Let loose with WallBalls, a collaborative tabletop instrument for tomorrow

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Abstract

Tabletops—and by extension, tabletop computers—naturally facilitate group work. In particular, they provide a fascinating platform for exploring the possibilities of collaborative audio improvisation. Existing tabletop instruments (and digital instruments in general) tend to impose either a steep learning curve on novice players or a frustrating ceiling of expressivity upon experts. We introduce WallBalls, an intuitive tabletop instrument designed to support both novice and expert performance. At first glance, WallBalls resembles a toy, game or whimsical sketchpad, but it quickly reveals itself as a deeply expressive and highly adaptable sample-based instrument capable of facilitating a startling variety of collaborative sound art.

Keywords: Tabletop computers, collaborative instruments, collaborative composition, group improvisation, spatial audio interfaces, customizable instruments.

1. Introduction

Tabletop musical instruments often feature striking commonalities. In most cases, the hardware is specially designed for the musical purposes of the table. Iwai's Composition on the Table, for example, employs custom surfaces with integral physical widgets such as spinning platters and push switches [4]. This parallels the traditional conception of musical instruments as specialized devices, intended for use in a particular way and for a particular purpose.

An alternative approach is to design an instrument that could be loaded onto a variety of tabletop computers. This strategy better reflects the reality of tabletop computers now appearing on the market. Just as computer musicians currently launch Ableton Live or Max/MSP on their laptops, soon they will launch musical *applications* designed for general-purpose tabletops.

Given the very real likelihood that tabletop computers or other multi-touch surfaces will soon become commonplace, it stands to reason that there is value in building applications that support both casual and virtuosic musicianship. Much has been said of the notion that digital instruments should be easy to use by novices, yet allow for sophisticated expression in the hands of experts [13] [5]. One strategy to satisfy both groups is to compromise by finding a single configuration that supports the basic needs of all players. Such a solution may appeal to a wide range of users, but is likely to produce an instrument that feels like a toy, one incapable of providing a rich experience to the sophisticated player. A more successful approach might embrace customization, allowing the instrument to serve the multifarious needs of a wide range of players. Such an instrument could provide a range of options that allow players to strike a balance between expressivity and ease of use. Whatever the means, the net effect should be a musical experience tailored to the needs of each individual player.

With this in mind, we set out to develop a musical instrument that harnesses both the power and the flexibility afforded by tabletop computers. The result is WallBalls, a collaborative platform that challenges conventional beliefs about the functionality of musical instruments.

2. Related Work

WallBalls tends to draw immediate comparison to other tabletop instruments, but several essential qualities of its design are unique. The reacTable* [6], being the most famous tabletop instrument to date, is frequently cited as a similar instrument. But save the fact that both are tabletop-based, the two devices have little in common. The reacTable* is essentially a modular synthesizer, while WallBalls produces sound via sample playback. Other tabletop instruments, like Musical Squares [10] or No. 1 Push from the aforementioned Composition on the Table [4], bear a stronger resemblance, though WallBalls features greater flexibility and functionality. Another key inspiration was Tenori-on [9]. Some features shared by WallBalls and its predecessors include a grid layout and interchangeable sample banks.

WallBalls is fully operable by a single player, though it was always envisioned as a tool to facilitate a shared group experience. In particular, we aimed to offer a more flexible social structure than collaborative instruments that precisely prescribe the roles of each participant (such as Fels and Vogt's Tooka [3]).

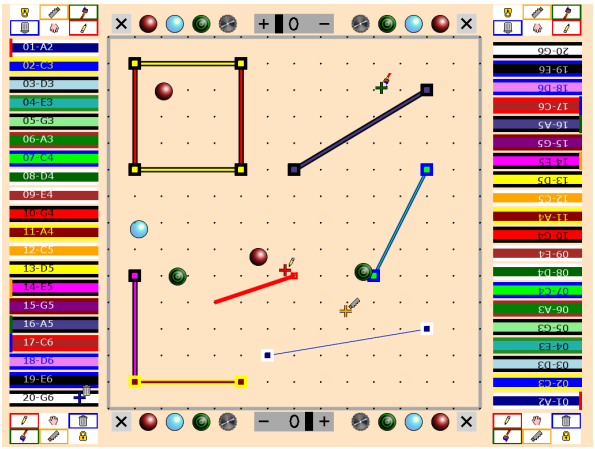

Figure 1. Screenshot of WallBalls.

One intriguing idea that struck us during the initial planning for WallBalls was that interesting things might happen if the input to the instrument were somehow less tightly coupled to the resulting audio. This is very similar to Schnell and Battier's concept of composed instruments [11]. In general, the effect of such a decoupling is that the instrument itself assumes responsibility for much of the minutiae of the performance, something that significantly alters the role of the human performers.

3. Technical Details

WallBalls consists of two parts designed to work together, though each could conceivably be useful independent of the other. The *front-end* is responsible for processing input and managing the display, and is written in C# using the University of Manitoba's idenTTop framework for identity-enabled [1] tabletop application development. The *back-end* is a Pure Data patch that loads up to 20 samples and triggers them upon receiving MIDI messages from the front-end.

The prototype tabletop used for the development and initial performances was custom built in the University of Manitoba's Human-Computer Interaction lab. It consists of a dual-core Windows XP machine, a ceiling-mounted projector, and a Polhemus electromagnetic motion tracker equipped with four styli to track input from four simultaneous participants. In lieu of a proper tabletop computer, WallBalls can be controlled with one or more ordinary USB mice plugged into a desktop computer, thanks to the SDG toolkit made available by the University of Calgary's iLab [12].

4. Features of WallBalls

As the name implies, the main features of WallBalls are virtual *walls* and *balls*; together, these elements combine to produce sound.

[1] Programs built with idenTTop can be easily adapted to run on any surface that is able to recognize which user has performed a given action. The DiamondTouch is one such compatible machine [2].

4.1. Walls

The action takes place in a play area punctuated by a grid of dots. Walls are drawn by connecting any two dots on the grid. Walls are associated with *samples*, and each sample with a color scheme; thus, the color(s) of a wall indicates the sound it makes. If two walls partially overlap, tapping one brings it to the front.

The grid is surrounded by indestructible gray walls that make no sound. All other colors of walls can make sound—but only when struck by a ball.

4.2. Balls

Balls are constrained to travel in one of sixteen directions, allowing precise and consistent control. Players can add and remove balls from play at will. Alternatively, balls in play can be picked up and thrown again. A ball may be set on a trajectory whereby it cycles indefinitely, or it may careen unpredictably. (Friction and gravity do not exist in the WallBalls universe.)

There are four types of balls. Each ball is associated with a certain *effect*, and certain balls are associated with special *behaviors*. The appearance of each ball reflects its characteristics. For instance, the *echo ball* is painted with concentric circles. When this ball strikes a wall, it applies a delay (echo) effect to the sample played. The blue, semi-transparent *ghost ball* does not bounce off walls in play. Instead, it floats through them, sounding each sample with a reverberation effect.

The third ball, the *buzzsaw*, adds an element of entropy to the system. Each wall can only sustain a certain number of hits from a buzzsaw before it is destroyed. Each hit weakens the wall, which shrinks the wall's width by a few pixels and reduces the loudness of subsequent sounds. Finally, there is a *normal ball* with no special behavior and a suitably bland brown appearance.

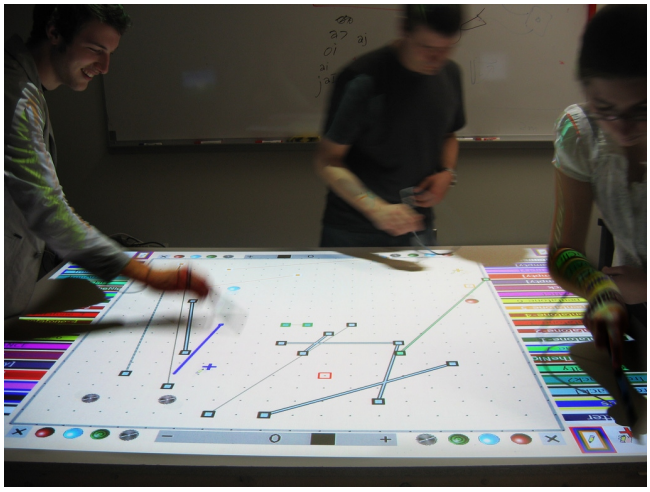

Figure 2. WallBalls in action on our tabletop.

4.3. Tools

WallBalls takes advantage of the familiar *palette* interface metaphor, which contributes significantly to its learnability. A palette presents a grouped collection of options, each activated by a single touch. WallBalls uses two types of palettes: one is used to select a tool, and the other allows players to choose which sample will be associated with newly drawn walls. To support multiple simultaneous users, we extended the traditionally single-user palette concept. Each player's current selection on each palette is marked with one of four colors, which is used throughout the application to identify that player. Palettes of the same type are linked, such that when a player chooses a new option, that choice is updated across all related palettes.

Note that each of the tools only affects walls. Balls can be grabbed, thrown, or removed (by dragging them out of the play area) at any time, using any tool.

The *pencil tool* allows players to add new walls to the table by drawing lines between points on the grid. When a player draws a wall, that wall assumes the color of that player's currently selected sample. Once a wall has been drawn, it can be moved with the *hand tool*. Every wall can be moved elsewhere on the grid by simply dragging its endpoints, which appear as protruding squares.

To delete a wall from the play area, a player selects the *trash can tool*, then taps the wall to be removed. The *paint brush tool* presents an alternative to deletion: when active, touching a wall changes its sample (and corresponding color) to match the player's current selection.

The *hand saw tool* is used to inflict damage upon walls manually. As such, it permits localized volume reduction. (Each tap with the hand saw causes as much damage as a hit from the buzzsaw.) Finally, the *lock tool* enables players to prevent damage to any wall with a single tap. A second tap with the same tool removes the lock, along with the corresponding gray halo that identifies each locked wall.

It is important to note that none of these tools confers any ownership rights upon its user. For example, anyone can unlock a wall, regardless of who locked it. Players must learn to negotiate conflict by working together, rather than by restricting their purported collaborators. Thus WallBalls (and improvisation in general) constitutes a model not only for collaborative social interaction, but also for more flexible and inclusive political dialogue.

4.4. Other Features

During WallBalls development, we took every opportunity to augment the basic functionality of the application with useful additional features, many of which arose from the brilliant feedback of our test players. These features serve to enrich the WallBalls experience and contribute to the overall "feel" of the instrument.

4.4.1. Sample Selector

Between sessions, a handy interface allows players to browse the file system for WAV, AIFF and MP3 files and build banks of twenty samples that can be rapidly loaded into WallBalls. Thus players can arrive at a session with a thumb drive full of samples and quickly assemble sound banks on the fly. We see this capacity for customization of samples to be one of the most important features of the instrument, since it gives players the power to adapt WallBalls to their needs—regardless of style, experience or intent.

4.4.2. Spatial Audio

WallBalls lends itself ideally to experimentation with spatial audio. At present WallBalls provides up to four discrete channels of sound, hardware permitting. In its default configuration, a sound triggered by a ball-wall collision at a particular location on the display is mapped to an equivalent position in a 2D sound space. Various alternative mappings are also possible.

4.4.3. Democratic Clear

The initial prototype of WallBalls provided no easy means for clearing the play area, which often proved frustrating. Yet we recognized the danger of granting any one player the power to prematurely destroy a collective work in progress. Inspired by the "social borders" described by Morris [8], we incorporated special clear buttons which only work when pressed simultaneously by a majority of the players.

4.4.4. Speed Slider

The speed slider allows for global control of ball speed. By dragging the slider to the right, all balls accelerate, causing a more rapid succession of samples. By sliding to the left, ball speed is reduced. At the midpoint, the balls stop; beyond the midpoint, they travel in the opposite direction. For convenient access, WallBalls has two speed sliders, which are synchronized such that only one may be used at a time.

5. WallBalls Technique and Theory

Group improvisation is not just an approach to musical performance; it is also a highly complex social activity with far-reaching implications. Appropriate WallBalls playing techniques are therefore context dependent—integrally linked to group dynamic, and to the loaded samples.

For casual musicians or novice WallBalls players, we have assembled a set of pentatonic piano tones. By constraining the available pitches to those of a pentatonic scale, we eliminate the possibility of any intervallic dissonance stronger than a major second, thereby maintaining a relatively open and stable pitch space. More adventurous players may bring their own sounds to the table (literally), enabling entirely new, more elaborate avenues of expression.

With a bit of practice, players can learn to throw balls precisely. Cyclic paths are useful to produce familiar musical elements such as ostinati and drones. Alternatively,

balls can be flung wildly and unpredictably. Eventually, most balls will stray slightly from a given course, introducing subtle and progressive variations in rhythm, until they miss a wall and pursue another path entirely. Thus WallBalls is inherently aleatoric in nature, making it an ideal platform for chance music.

WallBalls allows an incredibly wide range of artistic expression. A session may be sparse, involving just a few walls or balls, or so dense that collisions occur many times per second. In the former case, players may choose to explore the spaces and silences between events, investigating time in a meditative, introspective manner. In the latter case, players may choose to focus upon higher-level features of the aggregate sound like changes in dynamics, timbre and rhythmic intensity, instead of attending to the triggering of individual samples.

Regardless, the goal—which is the same across all types of performance—is to master technique in order to move beyond it. As legendary trombonist George Lewis notes,

> ...improvisation is about...interaction and behavior as carriers for meaning. On this view, notes, timbres, melodies, durations, and the like are not ends in themselves. Embedded in them is a more complex, indirect, powerful signal that we must train ourselves to detect. [7]

The core interface of WallBalls features extensive functionality and a plethora of opportunities for experimentation. One especially interesting class of interaction strategy that frequently arose is role-playing. During the debut WallBalls performance, for example, one of the players assumed sole control of the speed sliders, while the two others shared the responsibility of placing walls and launching balls. By switching roles between pieces, the performers were able to maintain artistic focus in a variety of contexts.

More importantly, role-playing served to raise the intensity of collective focus, or what is sometimes described as "collective consciousness."[2] This is really the beauty of WallBalls: The interface does not merely facilitate group creativity—it helps players transcend the confines of individual awareness, elevating them, if only momentarily, to a more universal realm of collective awareness.

6. Current and Future Work

In November 2008, The University of Manitoba's eXperimental Improv Ensemble (XIE) introduced WallBalls to an enthusiastic reception at the Faculty of Music. The group also demonstrated the instrument in the university's expansive Engineering Atrium, where passers-by had the opportunity to test WallBalls in a spatially rich audio environment.

Still, we get the sense that we have not yet fully explored and exploited WallBalls, and continue to entertain all sorts of possibilities. These include relatively minor alterations to the instrument, such as free-form wall drawing, a grouping function for composite wall structures, and a more extensive array of templates. We are also entertaining more radical functions and applications such as a portable, interactive GPS version of the instrument that would utilize hand-held devices. As with all creative endeavors, the capabilities of WallBalls appear to be limited solely by our imagination.

[2] For a thoughtful discussion of collective consciousness as it applies to free improvisation, see [1].

7. Acknowledgements

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