Experiencing music through an expressive touchless interaction

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Abstract
The Sono is a sound installation that allows people to experience and create music in a new and unique way without the traditional musical background. The focus is on creating music with an expressive interaction without touching the instrument. People can record their own speech or other random sounds and modulate the sound by moving their hand within a three dimensional field above the goblet. The installation makes use of ultrasonic sensors to detect the movement of the hand. The sensor data is linked to various sound modulation effects.

Keywords
music, touchless interaction, sensors, lights

Introduction
The development of innovative music and musical instruments is increasing rapidly [1, 2]. Where musical instruments used to express the emotions of the musician, it is time for musical instruments to be able to translate musical expressions into music. This vision lies within the philosophy of the Klankspeeltuin; the client at the start of this project. [3]

In this paper there is a new interactive sound installation presented designed to explore new expressive ways of making music. First the aim of the project will be presented in the objective, next the interaction will be showed, thisrd the technology behind the interaction will be explained and finally there will be made a conclusion from the investigation and development.

Objective
The Klankspeeltuin aims on educating children between 7-11 years old in music. They want to make children aware of music, motivate them to listen more carefully to each other, to stimulate team working and let the kids experiment and play with music. Studies also prove the benefits of music training for children [4, 5]. The Klankspeeltuin has four installations but is aiming on increasing their collection resulting in a cooperation with the TU/e and the project objective: "Design a new installation for the Klankspeeltuin that allows children to create music in a non-traditional and playful way and which stimulates teamwork"

After half a year of development the result was a musical installation based on an interaction without physical contact using an arrangement of ultrasonic sensors to track the position of the hand within a 3-dimensional field. Unfortunately the Klankspeeltuin wasn't able anymore to financially support the project because of loss of subsidizing.

The Department of Industrial Design supported the project for further development resulting in a new project aim: to develop the concept to a high quality prototype to be presented at exhibitions as a promotional object for the Department.

Figure 1. Klankspeeltuin Concept

Figure 2. Final TU/e concept

Interaction
Aim was to create a new way of making music. Orientation within the market of interactive musical installations resulted in the conclusion that most designs focus on screens and tables and interaction through physical contact. The inspiration and room for development were found in the opposite style of interaction not relying on screens and physical contact. The Theremin [6] which makes use of a touchless interaction proved to be a strong inspiration.

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'Flirting with the Future', Proceedings of SIDeR '09, April 15-17 2009, Eindhoven University of Technology, the Netherlands.

Second aim was to make the interaction very open for various ways of creative input instead of pushing the user to a specific action. Creating music is a form of expression and people should be free in their way of expressing themselves. There shouldn't be a wrong way to use the installation.

Sound modulation

The main interaction consists of moving your hand freely within a three-dimensional field to modulate predefined samples or recorded sounds played in a continuous loop. The technique makes it able to program a large range of interaction possibilities relating specific movements to particular sounds in various ways.

Figure 3 Creating sound effects with hand movement

For example simple interaction, like moving your hand up and down to change the pitch or a complicated one using more expression, like creating wild effects with wild gestures and subtle effects using elegant moves. For the final model there was chosen for a range of three different interactions with a variety in complexity.

Feedback

Only making use of the sound effects as feedback, didn't prove to provide enough information for a clear interaction. The choice was made for additional visual feedback to provide information of the position of your hand consisting of a ring with a light that follows your hand.

Figure 4. Lights following the position of the hand 3

Light feedback was selected because it provides a clear and basic level of information and has room for a large range of feedback possibilities combining colour, intensity and position.

Record function

The record function is based on the link with an echoing well. The principle of an echoing well is that you yell inside the well and hear your voice echo. Just like an echoing well you bend over the edge of the Sono and yell your message or make a random sound. After leaning back you hear your recorded sound echoing from the Sono.

For controlling the record function the use of a physical interaction couldn't be avoided, because a non-physical interaction with hand position tracking conflicted with the sound modulation interaction.

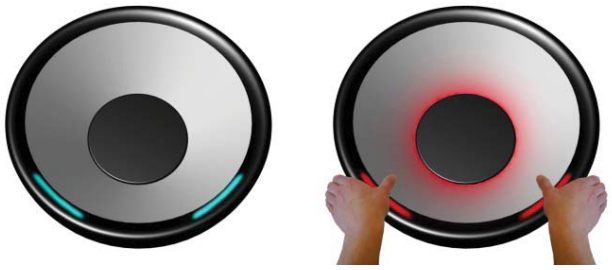

Figure 5. Switching on record function

Aiming on a subtle control related to the echoing well metaphor resulted in touching the ring while bending over to record your sound. Making use of coloured light in the touch sensitive area and the ring inside the goblet confirms switching on the record function

Technology

Sensors

SRF10 Ultrasonic Sensors measure the distance to an object by sending out ultrasonic sound waves and calculating the time between sending and the return of the reflection.

With the positioning of the sensors a three dimensional field can be created. This field is converted form XYZ field to a polar coordinate system where:

$r = (x2 + y\ 2)\ ½$

$\theta = \tan\text{-}1\ (y/x)$

$z = z$

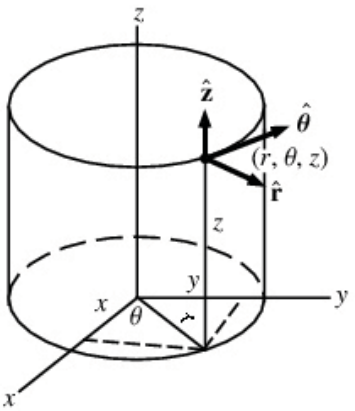

Figure 6. Cylindrical coordinates

With the polar coordinate system the sound can be changed with three values. These values can be adapted by moving your hand further away or closer to the center (θ), by changing the height (z) of your hand or by changing the angle (r) in the imaginary cylinder. These values are used in Max MSP to change the values of a patch.

Arduino
The Arduino is a microcontroller directly connected to the sensors. The data from the sensors is received and processed by the Arduino. The processed data is send form the Arduino to the computer through a USB connection. On the computer the data is being received by program called Max MSP.

Max MSP
The data from the Arduino can be translated into sound modulation effects using Max MSP, a program specifically designed for sound and musical purposes. The team was supported by Gustaaf Milzink, a student from the HKU, who designed the sound modulation programs (patches).

Sensor Positioning
Multiple tests with the sensors positioned in the three dimensional field resulted in the conclusion that registering the hand position didn't work stable enough. Tests were conducted to determine the range of the sensor beam. Main conclusion was that the range of the sensor beam covered a very narrow area between 0cm and 15 cm and covered a wide field form 15 cm.

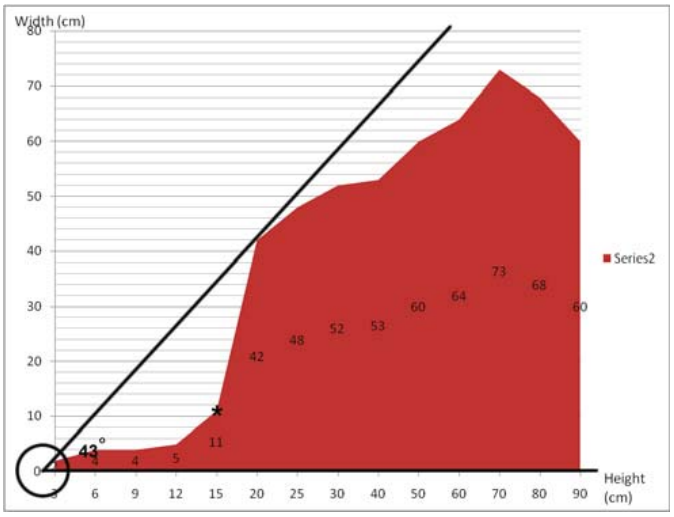

Figure 7. Sensor beam with maximum angle

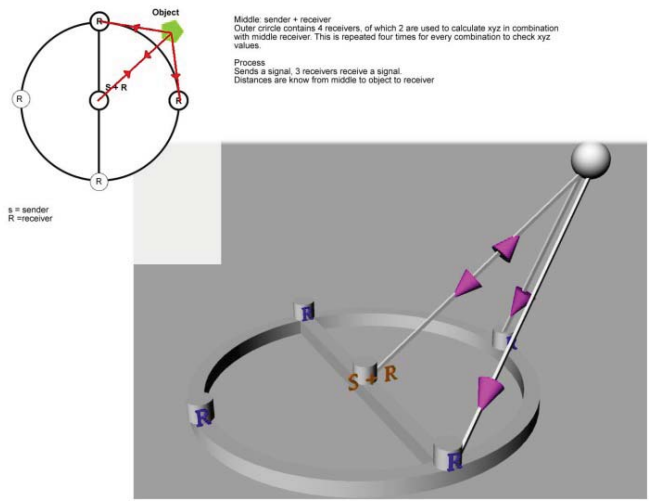

Figure 8. Sensor positioning in a ring

The options for having a single transmitter with multiple receivers were investigated resulting in a successful positioning, having one sensor including both a transmitter and receiver in the center with a circle of four receiving sensors around.

Recording
Two infrared sensors are implemented in the ring to register a person touching or nearly touching the ring to switch on the record mode.

Conclusion
Main conclusion is that the technology is thoroughly investigated and successfully implemented in such way that it provides the opportunity to create a very broad range of interaction styles. The creation of interaction options relies on programming, which makes it open for countless opportunities to be tested and implemented in the final stage of development.

The result is a sound installation which fits the demand of experiencing music in a non-traditional and playful way and also provides new chances for further exploration.

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This paper is the design argument of a submission to the SIDeR '09 Conference. The full submission, including an elaborate explanation can be found on www.sider09.com