flow of the improvisation; however there will be no pre-defined structure as there is in a pre-composed music piece.

The current strategies for analysis of the control-data is designed focusing on the performative aspects of music in the performance space. This led the design ideas to involve adaptive features based on the group dynamics of the collective improvisation. Concentrating more on the group dynamics and adaptability, swarm patterns came forward as a model for generating overall improvisation music materials as swarms in real-life organize themselves flock patterns.

The method of the control-data analyses is also structured on the basic rules that are governing the interactions between neighboring particles in swarm; *1) if apart, move closer (cohesion), 2) if too close move apart (separation), 3) attempt to match velocities (alignment)* [8]. The analysis structure will determine whether the participants' gestures move closer, move apart or attempt to match their velocities. Resulting rule will make the decision in adaptive control module and it will generate further parameters for audio synthesis. If the gestures will attempt to move closer or further apart than the system's thresholds, the overall control parameters will be generated to respond as negative feedback to the collective improvisation. If the velocities of the gestures will attempt to match, then the module will respond as positive feedback. David Borgo points out that positive feedback forms the recruitment and reinforcement activities and negative feedback keeps the balance by causing unexpected occurrences in improvisation [9]. In addition to positive and negative feedback, CAASAP will determine random choices as well not to result too much regular and repetitive moods for the improvisation. Resulting overall improvisation will be formed based on direct and indirect interactions; interaction happens among the individuals as participants and the group as a whole [9].

5.1 Audio Synthesis

The audio synthesis module in CAASAP consists of two different parts. First, the system responds to parameter changes received from interface module and maps them onto a number of musical textures. Second, the audio synthesis module will respond directly to the adaptive module parameters based on the analyzes of the control-data. The sound-action strategy in audio synthesis is focusing on main action as *tilt to change state*. Participant's tilt to change state, accelerometer sensor data, determines the similar control features of each instrument. Participant can choose, switch, add and control four different instruments. Volume, reverb and noise levels can be set through the interface module.

The first instrument, *Low3P* is based on the combination of three signal-controlled lowpass modules. In each module the resonance frequency is set by continuos sinusoidal waves, which bring changes in the bandwidth of the cutoff frequencies. Accelerometer data is mapped to control the frequency values of the sawtooth and sinusoidal waves that determine cutoff frequencies. The tilt movement also changes the width of the resonant peak. The gain of resonance frequency results in more dramatic texture when all three modules are activated within the equivalent low frequency scale.

OscMood is the second instrument and it is based on the basic frequency modulation where the carrier audio signals and modulation frequencies are controlled through accelerometer sensor data. The frequency range is set on a very limited scale and this gives more weight to the modulation frequencies to affect on resulted sounds. *BeatMove* is an instrument that creates dynamic rhythmic patterns through pulses generated by granular samples from a wavetable. The speed and the force values of the accelerometer data creates the beat-move. Sound manipulation performed with the fourth instrument, *WaveStretch*, is based on the playback use of the sampled sound source and overlap mixing of the wavetable reading points with sawtooth wave oscillator. The gain of the oscillator is controlled by the amount of samples in the sound file and changes in the noise texture.

The instruments, *Swarm1* and *Swarm2* will be controlled through the adaptive control module. These instruments will apply resulted parameter changes to the transformations of sampled sound materials, using them as a source for the synthesis of a new sound output. The transformation of the sound will use a polyphonic synthesis patch with four different parameters. Pitch, amplitude, duration and starting point in milliseconds will be all modified by variations. *Swarm1* and *Swarm2* will generate a class of sounds with multiple sonic gradations and variants.

5.2 VBAP - Direction and Communication

The spatial sound feature in CAASAP will make it possible to transform and perceive generated sounds from various directions based on speaker locations in the actual performance space. Receiving audio stream in different directions during a collective improvisation performance can cause alternative communication possibilities among the participants and it can change the flow of improvisation. CAASAP will use VBAP technology to control the direction of the audio stream in the performance [10].

5.3 Visual Representation of the Sonic Location

Spatial sound also gives possibilities to represent participant's location through the decisions made for the audio streaming directions in the performance. CAASAP will visualize sonic movement and the interactive gestures of the performers. Projecting these visual representations will support participants to recognize their sounds and their act of control within the overall improvisation.

6 AUDIENCE-ORIENTED DESIGN

CAASAP aims to develop a set of evaluation methods in order to study and examine the interactive system's features and its engagement with the audience reflecting its participatory attributes. System design strategies will be developed further based on the audience experiences. Evaluation methods will involve observations, interviews and questionnaires, which will be designed in order to achieve a certain level of comparison and assessment of the effectiveness of sound-action-gesture strategies and to reflect on the CAASAP research arguments.

CAASAP claims that besides exchanged musical events in a collaborative music performance, musical activity of the participants can be observed through participants' exchanged gestures in the moment of playing. Sound and gestures can be both regarded as an important mode of interaction in a collaborative music making process. This is a generic hypothesis of musical interaction that CAASAP research accentuates. The validity of this hypothesis is supported by a recent study [15] that categorizes the movements of musicians as sound-producing, ancillary, sound-accompanying and communicative that results in the music-related body movements.

CAASAP also argues that the dynamic social interaction in real-time performances challenges the traditional roles in music by changing the role of the audience to that of a performer of improvised music. The main building block of the modular structure of interaction in CAASAP research (Figure 1) is necessary and sufficient for wide-ranging scenarios in defining social roles and social behavior in collective music performances. Understanding the social behavior in a collective music making process will develop the adaptive ability of the CAASAP interactive systems, which will support the creativity and productivity achieved during the participation. This will result in a shared collective musical experience. Support for this hypothesis comes from the ongoing fundamental research issues in theoretical approaches to social behavior in music and in analysis of social roles in performers [11].

CAASAP research strongly claims that the level of interaction in music performances will be increased by providing audience control, feedback and communication blocks in social interaction in music. This hypothesis is supported by specifically, in the context of experience and interaction design [3]. While mediated music making and listening is usually concerned as a passive, non-interactive and non-social experience, CAASAP will facilitate audience participation by providing finely balanced mechanisms for dynamic social interaction.

7 CONCLUSION

Collective improvisation enriches the musical experience and audience participation enhances the pleasure achieved in a musical activity. Interactive performance systems can facilitate audience participation by providing finely balanced mechanisms for dynamic social interaction that expands in event participation. These include accessible and *easy use - easy control* tools that give audience control over creative acts and allow them to explore musical experience. Controlling group communication is another mechanism that can provide a flow in the event. This paper focuses on the modular form of these mechanisms in the CAASAP system and explicates the strategies in developing the interface and adaptive modules. In this process, enabled technologies, such as mrmr and RjDj, extended the research ideas in the study of interactive gestures with mobile devices.

Computer-supported collaborative work has been a traditional focus in human-computer interaction (HCI), and collaborative music making is perhaps one of the most interesting application domain. However, applying HCI methodologies directly to the interactive art [12] and computer music [13] could be problematic, as HCI relies on a task-based paradigms and graphical stimulus & response model (e.g., WIMP), whereas interactive art and music systems are based on continuous interaction and multisensory feedback. Especially, the special nature of musical interaction by the use of gestures requires special care for grounding our design decisions [14, 15]. In the next phases of the system it is apt to consider HCI methodologies such as hierarchical task analysis and interface design, as informed by interaction design [16]. In a complementary task, there will be more advanced feature analysis of audience voluntary actions in order to broaden the strategies for mapping gestures to musical output in the CAASAP system.

During a collective improvisation, participants discover expressiveness in themselves, which is supported by the easy to use interfaces. In this process of investigation and exploration, the audience can learn more and without difficulty. Therefore, alternative levels of learning curves will be implemented in CAASAP in order to reach a wider musical expressivity, varying from instant gratification to virtuosity.

The modular structure will help to extend the amount of participants in the performance and develop interface modules that will not be dependent on a certain type of mobile device as well. CAASAP is in early development stages aiming to involve audience experiences in the process of its development by organizing more collective performances.

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