Drum Duino: a Tangible Interface to Create Rhytmic Music with Everyday Objects

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Abstract
In this paper, we present a novel sound controller that generates music by tapping on everyday objects. Drum patterns are created using a tangible user interface operated with wooden (drum) sticks (or bars). They can be saved to different levels each linked to another object and therefore another sound. This concept enables users to tangibly alter their own sound and to not only hear but also see the music they are creating. In this paper we explore the design of such a device. We define the results of a first version of this controller and describe the alterations that were needed for a second version of the controller.

Keywords
Tangible user interfaces; sound creation; drum patterns; Arduino;

ACM Classification Keywords
H.5 Information interfaces and presentation (e.g., HCI) (I.7): H.5.5 Sound and Music Computing: Methodologies and techniques, Modeling, and processing, Systems.

Introduction
As the line between the real world and the physical world becomes thinner, the need for tangible interactive devices increases. It is important for designers to learn to explore new possibilities of interacting with the digital world. To encourage this exploration we try to give the students the tools for creating such new interactions. Arduino is a tool that makes it easier for designers to create their own interactive devices [1].

In the Mechatronics Design courses at students get the chance to learn mechatronics through the creation of interactive prototypes using the Arduino platform. One of the prototypes, developed by the students, is the Drum Duino. The Drum Duino is a novel device that makes music or rhythmical sounds using any object as percussive instrument. The rhythmical sounds follow the drum patterns that are programmed using a tangible user interface. The main focus in this project was to design a tangible link combined with digital processing and physical output. This physical output is then transferred into audible sounds so it becomes a novel instrument. In addition it is a fun instrument to use because the user can experiment with different sounds using common objects found in his environment. Many of us may have grown up playing and learning music through beating and tapping on any object we could find in our vicinity. You might remember playing drums using buckets and kitchen utensils, as composer Tod Machover did [2]. The more creative the user is, the more exciting the music gets. Both shape and material of the chosen objects will determine the sound that will be created by the tapping of the Drum Duino device.

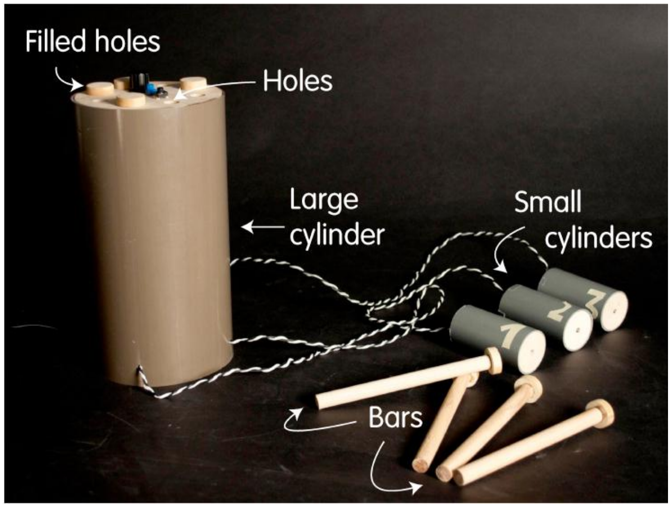

Figure 1. Prototype of Drum Duino version 1.0

Related work
The idea of manipulating music using tangible artifacts has been explored by many others. Related work in this domain is the "Reactable", developed at the Audiovisual Institute at the Universitat Pompeu Fabra in Barcelona, Spain [3]. The Reactable is a tangible tabletop designed to create live music or sound effects with the possibility of multiuser interaction. By manipulating physical artifacts on the table the music can be controlled by several people simultaneously. The Reactable also offers visual feedback by projecting graphics onto its translucent tabletop surface.

Another tangible interactive music device is called "Block Jam", described by Henry Newton-Dunn, Hiroaki Nakano and James Gibson [4]. Physical magnetic blocks are being used as an input device for manipulating sound. By linking the blocks in different ways, the music will be altered. Block Jam offers both visual and haptic feedback. By placing magnets to the side of the blocks the user can feel which sides of the blocks can be linked and which cannot. E. Costanza, S.B. Shelley and J. Robinson created D-touch, which is also a tangible user interface used to compose music [5]. Augmented staves and blocks, which are recognized by a camera, are the physical representation for the musical notes and rests. By arranging those interactive objects within an interactive area, the user can compose music in a tangible way.

Also others have explored the intuitive use of everyday objects as musical media. Everyday objects are a fascinating source of sound generation and transforming everyday objects into percussive musical instruments is an old concept: music and new musical instruments often have their origin in objects around us such as household objects, natural objects, and crafting tools [5]. In the early 1920s Erik Satie and Darius Milhaud already suggested the concept of transforming household objects into musical materials [6]. And other projects that explore the use of everyday object in the musical context exist [7, 8, 9]. Perry Cook highlights that "everyday objects suggest amusing controllers" [10].

A number of related works explore transforming everyday objects into percussive instruments in an automated fashion. Duper/Looper, Beatbox, and Buonda focus on a modular tangible drum machine interface that can simply be attached to or placed on top of physical objects (Figure 2) [11, 12, 13]. Their interaction models are based on the relocation of knockers, actuators typically composed of solenoids or servomotors, which act in the manner of the user's knocking hand gestures. The user simply places the knockers on top of objects or attaches them to the objects that they would like to generate a rhythm from.

Drum Duino version 1

Concept

The Drum Duino is a rhythm-box for creative people who want to create music using everything they find in their environment. Using three solenoids you can strike three different materials at once and thereby creating your own music. When you hit or tap different objects, different sounds will be created, depending on the material, shape and orientation of the objects. This approach formed the inspiration in the Drum Duino project.

You can use all kinds of materials to make you own music using the Drum Duino. Examples are: your kitchen materials such as glasses, pots and pans, wooden block, etc.

Design

Figure 1 shows the design of the device. It consists out of three small cylinders that are connected to a much larger cylindrical base with eight holes in it. The small cylinders contain the solenoids and the large base contains the user interface and the Arduino board. When a hole is filled with a stick, the solenoid will create a “tick” by moving a tiny swab back and forth. The sound of this tick depends on the colliding object.

To compose a tune, the user constructs a pattern by filling any of the eight holes with a stick. If an opening is filled you will hear the sound, if not you will hear nothing. When the user is satisfied with the pattern, it can be stored by pushing the save button. Turning the rotary switch to another channel (1-2-3) allows the user to create extra patterns that will actuate the corresponding solenoid. In this setup the user can store up to three patterns. The users can adjust the tempo by rotating a potentiometer (Tempo button). The buttons are illustrated in figure 2.

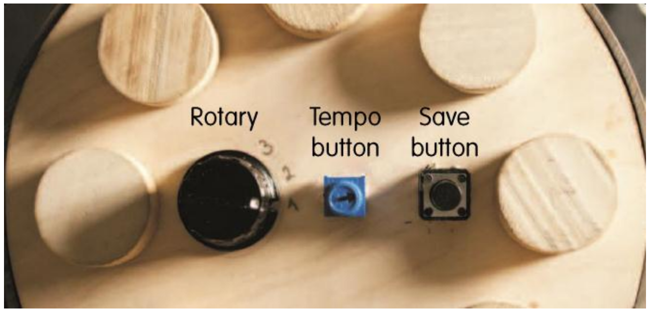

Figure 2. Buttons for the user interface that manipulate the music.

Circuit

In figure 3 a block diagram of the circuit of the Drum Duino is visualized. The green circles represent the sticks that fill the holes and the red circles are the empty ones.

If a channel (1-2-3) is chosen with the rotary switch, the pattern of the sticks will be active on the corresponding solenoid (Live Mode). When a stick is being put into a hole, it pushes a switch (orange square) to its ON-state. Every push-button is connected to the Arduino sending it an on or off status.

Pull-up resistors are being used with the push buttons in the circuit. The switches used in the holes are limit switches that are also connected to pull-up resistors.

The rotary switch, save-button and tempo-button are also connected to the Arduino. All these buttons are inputs to manage the outputs that are the solenoids, visualized in figure 4 in green with numbers 1, 2 and 3.

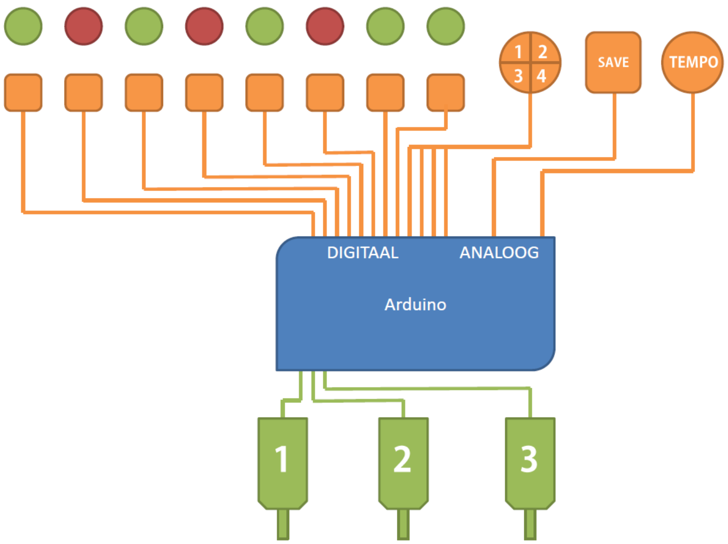

Figure 4. Block diagram of the Drum Duino

When the save-button is pressed, the current pattern will be stored inside the memory of the active channel. This beat keeps on playing as long as that channel is not modified.

The Drum Duino allows multiple users to work on the same piece of music, which makes it more fun to play with and to explore the possibilities.

Because the Arduino can't supply sufficient current for the solenoids, an external power supply is used. Every coil needs 200 mA at 12V. To separate the Arduino-signals with the power supply, a transistor is used. To catch up high voltages generated by the coils when the power is turned on, a schottky diode is placed.

How to use it

User's feedback

We wanted to know if the Drum Duino was a user-friendly tangible interface and if it was being used correctly. Did we need to give lots of information to people for them being able to use it, or did it felt naturally for them to use such a device to create music? A group of people tested the device and offered us feedback in what was good and what could be better.

We found that users were experiencing a lack of visual feedback. They know where to put the bars, but it is difficult to know where you are in the pattern while the beat is playing. In this case the sticks were taken away randomly without well knowing what will happen to the beat.

Another remark was that the Drum Duino 1.0 was not appealing to the eye. When prototyping the device, PVC pipe was used as a casing for all components. The main focus was on creating and assembling a working device and less on its appearance.

Users also encountered difficulties when putting the small cylinders against a material. The cylinders were pushed from the material so they needed to be held down in order to make contact with the material so sound could be produced.

But the most important feedback for us was that the people had fun using the device and played with the pattern, by filling the holes to create their own tunes. By exploring the device, the user knew what to do without needing to ask for instructions.

Drum Duino version 2

Design

The Drum Duino v2.0 (figure 5) is an enhanced version of the Drum Duino v1.0 that takes this user feedback into account. We did not make a new model but improved the existing one. All parts were painted white to give the device a more unified look. This also causes the wooden part, where all the controls are located, to stand out more so that the user will be attracted to this area.

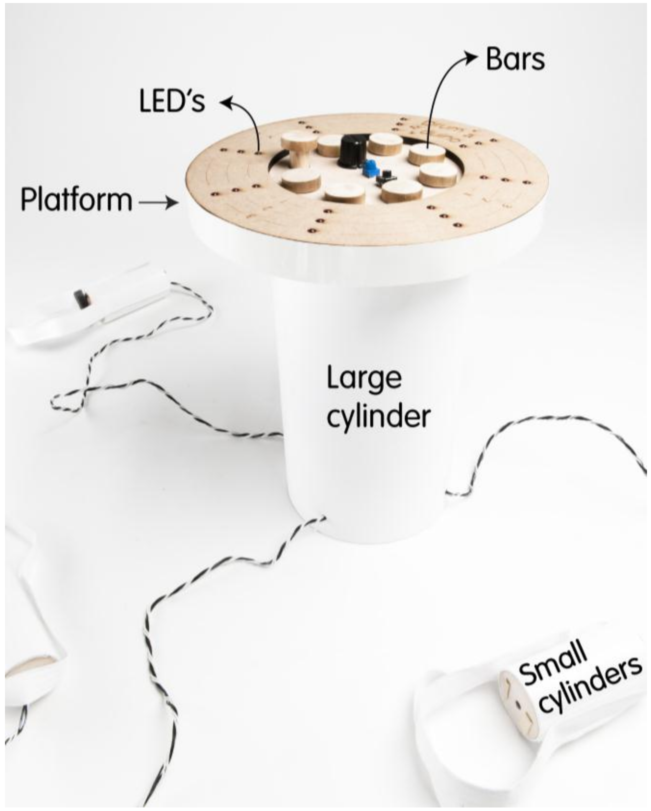

Figure 5. Prototype of Drum Duino version 2.

To enhance the visual feedback, leds are added to the Drum Duino. These leds are linked to the holes. When a hole is filled the associated led will light up, if it is not filled it will not light up. For every beat-channel used, an array of eight leds is needed. The leds are placed so that they can be visually linked to each stick.

Materials placed in front of the small cylinders need to be fixed to keep making contact to hear the "ticking" noise. To keep the small cylinders from moving, a Velcro strip was attached so the materials can be strapped on the cylinders.

After testing this method we noticed that only the Velcro approach was not working. Either the solenoids did not have the room to move themselves because they were fastened to tight or they were fastened too loose and the solenoids did not touch the material after one tick. To solve this problem a spring-like component was needed to keep a small distance between the solenoids and the material.

Pieces of soft polyurethane were placed up on the top of the small cylinders nearby the hole where the plunger comes out. After fastening the Velcro attached to the small cylinders to the material it would go back to its original state and produce a noise after each tick.

A flat cylindrical platform was created on top of the existing base to integrate the LEDs. This platform was cut and engraved using a laser cutter. In profile the apparatus shows us a T-shape, which stands for Tangible.

Circuit

Because there are not enough pins available on the Arduino to connect all LEDs, three shift registers were used to operate all three arrays of eight leds. The leds are linked to the switches in the holes so they light up when a bar makes contact with the switch in the hole. The spaghetti of wires was bundled and labeled to maintain a clear overview of the circuitry. Fragile points in the circuit were re-soldered to obtain a stable circuit and to reduce errors.

Drum Duino version 3

A third version of the Drum Duino will be developed in the future. We consider a new design that is more linked to the music. We could get inspiration from existing musical instruments like for example a djembe. A number linked to the associated channel should also be visualized on the small cylinders.

The soft polyurethane on the end of the cylinders could be integrated more nicely. We could expand the channels of the Drum Duino to a higher number that would result in more possibilities and creativeness when producing music.

Conclusion

In this paper we have presented the design and implementation of two versions of the Drum Duino. We have established that the Drum Duino is used successfully as a tangible interface to manipulate and create music. We found that people who used it had a lot of fun and were excited to play with the device. Experimenting with music and different sounds resulted in a positive experience.

People are drawn to sound and therefore the Drum Duino attracts other individuals' interest.

References

[1] Moussette, C., Tangible interaction toolkits for designers. Student Interaction Design Research Conference 2007, Sweden, Umeå, Sweden (2007), 1-4

[2] Machover T., My Cello in S. Turkle's Evocative Objects: Things to Think With . MIT Press, 2007.

[3] Kaltenbrunner, M., Jordà, S., Geiger, G. & Alonso, A. The reacTable: A Collaborative Musical Instrument. In Proc. of the 15th International IEEE Workshops on Enabling Technologies (WETICE 2006), Manchester, U.K (2006), 1-6.

[4] Newton-Dunn, H., Nakano H., Gibson J., Block jam: a tangible interface for interactive music. In Proc. of the 2003 conference on New interfaces for musical expression, Montreal, Quebec, Canada (2003), 170-177.

[5] Costanza, E., Shelley, S.B. and Robinson, J., D-touch: A Consumer-Grade Tangible Interface Module and Musical Applications. In, Proc of Conference on Human Computer Interaction (HCI03), London, UK (2003), 1-5.

[6] Cox. C. Audio Culture: Readings in Modern Music. Continuum International Publishing Group, Aug. 2004.

[7] Monache D. S., Polotti P., Papetti S., and Rocchesso D. Sonically augmented found objects. In Proceedings of New Interfaces for Musical Expression (NIME) conference, 2008.

[8] E. Mugellini, O. Abou Khaled, S. Pierroz, S. Carrino, and H. Chabbi Drissi. Generic framework for transforming everyday objects into interactive surfaces. In Proceedings of the 13th International Conference on Human Computer Interaction. Part III: Ubiquitous and Intelligent Interaction, pages 473-482, Berlin, Heidelberg, 2009. Springer-Verlag.

[9] S. O'Modhrain and G. Essl. Pebblebox and crumblebag: tactile interfaces for granular synthesis. In Proceedings of the 2004 conference on New interfaces for musical expression, NIME '04, pages 74-79, Singapore, Singapore, 2004. National University of Singapore.

[10] P. Cook. Principles for designing computer music controllers. In Proceedings of the 2001 conference on New interfaces for musical expression, NIME '01, pages 1-4, Singapore, Singapore, 2001. National University of Singapore.

[11] A. Hungtinton. Beatbox, 2005. http://extraversion.co.uk/?p=188.

[12] K. Iwasa, H. Kotaki, S. Nagata, and H. B. Yamano. Buonda, 2010. http://buonda.ifdef.jp/top.htm.

[13] R. Kuwakubo. Duper looper, 2001. http://www.lucymackintosh.ch/oeuvre.php?id=272&artiste_id=kuwakubo