

Back to the sandbox - Playful Interaction with Granules Landscapes

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ABSTRACT

We present a novel, tangible interface demonstrated by means of the artwork, GranulatSynthese, an installation for the intuitive, tangible creation of ambient, meditative audio-visuals. The interface uses granules distributed over a tabletop surface and combines them with rear-projected visuals and dynamically selected sound samples. The haptic landscape can be explored with the hands, shaped into both hills and open space and composed intuitively. Form, position, and size of cleared table areas control parameters of the computer generated audio-visuals. GranulatSynthese is a meditative application, which invites to either play or step back, watching the visuals and sounds evolve. The installation has proven very accessible. It is inviting and absorbing for a long time for many visitors to the installation.

Author Keywords

Innovative Human Computer Interaction, Interactive Audio-Visual Installation, Music Tables, Continuous TUIs

ACM Classification Keywords

H5.2. [User Interfaces] Input devices and strategies, *Interaction styles*.

INTRODUCTION

Computer interfaces typically are meant to disappear behind the task to be fulfilled. They are supposed to support the users in their interaction with the digital domain, while being neither noticeable nor being even considered to be part of the application.

Recent advances in human-computer interaction have enriched the interaction space by integrating input and

output domain. In Augmented Reality, TableTop, and Tangible Interfaces the visual projection surface and the interaction space merge, forming a close relationship between both.

In this paper, we present an audio-visual-haptic interface using vinyl granules on a rear-projected table, as shown in Figure 1. In this interface, the vinyl granules are used as a three-dimensional projection area and as a sculpturing material for a landscape with haptic and auditive components. Parameters that control the computer generated audio-visual content are taken from the size and form of open table surface, i.e. surface areas not covered by granules. The interface is rich in the real and virtual domain: the granules are both interface with sonic, haptic, and playful features and a three-dimensional projection area; plus it creates sound both in the computer generated and in the real domain: working through the material, flattening the landscape by patting it, or letting the material flow in a stream on the table will contribute distinctive real acoustic and haptic information to the experience.

The remainder of this paper describes the interface through an exploration of our installation GranulatSynthese in more detail. GranulatSynthese is a meditative application that explores some of the interface's features.

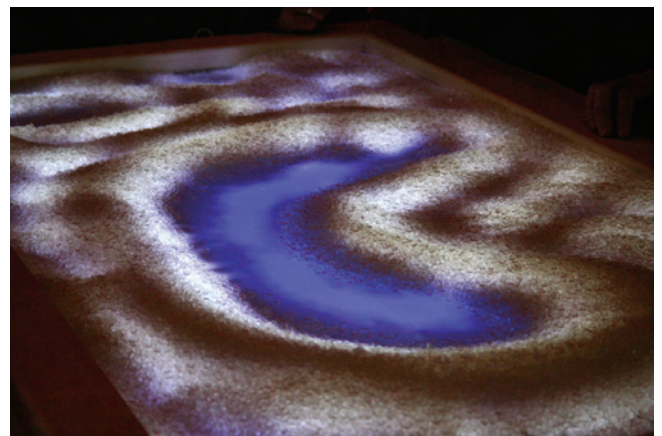


Figure 1. Granules landscape as haptic projected surface using the exposed table surface to control the application.

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RELATED WORK

The silent beauty and emanating energy of Japanese rock gardens [8], as well as sand animation movies and two audio-visual installations, SoundVision and Scrapple, inspired the creation of this interface. SoundVision is a distributed collaborative tool, which either creates Midi Sound from drawings and webcam images, or, vice-versa, visualizes sound input. Several terminals with different input devices can be connected to allow users to work collaboratively, creating a “collectiveSoundImage” [1]. The Scrapple system by Levin scans a table surface as if it were a kind of music notation, producing music in real-time from any objects lying there [3]. Both installations explore the playful, collaborative creation of sounds, visuals, and their interplay, following a parameter driven model.

Sand as a means of having a flexible, haptic material and surface to project on was used by Sheridan [6]. Ishii et al. in SandScapes, additionally, used sand as a computer interface [2]. Their project focuses on the creation of 3D landscapes for the purpose of landscape design and analysis. The landscape is formed with sand or clay and its shape is analyzed. Visual content is projected onto the surface of the material, aiding the architectural design process. Different to SandScapes, our current project uses the “absence” of 3D landscape to control parameters and our visuals are back projected, therefore, in the covered areas, filtered by the material.

O’Modhain and Essl explored the sound quality of granular material for controlling a granular sound synthesis application [5]. They analyze the acoustical data collected from the interaction with the granules to extract control parameters. By extending GranulatSynthese with a single microphone or an array of microphones, this could easily be implemented. Our current installation, however, focuses on controlling the application purely by visible forms on the table surface. The acoustical quality of moving the granules is meant to contribute “as is” to the experience.

GRANULATSYNTHESE

Working with granules is a well-known experience. Most people played with sand as a child. Even though building something may have been the apparent motivation to do so, the haptic, tactile sensation itself may have contributed something to the appeal of sand boxes. Furthermore, the tactile stimulation is known to have positive effects on learning and the development of the brain in childhood. The appeal of the flexible, semi-liquid but still formable, haptic matter makes sand and other more course-grained materials enjoyable to work with.

In GranulatSynthese, users move and form the material, creating a landscape of granules with “hills and lakes.” In extension of the SandScapes metaphor, GranulatSynthese additionally includes the form, size and position of *exposed table surface* into the interface metaphor. The lakes are areas on the table, which are not covered by granules and fully reveal the table projection surface. It, thereby,

generates distinctive, easily repeatable control parameters in addition to the form of the 3D surface.

Our installation is rear-projected. Visuals are projected from underneath a semi-transparent table surface; waves pulse and move through the projection plane and landscape, as can be seen in Figure 2 and 3. The transparent vinyl material utilized was chosen to form a semi-transparent surface that blurs the visuals projected from underneath according to the thickness of the material. Free areas show sharp images on the table surface, while covered areas show the projected image modified by the granules, adding some mystery and depth to them.

The interface invites one to play with the granules, like in a sand box. Deeper aspects can be discovered by exploring the work, revealing its potential as a musical, haptic, and visual device. The interface provides users with opportunities for more implicit forms of communication with the installation and other users. Control Parameters are not explicit and precise but very intuitive to explore.

GranulatSynthese derives its name from the vinyl granules used as the main interface component. Granulat is the German word for granules. The granules in this installation are both part of the projection surface and the interface itself. The name is similar to Granular Synthesis [4], where one also plays with grains. In this case, however, the grains are small sound samples. Bringing both together is part of our current work, but is not presented here. In this installation, exploring in



Figure 2. Visuals generated by GranulatSynthese

Technical Implementation

The current installation of GranulatSynthese is a box occupying about one cubic meter, containing a glass plate covered with a thin semi-transparent layer, a mirror, a projector, a camera, speakers, and the controlling PC. Initially, a layer of granules, approximately 1cm thick, covers the table surface. The installation is situated in a darkened or semi-lit room, flooded by overhead infrared lighting. Underneath the table, an infrared camera observes the table surface. From these images, the software detects the shape of granule-covered area and the exposed space in between (the “hills” and “lakes” of the landscape). From the shades of the infrared light filtered by the transparent material it is possible to calculate the three-dimensional

shape of the granules landscape [2]. Our current installation instead uses the position, size, orientation, and shape of the resulting spaces as control parameters in two ways.

Visually, the forms of the opened areas are filled with color and waves flow out from these forms through the covered areas, like waves flow around an island. The waves are reflected from the boundaries of the installation, but lose energy over time. Acoustically, depending on position, orientation, size, and shape, sound samples are selected and adjusted in volume and pitch, to conform to the “selected” parameters. Instead of having immediate effect, changes to parameters gradually lead to changes in the generated audio and visuals. The software was built with the multipurpose toolkit vvvv (<http://www.vvvv.org>) using DirectX and shader technology.



Figure 3. Users playfully shape the granules landscape

User experience

Experience with many visitors has shown that the installation is very accessible and easy to interact with and, therefore, very user-friendly. The landscape can be dynamically explored; a composition can be continually developed. On the other hand, the interface has a certain persistency to it, in that one can leave the landscape untouched, as a pause for a lasting effect or in a physically saved state, to later return to it. The work has its own presence, influencing the surrounding space and mood. There are different flavours of generated sounds and visuals, ranging from naturalistic to musical or noisy sounds and from meditative to energetic moods.

If the landscape is flattened and no open spaces remain, the installation gradually comes to a still state; it becomes silent and the waves slowly disappear. Figure 4 shows this state. Starting from this non-computer influenced state, the usual first approach of new users is to move the fingers through the material. Typically, with the system adjusted to react on exposed table surface, this response is small and not persistent. The granules fall back to their previous space, re-filling the table surface. Gradually, users discover the system and its underlying model. They start creating stable open forms on the table, rearranging the landscape or just watching the results.

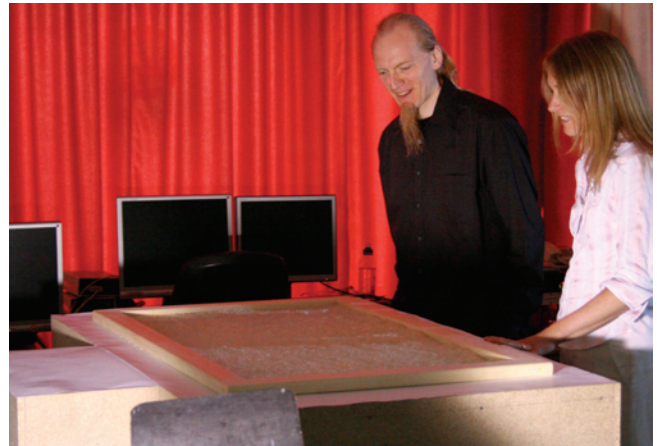


Figure 4. The interface box becomes silent with granules evenly covering the interaction space. A last dark wave flows through the granules.

One of the main features of the interface is the joy of interacting with the granules. Touching the granules (see a close-up in Figure 5) is a very haptic experience, similar to touching rice or coffee beans. It also has very similar acoustic features. The material is hard enough, to make clear and distinctive sounds when dropped on the table; but it is also warm and pleasant to the touch. It encourages moving one's hands through the granules to shape hills or free spaces, making noise by moving the material. As can be seen in Figure 3, users enjoy rummaging through the material. We observed many visitors to our lab playing absent-mindedly with the granules, even when the installation was not switched on. With a working system, visitors often just step back to watch their or other users' audio-visual creation evolve.

A major motivation behind the design of GranulatSynthese was to experiment with correlations between audio, visual, and haptic aspects of media and make them easy to explore in a dynamic environment with very direct feedback. Most users have described the different modes as integrating well and the relations between them to be very close with respect to a given mood or flavor. A flavor describes a pre-defined set of matched sound samples and visual properties.

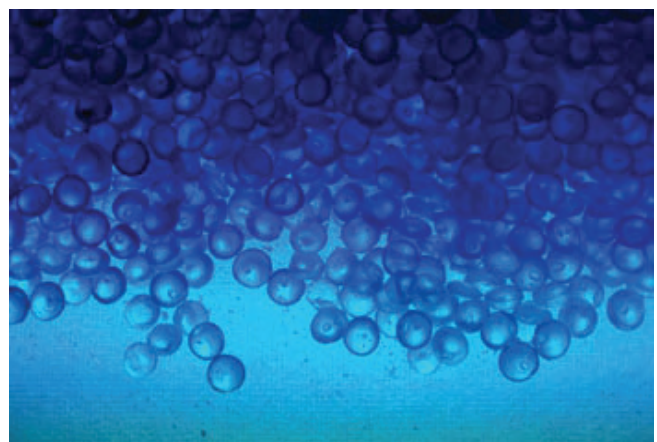


Figure 5. Close-Up of vinyl granulate

DISCUSSION

The presented interface provides multiple sensory components in the real domain, which can be further enriched by virtual content, as was done in GranulatSynthese. In the real domain, the granular landscape created generates a visual impression, reminiscent of Japanese rock gardens or childhood sand boxes. Adding computer generated content results in a merged visual-acoustic space, creating a glowing landscape. The real sounds and the virtual sound space combine to form the audio landscape and the visuals modify the appearance of the real granules landscapes. This effect depends on the properties of the material used. When testing the interface with different granule materials, we found that the visual appearance was highly dependent on the materials properties, as is the haptic experience. Moreover, the use of smelling granules would add an olfactory component to the experience, and jelly granules could even provide a gustatory and edible interface.

The presented interface is not a classic TUI according to the key characteristics defined by Ullmer and Ishii [7]. In our case, a physical “non-existence,” a free, exposed table surface in a specific form, is coupled with a digital meaning. Following from that, there is no persistent tangible. Therefore, the interface would, strictly speaking, fail as a TUI on characteristics 1 and 4. The granular landscape, however, is tangible, carries a physical state, embodies a mechanism for interactive control, and physical matter is perceptually coupled with an actively mediated digital representation.

Ishii et al. describe their landscaping interface as a *continuous TUI* [2]. Here, the TUI description holds, as the sand or clay interface is a continuum and the meaning is encoded into this landscape. Its continuous landscape can be seen as a single tangible. Our interface features a mixture of continuous TUI attributes and free space. The physical elements, the granules, may either hold a meaning, as in SandScape, or model a space outside the physical elements, which then holds a meaning and connects to the digital space. Any “open space” shape that a specific granular material allows to arrange, together with its size and position, can be utilized as a parameter to the computer and extend the height parameters encoded in the landscape.

The current installation explores only part of the potential of the interface. As the covered landscape shows blurred but nevertheless visible information, this feature can be used to tease users to further explore a specific area. Several information threads can be presented on a table but the user's focus of attention would be less distracted than with information appearing fully accessible all over the table. Covered information can be intuitively discovered and irrelevant information easily covered, thus discarded.

CONCLUSION AND FUTURE WORK

In this paper we presented a multisensory, playful, and joyful interface using granules as interaction and projection

space. Current computer interfaces often lack easy usability and disregard the intuitive accessibility and haptic, plus auditive, reward of real matter. Not only does the moving of the granulate add a haptic dimension to the installation, but it also generates sound in itself. This adds to the composition and is an effect in itself.

The GranulatSynthese installation sets the frame for the user to explore and create compositions. Most flavours of the current installation have a very meditative character. Users are often seen to pause and just take in the effect. The installation has potential, both as tool for intuitive control of parameters in a computer and as a stand-alone installation with a three-dimensional dynamic visual dimension combining both real and virtual content in a new way.

The interface was presented by means of an art installation to explore its accessibility and appeal. It, however, has the potential to be applied in diverse application areas. We envision it, for example, as a playful and explorative interface to interactive storytelling content. One other area is its refinement as a musical instrument. We plan to further explore the interface as a device for generating music and sound both in the real and virtual domain. The sensing capabilities of the interface can be extended by microphone arrays. This would allow us to distinguish between the different ways of interacting with the granules and to use the trickling or swooshing sound of moving granules as control parameter. Furthermore, we plan to exploit the interface as a device for occupational therapy, combining the accessibility and haptic dimension of the interface with training programs for motor and cognitive skills.

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