The Music Ball Project: Concept, Design, Development, Performance

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ABSTRACT

We report on the *Music Ball Project*, a longterm, exploratory project focused on creating novel instruments/controllers with a spherical shape as the common denominator. Besides a simple and attractive geometrical shape, balls afford many different types of use, including play. This has made our music balls popular among widely different groups of people, from toddlers to seniors, including those that would not otherwise engage with a musical instrument. The paper summarises our experience of designing, constructing and using a number of music balls of various sizes and with different types of sound-producing elements.

Keywords

music balls, instruments, controllers, inexpensive

1. INTRODUCTION

Although there have been a slight change over the last decade, most commercial, and many experimental, interfaces for musical expression are still costly, complex, key or button-centric and with square corners. In this paper we report on a side-project we have been running since 2005, the *Music Ball Project*, where the aim has been to develop instruments/controllers that are inexpensive, simple, fun, human-oriented and with no corners (Figure 1).

The Music Ball project has been inspired by ideas of simplicity in design and usage [5], the creation of devices that utilise natural affordances [6], and the playfulness that may arise when creating electronic instruments with a limited number of possibilities per instrument [3]. Dependent on the size, a ball can be kicked, thrown, bounced, squeezed, and shaken. Thus it is possible to create many different types of instruments based on a single ball design.

Throughout the years we have developed a number of music balls with different visual designs, technical solutions and action-sound mappings. The underlying philosophy has been to create many simple and inexpensive interfaces rather than a few, large and expensive ones. As such, our approach to music ball development is slightly different than some other projects based on the ball shape/metaphor, e.g. [2, 8, 7], that use more complex and/or expensive solutions. For us it has been a requirement that each ball should be as simple as possible on its own, so that we can build a complex setup by having many such music balls that together allow for a rich set of interaction possibilities. Also, our experience of teaching courses on development of new interfaces has shown that students are much more eager to put an effort into their controller if the materials are so cheap that they can actually build more controllers at home.

The paper starts with an overview of different types of music balls we have created; ranging from handheld balls to the Music Troll and Big Buoy. Then follows a reflection on various aspects relating to the design/development process as well as the usability of the devices.

NIME'12, May 21 – 23, 2012, University of Michigan, Ann Arbor.

Figure 1: A music ball in use at a research fair (left). One microphone-based and one sensor-based music ball (right).

2. HANDHELD MUSIC BALLS

Any ball can potentially be used as the starting point for a music ball, but we have found two types that we are particularly found of: toy balls for dogs and boat buoys. Toy balls for dogs work well as the basis for smaller handheld balls. They are durable, and are often manufactured in many colours and with many different surface designs (Figure 1). When it comes to developing larger balls, we have found that boat fenders and buoys are practical, since they are both durable and are easily available in many different sizes and shapes.

As for most other types of sonic interaction, music balls can be designed to be either acoustic, electronic or both acoustic and electronic, and we will describe these approaches in the following sections.

2.1 Microphone-based music balls

Our first music balls were created by stuffing hollow toy balls with materials having different sonic qualities: paper, peas, steel wool, synthetic fibres, etc. The challenge here was to find materials that sounded nice when they were squeezed, but that were also durable enough to withstand heavy use over time. Newspaper sheets, for example, provide a crispy sound, but contracts so quickly that they are more or less useless in our context. Then many synthetic materials, like plastic sponges, work better, since they are elastic and expand quickly after being squeezed (Figure 2).

Figure 2: Different synthetic materials (sponges and steel wool) that work well together with dynamic microphone elements (seen at the top).

The sounds coming from such squeezable music balls are not particularly loud, so it is necessary to do some kind of amplification of the sound. This could be done with a microphone pointed at the ball from the outside, but a more sonically interesting solution, and we also think conceptually better, is to place a microphone inside the balls. Here we have explored different types of microphones: contact, dynamic and condenser. While the latter works well, we find condenser microphones to be too expensive and too fragile for our use. Then we have had more success with contact microphones placed in the middle of the sounding material, since they easily pick up sounds when squeezing the balls. In general, however, we have been most satisfied with using the elements from cheap dynamic microphones, as they are slightly more responsive than contact microphones. Furthermore, cheap "karaoke-type" microphones may cost as little as a chocolate bar, and leaves you with a microphone element, a cable, and a jack (1/4") connector after removing the plastic cover. So a dynamic microphone element is an inexpensive starting point for soldering-free development of a music ball.

Acoustic music balls have the advantage of being a full instrument in themselves, and they can be connected directly to an amplifier or audio interface for further processing of the sound. Analysing the incoming audio, the microphone signal can also be used as a "sensor", using various sonic properties for further control of digital sound synthesis.

2.2 Sensor-based music balls

A second type of music balls we have created have been purely electronic, based on placing different types of sensors inside the balls. To keep things simple we have tried to constrain ourselves to using only one sensor type per ball. There are both practical and conceptual advantages to this. On the practical side, having only one sensor (or sensor type) in each ball, also makes them cheaper to develop. This allows for creating several balls for the same price as one ball with more sensors. Also, with less sensors and cables, there are fewer things that can break, and, if a ball does break, you have some extra ones to replace it.

The constraint of using only one sensor per ball also has some conceptual advantages, as it encourages only one type of interaction per ball. This may again lead to music balls that are more intuitive to use. When teaching, we have seen that students come up with more creative and interesting sound interaction designs when only one sensing modality is available. In our experience this leads to more diversity among the balls, which, combined with different visual identities, also make them more fun to play with.

For squeezing-types of interaction, we find flex sensors and force sensing resistors to be useful. One of the greatest problems with such sensors, though, is that they are often small in size. A solution here is to use several sensors to get data from all sides of the ball. But this also requires more sensor inputs, hence more sensor interfaces, and more complex preprocessing and mapping.

We have also seen that placing a joystick, slider or potentiometer inside a music ball stuffed with some soft material may be interesting. In these cases the sensor data coming out may be somewhat irregular and unintuitive, but this sensing limitation can also be turned into a challenge of creating interesting mappings.

For shaking-types of interaction, accelerometers and gyroscopes work well. They can be bought separately and connected to a generic sensor interface, but our current favourite is the USB accelerometers from Phidgets [1]. These accelerometers come with all the necessary electronics embedded on one small chip, and with a USB cable that can be directly connected to a computer. The fully integrated hardware solution, and possibility to connect multiple accelerometers (hence balls) to one computer, greatly simplifies adding an accelerometer to a music ball. This again gives more time to focus on the sonic interaction design and musical usage of the balls.

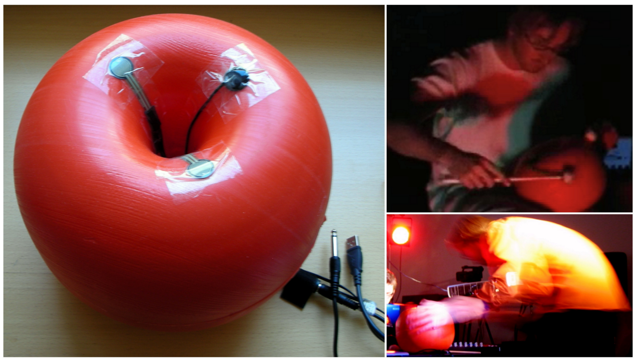

Figure 3: Our favourite "electroacoustic" music ball is made from a hard-shall buoy.

2.3 Electroacoustic Music Balls

Even though some of the electronic music balls are quite responsive and feel intuitive to play, we have not been able to make them as expressive as the acoustic balls. On the other hand, electronic music balls allow for a larger sonic exploration than the acoustic ones. To get the best of both worlds, we have also created some balls with both sensors and microphones. To keep with our philosophy of keeping things simple, we have still tried to constrain ourselves to using only one sensor type and one microphone in each ball.

One such "electroacoustic" ball that we think works well is made from a small, hardshell buoy (Figure 3), with one contact microphone and two pressure sensors fastened to the surface. The microphone is used to pick up the acoustic qualities of the buoy, and the two pressure sensors are used to control a set of sound effects to modify the sound. We have used this ball in a number of performances, using many different types of playing techniques: both impulsive and sustained actions, and with both hands and sticks.

3. MUSIC TROLL

After having developed a number of smaller music balls, we were interested in exploring how we could extend the music ball concept to an installation for children. The end result was the *Music Troll*, a standalone "installation instrument" with four "heads" sticking out of a wooden box. The box holds all the electronics (computer, sound card, amplifier, speakers), and supports the arms for the four "heads" hang-

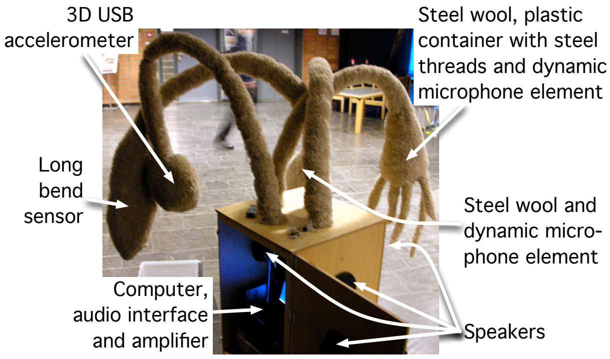

Figure 4: Setting up the Music Troll in the foyer of the Norwegian Academy of Music.

ing out of the box, each with a different shape and sonic interaction (Figure 4).

As for our handheld music balls, each head of the Music Troll is based on only one type of sensing. Head #1 uses the envelope of the signal coming from a dynamic microphone element surrounded by steel wool to control the speed and velocity of a voice sample playing backwards. Head #2 is a cone-shaped ball with five "fingers" created with plastic strips fastened to a plastic container with steel wool surrounding a dynamic microphone element. The sound from the microphone element is amplified and compressed heavily to create a squeaky sound. Head #3 is a small spherical ball with a USB accelerometer inside, and controls a percussive sound model. Head #4 is a long flat head with a long bend sensor inside, which controls a long sweeping filter.

The Music Troll has been shown as an installation in public areas in Oslo several times, and has each time been played on by thousands of children of all ages. Even though it is possible to play on the Music Troll alone, it encourages collaborative exploration, and that is also how most people have used it. Although it was never built for stage performance, we have also performed with the Music Troll in concerts a couple of times (Figure 5).

Figure 5: Performing with the Music Troll in Oslo Concert Hall.

4. BIG BUOY

After having created the Music Troll, we were interested in going back to the original idea of a single, unified ball, but at a larger scale than the handheld ones. This led to the creation of *Big Buoy* (Figure 6), based on a large ship buoy. Due to the large size of the ball, we here decided to use more than one sensor, but we still tried to limit ourselves to only a few sensing modalities: contact microphones and pressure sensors on the sides of the ball, and a 3D-accelerometer at the top. We would have preferred to place the microphones and sensors on the inside of the buoy, but this was difficult in practice, since the buoy needed to be inflated to look and behave nicely. So we ended up fastening the sensors on the outside, in stripes along the sides.

Figure 6: Pictures from the construction, setup and usage of Big Buoy.

When creating the original sound interaction design in the lab, we thought that the contact microphones worked well for picking up the subtle sounds of tapping and slamming the buoy. However, out in the public we quickly realised that people (mainly children) aimed for the contact microphones themselves, which did not work very well with our original mappings. So we had to give up the idea of picking up subtle sounds and sustained sound-producing actions with the microphones, and rather use them for detecting attacks together with the pressure sensors. These attacks were then used to play various types of electronic sounds and short musical patterns.

5. ADHD BALL

An interesting possibility appeared when researchers at the Norwegian Institute of Public Health asked us to develop a music ball for clinical experiments on children with ADHD. The idea was that the children would play with the ball in the test room, and that their interaction with the ball would trigger different sound and light stimuli, which again would be used to study the children's response patterns.

We decided to make this ball as a scaled-down version of Big Buoy, with a similar type (but considerably smaller) soft buoy, stripes of force sensing resistors (FSRs) fastened to the surface, and an accelerometer at the top (Figure 7). To allow for rough use, the sensors and the buoy were padded with antistatic foam, and a large, heavy-duty party balloon was stretched around the buoy to serve as a protective outer skin. The ball was nice to look at and had an interesting haptic feel, but even though it had been padded very heavily, it broke down several times due to the hard treatment by the children.

A second version of the ball was created, where sensing was done only with an accelerometer, and with a sown zipper-equipped thick fabric cover. This has been our most heavy-duty music ball to date, but even this version has had to be repaired a couple of times due to the rough treatment during hours of daily clinical experiments with children.

Figure 7: Pictures from the design, sensor construction, padding and installation of the ADHD ball.

Figure 8: Ideas from the Music Ball project are used in the *Oslo iPhone Ensemble*, where the musicians play with a ball-shaped speaker.

6. DISCUSSION

After having developed a number of different music balls over the years, we have gained extensive experience in what works and what does not work so well:

Durability The lesson learnt is that a construction can never be solid enough, especially when it is to be used by children. Even when we have made things much more solid than we originally thought necessary, we have still had different types of hardware failures. Most of these have been related to broken cables, particularly at various types of connection points, so we have been more careful about including extra protection around cables and connectors.

Simplicity The underlying philosophy for all our music balls has been to keep everything as simple as possible. It is always tempting to add more sensors and more features, but our experience is that the simplest balls, with the most intuitive action-sound mappings, have been the most successful and fun to play with.

Inexpensive Another driving force has been to come up with solutions that are so cheap that it is possible to buy equipment for a group of students on a regular teaching budget, and let them keep the balls they make. All our balls are built from inexpensive consumer products (toy balls, buoys, cheap microphones, etc.) and not too expensive sensing solutions (e.g. Arduino, CUI, Phidgets). We have also explored using home-built sensors [4], but they often wear out too easily, unfortunately.

Non-electronic feel Even though all balls contain electronics of some sort, we try hard to hide cables and sensors inside the balls, or properly covered. The aim is that only one (or sometimes two) connector(s) should come out of the ball. This improves the non-electronic look and feel.

Stability The simple hardware solutions have encouraged simplicity also in software, something which makes the sound programming (mainly in Max/MSP) cleaner and more stable. Our approach has been to create one separate patch/application for each ball. This makes each music ball behave as a coherent instrument, and it is easy to use the balls in different combinations.

All in all, the Music Ball project has been, and continues to be, an inspirational side-project of ours. Besides making some new music balls for our own needs from time to time, we use the concept in various courses and workshops with students and children. We also see that the underlying philosophy of *keeping things simple* influences our other projects. One such example is the setup for the *Oslo iPhone Ensemble*, in which all musicians play their iPhones connected to active, ball-shaped speakers (Figure 8).

7. ACKNOWLEDGMENTS

The *Music Ball Project* has received funding from the Norwegian Research Council, Arts Council Norway, University of Oslo, Norwegian Academy of Music, NOTAM and Norwegian Institute of Public Health. Thanks also to Einar S. Martinussen, Kristian Nymoen, Kjell Tore Innervik, Eirik Østby, Heidi Aase and many others.

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