A Musical Game of Bowls Using the DIADs

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ABSTRACT

We describe a project in which a game of lawn bowls was recreated using Distributed Interactive Audio Devices (DIADs), to create an interactive musical experience in the form of a game. This paper details the design of the underlying digital music system, some of the compositional and design considerations, and the technical challenges involved. We discuss future directions for our system and compositional method.

Author Keywords

DIADs, Networked Music, Game Music, Bowls

ACM Classification

H.5.5 [Information Interfaces and Presentation] Sound and Music Computing, H.5.2 [Information Interfaces and Presentation] User Interfaces—Haptic I/O

1. INTRODUCTION

Bowls was presented at *Musify+Gamify*, an inter-disciplinary performance and installation event held at the Seymour Centre, Sydney, Australia, as part of the Vivid festival held in 2015. *Bowls* was a new musical interface and installation that explored novel methods of interaction with musical interfaces, and created a social non-competitive musical game, which was an adaptation of the game of lawn bowls. The game was based around rolling, holding, placing and throwing 6 DIADs [1] (battery powered wirelessly networked single board systems with attached loudspeakers) which were contained within bowl-shaped 3D-printed enclosures. As each group member rolled a bowl the devices responded, with the game object being to interact with the devices in a collaborative manner. In this paper we examine previous work in this research area, and we discuss the design of the installation, in terms of both technical lessons learnt, and design processes and techniques that proved important. We also reflect on the software and hardware used, and its effect on the design of the system.

2. RELATED WORK

Games have had a long history in music, digital art and interaction design, as a method by which groups of people can be encouraged to collaborate within a social artwork. Musical games were created by composers such as John Zorn and Iannis Xenakis [4]. Even further back, dice music was a form of composition found in the 18th century, with K.516 being attributed to Mozart (but without confirmation) and other composers such as Kirnberger or C.P.E Bach composing in the style. A classic example of a digital game system is the work by Loren and Rachel Carpenter, whereby a video game of *Pong* was projected in front of a large audience, who received physical paddles with 2 coloured panels. The game system responded to the number of panels showing a particular colour on each side of the room, and each side of the audience needed to show the right number of paddles to move the in game paddle [3].

Camera and display based interaction systems such as the above have steadily been joined by physical or tangible systems using accelerometers, gyroscopes and wireless technology. For instance, in 2007 Jon Rose created 'Spheres of Influence', a 2.4 m beach ball that was instrumented with an accelerometer which was wirelessly used to drive audio synthesis algorithms[1]. Similarly, in *Urban Musical Game* [5], Rasamimanana et al. instrumented a set of foam balls and used accelerometer data to drive Max/MSP based sonification.

Much work recently has looked at the casual involvement of music into physical interaction scenarios, providing auditory feedback to game users. This involves finding a suitable meeting point between the requirements of an interactive user experience and the compositional constraints and needs of a musical work. Increasingly, musical composition methods and tools are being developed with this in mind. The work described in this paper draws on these diverse precursors in various ways, but it is also one of the first audio games we know of that not only instruments the interface, but also embeds the audio processing, synthesis capability, communication and the computational logic within the device, rather than requiring a central computer to control the process.

3. DESIGN

Following previous DIADs projects, and in keeping with the theme of *Musify+Gamify*, we set out to adapt an existing game by 'musifying' it, combining playful physical interaction with a musical experience. Lawn bowls was the ideal candidate for several reasons. Lawn balls are similar in size to our previous DIAD prototypes, and big enough to house the required electronic equipment. The game involves tactile interaction, but is gentle in nature and therefore not likely to damage or wear out equipment. It is a quiet, collective experience. It has a simple order and logic which adapts itself nicely to a musical structure. Lastly, it is hugely popular in our home country of Australia. This is the first instance we know of of a ball game being adapted for a musical purpose with the entire interaction and sounding technology incorporated inside the ball itself.

Like most games, *Bowls* has a clear progression of states. We can detect whether balls are rolling (strong oscillatory patterns in the accelerometer data), resting (minimal variation in the accelerometer data), being held in the hand (light variation in accelerometer data), in mid-air/freefall (near zero accelerometer values), and being im-

[1] http://www.jonroseweb.com/f_projects_sphere.html

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pacted (sudden variation in accelerometer data). This makes it easy to chart the progress of the game. As successive balls are rolled and come to rest, we can make reasonable estimates about which balls have been played, and therefore how many are in play. Once all of the balls have come to rest we can tell that the round is over, soon after which we can expect all of the balls to be picked up.

The musical elements consisted of a series of harmonised sounds for each state, which were modulated by the accelerometer data. Simple mid-range undulating drones were used in the hand-held state. A higher pitched bell tinkle was used for the freefall state. Mid-range shimmering piano drones were used for the rolling sound, giving a sense of build-up. Electronic drones were used for the resting state. Heavy acoustic guitar plucks were used for impact events. Climactic harmonious drone were used when the end of the game was detected, ending when the balls were picked up. The overall effect was therefore one in which the game structure dictated a clear sonic progression, which would then repeat, creating an immersive soundtrack to the game.

This installation context prompted a re-think of the DIAD's physical enclosure design. We noticed that the previous physical design (an egg shape) had made some interactions difficult to perform – rolling or bouncing the device was unpredictable and difficult. The enclosure was also quite difficult to open and close, as it required the precise placement of 4 grub screws per device, but this was necessary to switch the electronic device on and off, meaning that beginning a performance was a tense process. The lawn bowls game we were imitating uses balls of a certain shape and size, and so we imitated this physical form for this installation, permitting rolling and (to some extent) bouncing of the devices. We found that the shape of the devices was very successful – the interaction possibilities were significantly extended and the device was capable of many new behaviours.

4. IMPLEMENTATION

The initial design of the DIADs system was described in [2]. At its core is a Java program that runs on the Pi, using the *Beads* library for computer music. The Java program is set to autorun upon startup, and begin listening on a local wi-fi network. Once Pis are online the central computer can send any Pis packets of Java bytecode, corresponding to specific Java classes that implement the PIPO (PI Playback Object) interface. Thus from the central controller one can easily experiment with code in real time. For the piece itself, a PIPO can be specified to run on autostart, and the Pis can run on their own as a network without the central computer being in use. For Bowls, each Pi was coded with a state machine tracking the state of the Pi according to the sensor data. State changes were broadcast to all other Pis, so that each Pi could keep track of the state of the entire system. A series of audio graphs were set up, corresponding to different sound scenes, with audio objects that were then influenced by these network messages. Elements were faded in and out during state changes, and the sensor data was continually used to modulate many of the sounds.

5. REFLECTIONS ON PICODE

The *Bowls* work is a continuation of a series of compositional and installation-based experiments for the DIADs. Our focus is on the ease and flexibility of development of the work, using code as the main tool for the creation of the musical content, integrated with the interactive behaviour. The approach of running device-side server software and being able to send compiled bytecode is, we have found, extremely productive. From a rapid development and deployment point of view, it is robust, indeed quicker than running and re-running software on a computer, because a large amount of the code has already been compiled and is already running on the device. This is an effective approach to working with embedded systems because compilation can be quite slow, and feedback can be difficult as these systems do not have good user interfaces. Likewise the simple suite of network communication tools we have made forms a solid basis for working creatively with multi-device music performance. Sending and receiving network messages can be done fluidly, as can programming behaviours for collections of devices.

In terms of the installation design, incorporating the logic into the physical design reorientates the game participant. With many display-based systems, there is a tendency for participant to hold the interface, and then turn to the screen for instruction, subordinating the participant to the display system, and requiring attention to the usually large display. With the integrated physical system the integrity of the social relationships of the group of participants may be more easily maintained, with the computational element being overlaid directly onto the physical devices (rather than being projected separately). This is predicated on the use of the auditory modality – participants cannot concentrate easily on the physical shape and social context while fixated on a visual display, but the auditory modality frees their eyes from this necessity.

6. CONCLUSIONS & FUTURE RESEARCH

This paper has detailed an implementation of a new musical interface that allows the development of a interactive musical game. This research has also explored the capabilities of the DIADs system - specifically its ability to run as a self-contained musical interface and reproduction system. In general, the system shows many strengths within the context of a 'musifyed' physical game system. It has highlighted the importance of a flexible software development and deployment system. In future work with the system, we plan to improve the audio reproduction capabilities of the system, by employing higher power amplification systems, and building enclosures that incorporate loudspeakers. We also plan to extend the systems for synchronising the playback of musical events, both in terms of representing the patterns and also in terms of smart time synchronisation of the group of devices. Nevertheless, the system has shown its potential for the development of complex audio installations based around group interaction and the augmentation of physical gaming through the auditory modality.

7. ACKNOWLEDGMENTS

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