resonate – a social musical installation which integrates tangible multiuser interaction

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ABSTRACT

Resonate was a musical installation created with the purpose of interactivity and collaboration. This paper will focus on the design-process and the different steps involved. It will also describe and discuss the methods to create, synchronize and combine the aspects of space, object, music and interaction for the development of resonate. The realized space-filling tangible installation allowed visitors to interact with different interaction objects and change therefore the musical expression as well as the visual response and aesthetic. After a non-formal quality evaluation of this installation the team changed some aspects which resulted in a more refined version which will also be discussed here.

Author Keywords

music installation, tangible, collaborative

ACM Classification

H.5.2 [Information Interfaces and Presentation] User Interfaces — Haptic I/O, H.5.2 [Information Interfaces and Presentation] User Interfaces — Prototyping

1. INTRODUCTION

The installation was developed as an interdisciplinary project with students from the fields of music, interior design, media design and communication design. We will describe two versions of the installation and the changes that have been made in between. The task was to create an engaging environmental installation that was supposed to engage visitors and encourage them to have some playful communication through the use of the musical interaction objects.

The development of a multi-user interactive installation which is filling a space of roughly 50 meters length, 8 meters width and 7 meters height is a difficult challenge, even for a professeional group. Classical design concepts, like iterative design, user centered approaches or spiral aspects could be used - but they would have to be adopted. With some aspects given - for example the environment of the installation, the nature of music and interaction, the master level students were divided into small teams. They started to develop spatial and interaction concepts. This starting phase used scribbles, evaluated and defined the typical user and visitors (mostly no experience playing an instrument, abidance and usage time of about 15-30 minutes, a low initial collaboration rate with others, age between 4 and 90), visualized their ideas in 3D models and build small scale real models (Figure 1). Also first interaction tests were implemented and their usefulness to influence musical and visual aspects was tested.

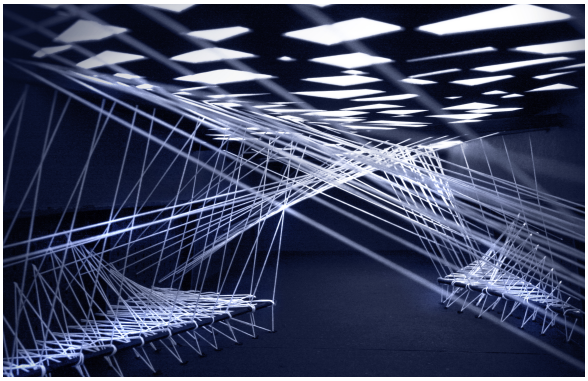

Figure 1: Detail from a small scale model

Figure 2: Mood images from other concepts

All concepts entailed a main theme which was used to hold the different parts together. Therefore the form of objects, material and color selection, interaction gestures, dynamic of changes in the environment through the interaction and so forth had the same core. This was very useful and we would like to define this as an imperative to develop a massive and multi-user interaction installation. After several

NIME'15, May 31-June 3, 2015, Louisiana State Univ., Baton Rouge, LA.

weeks of iterative drafts and a presentation of all concepts (Figure 2) an interdisciplinary review group consisting of interior architects, media-, light- and interaction designers, a computer scientist specialized in human-computer interaction as well as musicians and an economist selected one of the concepts for realization. From this moment on the whole team worked together on improving this concept, which focused on ideas about water, waves and oscillations. Lots of ideas and variations in 3D, real models, functional real scale interaction models and small models were developed and tested on how visitors could interact with the installation to create a musical composition.

We will give a short overview of related work in the following chapter and present the development of the main parts of the installation as well as the ideas to moderate the behavior of the visitors in chapter three. After presenting a non-formal qualitative evaluation in chapter four we will describe the refined version which was presented in a museum context and the changes the team made, partly necessary because of the changed environment but mainly due to the results of the evaluation of the first public installation.

2. RELATED WORK

A project that shares the spatial dimension of this work is [3]. Where Bort et.al. focused on the participatory design aspects of a spatially responsive installation, the group did not use the process of participatory design as their main process. Intermittent, users of our target group were invited, mostly in difficult situations where the team couldn't determine some design decisions because of their involvement in the development itself. But this was not as systematic as defined by Bort et. al.. Clair and Leitman [4] showed that its important to provide enough room for a shared multi-user experience, so that installations of that size make an ideal playground for collaborative interaction and experience design.

The differences between instruments and interfaces of large-scale installations have been discussed by Beilharz et al. [1]. Designing for novice users, who will spend only a short time with the installation, needs a different strategy than creating an interface for expert musicians. The mode of operation has to be primarily self-explaining and natural. As will be described in the next chapter a string-based interface was used for this installation, an approach that has been described by several others in the past [2]. However, these strings were used as a large-scale room-shaping design element, combining a familiar metaphor presented by Lakoff et.al. [5] with an immersive experience [7].

3. DESIGN OF FIRST VERSION

An old empty container-boat (Figure 3) was the starting-point for the first version, which was presented at "Luminale 2012" a great light art festival, taking place every two years in Frankfurt, Germany.

3.1 Iterative design process

To improve the usability and quality of the installation, the group used, as described in chapter one, an iterative design-approach [6] which was adapted to the complex approach of this multi-user installation. Further refined prototypes were again tested by team-members and uninvolved users to find weaknesses in design and usability. Learning from mistakes, it was possible to improve the installation into a robust and functional version. The following sections will give an overview of the different concepts, their approach and developments as well as the interaction decisions.

Figure 3: Raw corpus of the boat

3.2 Spatial concept

The body of the boat was transformed into a big room, with broad stairs leading to an area with eight illuminated interaction-objects. These objects were connected through a net of white cords to the ceiling and redirected to the walls of the room. This network of cords was intended to break up the spatial boundaries of the boat and create an impression of deepness. (Figure 4) shows a photo of the empty installation. Since the interior was quite dark, visitors had to adapt their eyes, when they entered from outside. A small platform at the entrance allowed visitors to wait there until they felt comfortable with the lighting situation. From this platform one had a good view onto the installation from an elevated spot and had the possibility to observe others interacting with the installation. By advancing down the wide stairway one could then enter the active part of the room to find out how the system responded to oneself.

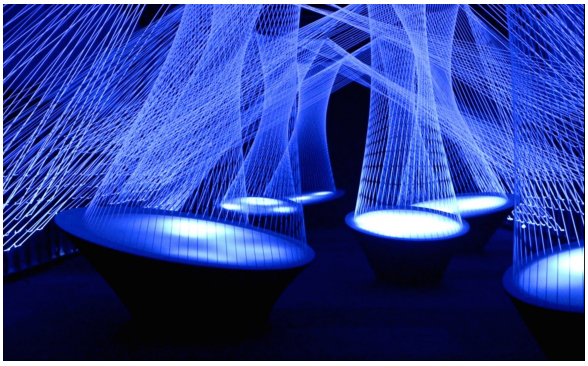

Figure 4: View into the empty installation

3.3 Lighting concept

The creation of an environment with impressive, if possible immersive, illumination was part of the main goals. Starting from an empty dark room, ultraviolet light tubes were used to illuminate the white cords that were stretched through the whole room. The tubes were aligned along the walls and directed upwards, to reduce the grade of blending the visitors, but the angle was wide enough to reach the cords. The glowing cords were the only source of light, when the installation was inactive and created some kind of mysterious atmosphere.

Each of the eight oval interaction objects had a matrix of 200 RGB-LEDs under a translucent surface. These were the displays, on which the visual feedback to user interaction

was displayed. The single displays acted like peepholes to a bigger surface. To play animations that spread through the whole room, it was necessary to know the exact location of every pixel to calculate the right colors at the right time. So when visitors began to interact with the installation, the objects surfaces came to life, and displayed waves, emerging from their center. The calm and dim ambience evolved to a lively colorful play of light. So visitors had a strong influence on the overall appearance of the installation.

3.4 Musical sound space composition

The human perception of space is significantly influenced by the perception of sounds. The sound installation of resonate used two layers with eight speakers each to generate the impression of spatial movement and to make an exact localization of the sounds possible. For the first layer, a base sound defined the entire body of the ship. This "drone" consisted of a tightly knit sonic weave which moved through the space in an eight-channel sound projection. The reflection in the metal hull of the ship amplified the resonances of the dynamic and constantly changing sound composition. The effect of water on the steel hull was also integrated. The interaction of interior and exterior defined the boat in its entity as a resounding body and a resonance system.

The sound of the objects formed the second layer. Plucking the tightened cords turned these into strings which provided an impulse for the generation of sounds. The sounds were generated from natural and synthetic sources including sounds of traditional instruments as well as sound samples that had been recorded in and around the ship. The sound produced via the cords was manipulated by the interactions of the visitors and created a rhythmic and spatial counterpart for the drone. The resulting auditive space changed constantly and offered a multidimensional sonic experience to the visitors, who could play and interact with each other musically.

3.5 Interaction

The installation was intended to act like a huge musical instrument responding to visitors interaction. Eight oval objects were distributed on the floor of the boat. Each object (Figure 5) had a speaker inside and a display as described in chapter 3.3. Elastic cords were attached to each object, which were guided through metallic rings on the ceiling and ended at the walls of the boat. By ultraviolet illumination, these cords became an outstanding visual focus point and invited the visitors to touch them. To use these cords as an interface, it was necessary to measure their movement. In an early attempt, piezo-sensors were attached to the interaction objects on the floor, to measure the oscillation of the cords, when they were plugged. But though using rubber mats for damping, there were still problems of decoupling the vibration of the floor when people were walking by, from the vibration of the cords. So the sensors were moved to the rings, that were hanging above the objects. The team had to test different materials and forms to get the best data but developed a good solution with the aforementioned welded metal rings. They were more sensitive for vibration, but only to that of the cords.

At first the interaction-objects were rotatable, as the idea was to use the rotation of the objects to have influence on the generated sounds. In the tests it became obvious, that the tension that the sum of cords would develop when they were stretched, had been totally underestimated. So it was really hard to rotate the objects and when released, they tended to snap back into their original position with enormous force. So the team decided to fix the objects to the floor in order to prevent accidents.

At this point the sensor-values were reliable and could be associated with the individual objects. This data was interpreted by electronics and a computer to control sonic and visual effects on each object.

The default mode of the installation was that plugging the cords triggered sound and light effects on the object, which the chord was attached to. Each object had an individual sound and color scheme, so by playing different objects an atmospheric composition could be created.

It was a challenge to adjust the visual and acoustic parts of the installation to fit well together. Specific days were installed, where the different groups presented their state of the project as well as the questions and side effects which would be of interest to the other groups.

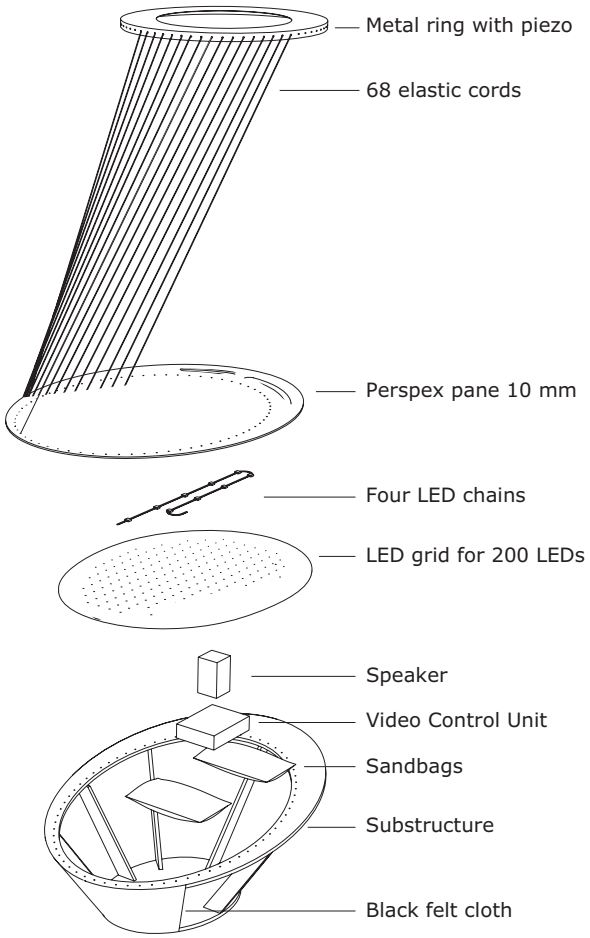

Figure 5: Structure of an interaction object

3.6 Moderating behavior

Regarding to the project's iterative design process, the first prototypes were evaluated and the following observations were made: One person alone seemed to understand the mechanics of interaction very quickly, that plucking the cords triggered a response from the installation. When a few people were interacting at the same time, their interest and pleasure seemed to increase, because they could not only react on the system, but to each other too. But at a certain point, more users did not improve the experience. To the contrary, the mass of inputs triggered too much feedback and resulted in noise. The users were no longer able to distinguish what reactions were caused by themselves. There-

fore it was harder to learn how the installation worked and led to a certain level of frustration. This is why the team felt the need for adding a moderating aspect to the installation and developed two different modes for that purpose.

3.6.1 Automatic moderation

The first mode was controlled automatically by the system and was triggered when too much input was measured at a single object in a short time frame. Then the installation went unresponsive to user input and played an animation that spread from this object through the whole room. It was accompanied by a suitable sound and took about ten seconds to expire. After this short break the installation returned to its default mode, giving the visitors the opportunity to start interacting again from a silent environment.

3.6.2 Manual moderation

The second mode was triggered by a staff member wearing a white umbrella. The umbrella was equipped with a sensor that was triggered when the umbrella was opened. Then it send a wireless signal to the computer which shut off the interactive part of the installation. The LEDs went dark and began to display raindrops falling onto a liquid surface. This was accompanied by appropriate sounds of rain and thunder. The umbrella was illuminated by the ultraviolet light like the cords, so it could be identified as a part of the installation more easily. By forcing the visitors to the role of a passive observer and exposing them to a quiet and meditative atmosphere (Figure 6), they should be appeased and calmed down. After several minutes of walking through the installation, the staff member closed the umbrella and the installation went responsive again.

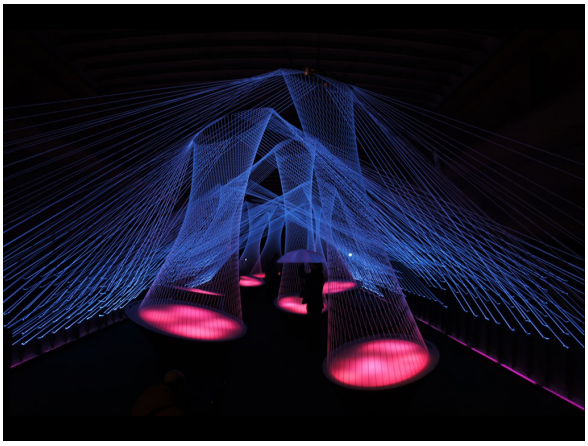

Figure 6: Installation in manual moderation mode

4. EVALUATION OF FIRST VERSION

While the installation was presented to a greater audience during "Luminale", a wide range of visitors could be observed. The team made extensive use of this opportunity to interview visitors to gather as much feedback as possible.

4.1 User experience and moderation

The experience was described in many different ways by the audience, but overall the feedback was very positive and satisfying. Though people had to wait in line for up to 90 minutes, only a few of them complained about it. After visiting the installation, most of them stated that it was worth waiting and a lot of visitors came back on a later day to show the installation to friends. There were also some people that did not like the installation, but their number was very low and most negative comments occurred, when the queue outside was very long and the inside was crowded.

The number of simultaneous visitors, had a big impact on the overall experience. Over 35 people decreased the experience drastically, as interviews at the exit of the boat showed. The best results were with groups of two to ten people. It was possible to keep track of the actions of others allowing to react on each other. With increasing numbers the chance of people blocking the way rose together with the level of noise, which made it difficult to identify the visual and auditive feedback of ones own actions. The only way to preserve an acceptable experience for the visitors was to limit the number of people on the boat.

The large amount of about 10.000 visitors within the week of exhibition made also a perfect test-environment for the two modes of moderation, that we described in chapter 3.6. The moderation-phase with umbrella worked pretty well to calm the audience: At first, most visitors watched silently to the new situation, then often started to talk about the installation and ask questions to the present team-members. This phase was perceived as an opportunity to reflect ones impressions, which lots of people seemed to enjoy. When the installation returned to its default interactive mode, a lot of visitors were even having a better experience than before.

The automatic moderation-mode on the other hand, did not turn out as expected: Instead of preventing the visitors from overacting, they seemed encouraged to trigger this special behavior of the installation again and again, like if it was a reward. Once learned, how this mode was triggered, many felt the desire to show this behavior to others. The result was more noise and frustration, which was the opposite of what was intended.

5. DESIGN FOR A MUSEUM SITUATION

Figure 7: ZKM_Kubus

Based on the evaluation and identified weaknesses of the first version the group developed a second version of the installation for a sound art exhibition at ZKM, a museum for media art in Karlsruhe, Germany (fall 2012 - spring 2013).

5.1 Location

The new location was a dark square-shaped room, surrounded by a glas cube, on a public open space in front of a museum (Figure 7). As it was smaller, broader and had a lower ceiling, all parts of the installation had to

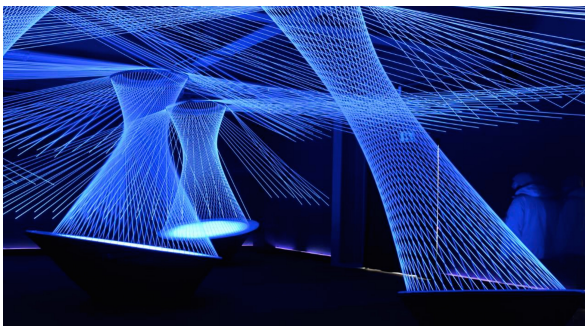

Figure 8: Second version of the installation in a museum

be rearranged, to adopt to this situation. The number of interaction-objects were reduced to seven, to compensate for the smaller floor space. As the first location was a long and tall room, it was possible to tie all the cords along the side-walls, forming a tunnel-like impression with a clear direction from front to rear. For the new version, all four walls were used and the network of cords was far less vertical because of the lower ceiling. (Figure 8) gives an impression of the new spatial setup. Because of the exposed situation inside of a glas-cube at a public place, the team decided to use this situation to attract and attune the audience. Holes were drilled into the walls to stretch the cords from the ceiling through the walls to the outside. Additional ultraviolet lights and speakers were mounted inside the outer glas-cube.

5.2 Interaction

Since the automatically triggered moderation mode from the first installation didn't have the desired effect, it was removed for the second version. However the radius of the standard visuals was increased, so that they reached the surface of other objects, which earlier was part of the moderation mode. This was discussed for the earlier version too, but was discarded in favour of a stronger distinction between normal and moderation modes. The effect was an improvement in localization of other users interactions.

5.3 Sound space composition

The sounds originating from the metal hull of the boat or the river had no relevance in the context of the museum's space at the ZKM. Hence the two layers of the sound space composition were completely revised and recomposed. The almost square like shape of the space allowed a reduction of the "drone" layer from eight to six channels (plus subwoofers). This sound atmosphere still consisted of electronic sounds, but with less noise or technical attributes. The constantly playing six channel sound projection with speakers hanging under the ceiling created moving sounds which could be better located than in the long drawn-out space in the boat. This "drone" layer was projected to the outside of the glass cube by 12 speakers (plus subwoofers) sounding through the half open glas walls. This created a moving sound space in the outside surrounding of the architecture.

The sounds of the interactive objects were also changed completely. Each object was assigned a very specific sound quality which could be distinguished more precise than before. Technically the objects were now changed to present the sound through three loudspeakers implemented inside of the objects to give them more definition. An additional loudspeaker was fixed in the ceiling above each object to allow for some kind of direction through the use of two channels for each object. Some of the objects sounded more like an instrument and others created more complex sound experiences, modulated by the power and the decaying vibration of the strings. The director of the ZKM Peter Weibel called this installation a "meta guitar".

6. CONCLUSION

The team been working on this project for the period of about one year. The final version of the installation could be visited for half a year at the ZKM and was functional with only one minor problem due to a bad soldering connection on an Arduino board. We think that successful interaction- and experience-design relies heavily on iterative steps and evaluation. The project could have never achieved as much approval and positive feedback without numerous models, prototypes and tests. Know-how and experience from preceding projects can help to accelerate this process, but it is our opinion, that creative work, especially in the context of art, needs experiments. Failure is a valuable source of learning and inspiration and we hope that others feel encouraged to invest the additional time, that iterative design - even with some small modifications depending on the subject - requires.

7. ACKNOWLEDGEMENTS

We would like to thank especially the projects initiators and project leaders Bernd Benninghoff and Klaus Teltenkötter as Resonate wouldn't exist without their enormous effort. Furthermore we like to thank the whole project team[1] which realized this installation. We like also to gratefully acknowledge our home institutions School of Design Mainz, University of Applied Sciences in cooperation with Mainz School of Music at the Johannes Gutenberg University Mainz as well as our project partners.

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