Klangkörper: Kinetic Sound Matter

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Abstract
Klangkörper is a kinetic machine that explores the materialization and embodiment of audio signals. With the Klangkörper sound can be captured, manipulated, stored and released in realtime. The form of the Klangkörper reveals informations about its content by visualizing the average levels through diameter changing circles.

Introduction
Every sound we make, every word we say has a very unique profile when we look at its volume amplitude over time. We wanted to create an object that not only lets us visualize sound through shape change but also provides an interesting way for physical manipulation of that sound in real-time. As soon as someone speaks into the Klangkörper, actuated "ribs" represent the sounds waveform, which seems to travel through the device in real-time. If the user covers the end of the Klangkörper with his hand the sound would be captured instead of just travelling through. This is one of many interactions we explored in this project, which will be described later.

Related Work
Numerous works explore the physical visualization and embodiment of sound. The design studio Realitat [1] created 3D printed sculptures that represent the waveforms of their favorite songs. The sculptures

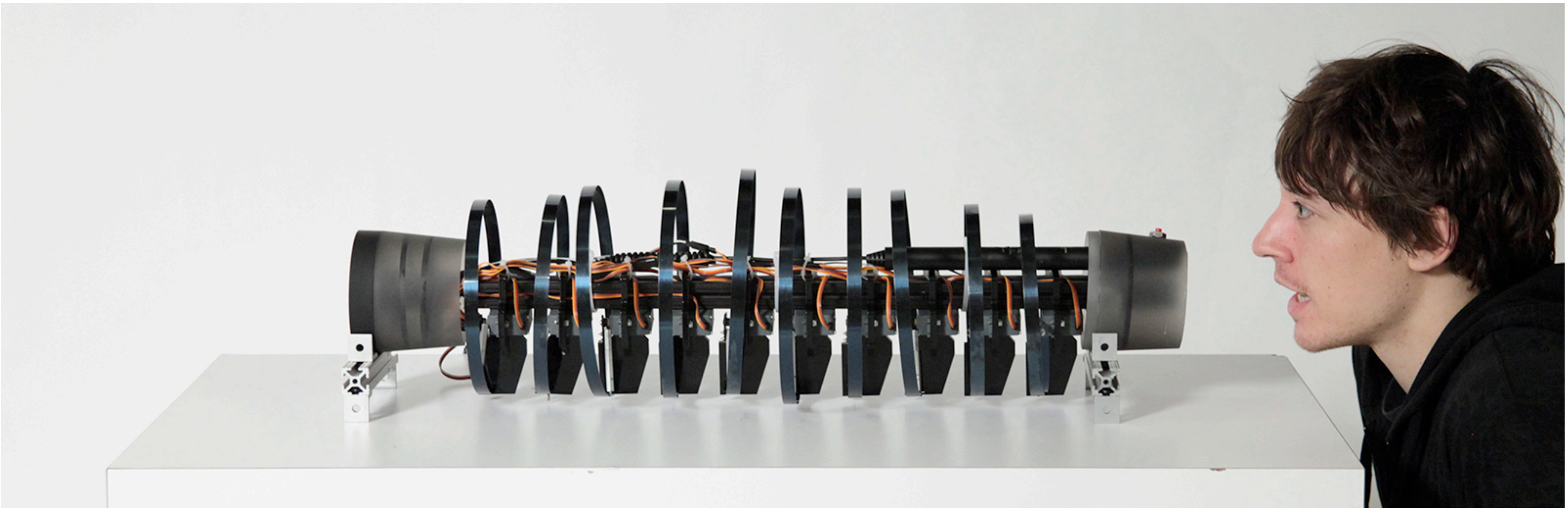

Figure 1: Klangkörper Prototype

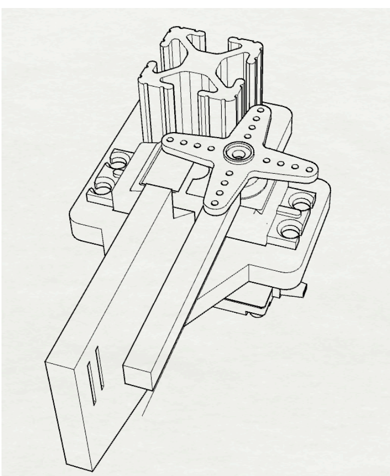

Figure 2: Diameter changing mechanism (rendering)

capture every songs unique mood. NOCC [1], on the other hand, with their "Object of Sound" project explore how the unique waveform of digitally captured sound can be used to create objects like a candle holder, vase or lampshade. Every object's form represents its spoken name. Daniel Bizer converts voice recordings into bracelets with rings representing the waveform of someone's spoken message [3]. The usually only audible sound transforms into a fashionable physical form which additionally incorporates a very personal meaning that is only readable by the wearer. These work are all static objects representing sound in an aesthetically very pleasing way. They make something invisible, visible.

Works that explore tangible interactions with sound are, for instance, musicBottles [5]. Users can release sound that is "stored" in a bottle by opening it. Sound Shaker [4] is a vessel, which captures sound when you speak into it. The sound can be stored if the user closes the vessel with a lid. If the user shakes the vessel the stored sounds will mix, like different liquids would mix in a bottle. The sound can then be released by tilting the vessel to "pour" out the sound. Another inspiring example is SpeakCup [7], a very intuitive device to capture and release sound.

Although all of the described projects are novel in their own way, none of them explore the combination of real-time physical visualization and manipulation of sounds, which we can achieve with Klangkörper.

Explorations

Sound relies almost entirely upon our sense of hearing, thus it has no obvious physical manifestation. Because of that completely open design space, we wanted to begin our explorations as wide as possible. Our first exploration began with mapping the frequency graph of each beat to a series of cubes. Then, by connecting their size and color directly and adding a touch of physics-based dynamic collision, we created a dynamically flowing set of cubes that behave in reaction to the music. From there we wanted to move one step closer to something actually buildable so we turned the cubes into spheres, and hung them from cords with computed weight.

To gain a better understanding of materialized sound signals, we created a set of dreidels, which shape encodes a given sound. The shapes were generated with the real-time programming tool vvvv and than ported to the 3D software Rhino/Grasshopper. The dreidels were then laser-cut out of acrylic and aligned on a wooden rod.

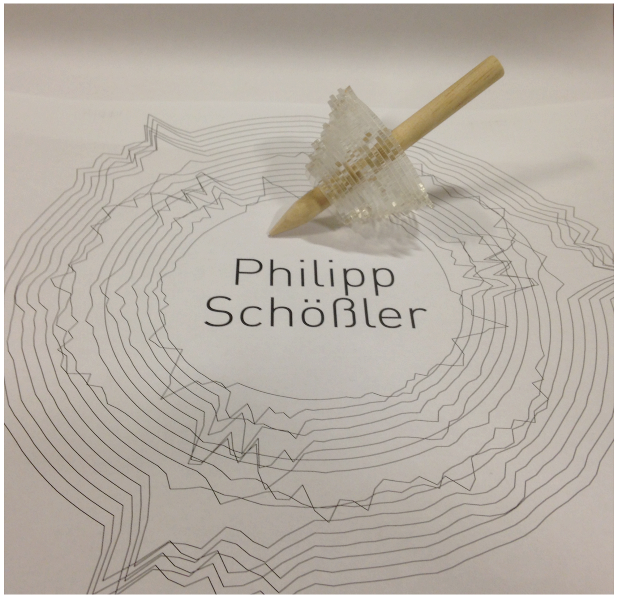

Figure 3: Klangkörper diagram

After three iterations it became clear that a more symmetric, almost circular shape was not only the better shape for a working dreidel but also aesthetically more pleasing. The circular mapping was inspiring but we still felt like we were missing the temporal and interactive aspects. After some discussion, we liked the idea of a dynamic "tube" shape, somewhat like a didgeridoo, that mapped volume and/or frequency in rings and each ring was the subsequent beat.

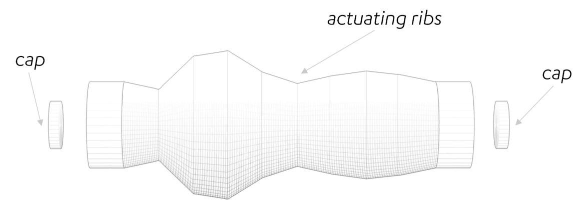

Figure 4: Klangkörper diagram

Klangkörper Prototype

We decided to represent sound as amplitude over time. To best understand the time factor we decided to design the Klangkörper to resembles a long cylinder with the shape changing mechanisms between the beginning and end [Figure 4].

Hardware

The object is made of 10 diameter changing “ribs” arranged linearly. Each rib consists of a servo motor in its center and ½In wide and 26In long spring-steel which is wound in a circle around the servo motor. One end of the spring-steel is fixed to a custom build frame, whereas the other end is attached to the servo’s 6.5cm long arm. By rotating the serve 180 degrees we can seamlessly change the “rib’s” diameter from 13cm to

20cm. The servo motors are controlled by an Arduino Mega with a custom made shield. We attached a Shotgun Microphone to capture the sound. At the back of the Klangkörper we installed a distance sensor to determine the captured sound's release speed.

Software
The software for Klangkörper is written in Processing and Arduino. For interfacing with the Servos, the Firmata Protocoll was used, offloading the control of the hardware directly to the Computer. To record, store, analyze and playback sound, the Java libraries minim and sonia were utilized.

The software captures a given audio-stream when the red button on the Klangkörper is pressed. The levels of the sound are being analyzed and displayed on the screen. Based on the determined values, ten average values are being calculated, each averaging 1/10th of the original sound signal. Those values are then being displayed on the screen and physical Klangkörper.

When a sound-stream is stored, it can be manipulated through the Klangkörper by compressing or extending the physical rings. This is reflected in the software as a relative change in volume for the affected recorded values.

When the user removes his hand or the cap from the rear end of the Klangkörper, the sound-stream is being played back with the manipulated levels applied. The user can hold is hand/the cap partially in front of the end to slow down the playback speed of the sample. A similar effect can be achieved by tilting the body. Both sensory inputs are collected through the fermata protocol and evaluated in Processing.

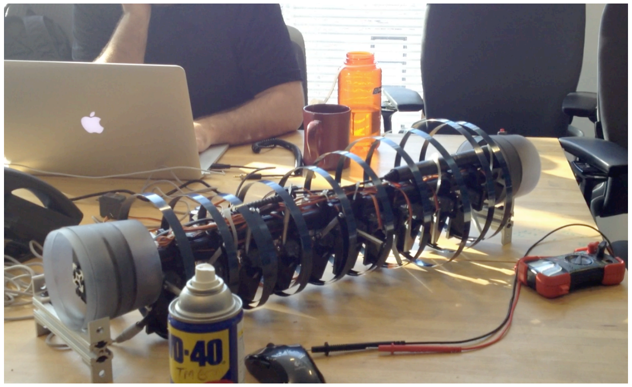

Figure 5: Klangkörper prototype

Interactions
We decided to treat sound as a liquid, which makes the interactions with the Klangkörper object very intuitive. Using different combinations of the caps, your hands, the actuating ribs, and some simple gestures, you can achieve a lot of interesting, dynamic, and organic results.

At rest, level, uncapped, and in its default state, the device shows the waveforms of sound as it passes into and then out of it at real-time speeds. Tilting the device, however, changes that playback speed. Tilt forward and the device proportionally plays back faster. Tilt backward and sounds start playing in reverse at proportionally faster speeds.

Tilt it back far enough while also speaking into it and it starts storing sound as each action has equal liquid push on each other. You can achieve the same effect by covering the opposite end with your hand or securing with a cap. As you record more than the device can show at one time, the sounds start compressing and the waveform more "summarizes" the overall waveforms of all recordings. By uncovering only a small portion of the other end of your hand, the device starts playing back at proportionally small rates less than 1x until fully uncovered.

While input is stored in the device, the actual waveform can be augmented and manipulated by hand by pushing and pulling on the individual rings of the device. And lastly, any sound can be stored for later by placing it upright with the bottom cap or placing caps on both ends.

Future Work
In future work we want to further explore possible interactions with the Klangkörper. For instance, we could invent physical objects that would constrain the sound travelling through the Klangkörper in a certain way. These objects could represent specific sound filters or manipulations. Furthermore, we need to improve the overall look and feel of the object as well as redefine some of the interactions both technically and conceptually.

Acknowledgements
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