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Nadia Al-Kassab, Axel Berndt Chapter 2

TouchNoise: A Multitouch Noise Instrument

Abstract TouchNoise is a digital musical instrument for noise modulation and is based on a particle system of sine oscillators. The oscillator's parameters are determined by the particle's location within a two-dimensional frequency and stereo panning domain. TouchNoise's sound is created by adding all sine signals. For playing the instrument, an interface was developed, that is controlled by bimanual multitouch gestures. It offers several possibilities of influencing the particle system indirectly and directly. Indirect manipulations include the manipulation of parameters of particle motion and the mapping of particle position on screen into the frequency domain. With the direct interaction, particles can be dragged, accentuated, attracted, and repelled to and from the touches. In addition to these, a series of further functionalities are implemented. This chapter introduces the TouchNoise interface and all its novel possibilities for noise modulation.

2.1 Introduction

Realtime sound synthesis paved the way for a new generation of musical instruments, digital musical instruments. Today, these instruments are more relevant than ever. They are present in many musical genres. Conferences are dedicated to new musical instruments and the concepts beyond, such as the annual conference "New Interfaces for Musical Expression" (NIME). Especially in the field of mobile applications, a lot of examples exist with which musical sounds can be created. Their multitouch screens serve as a great basis for novel interface concepts.

Noise is an important element of electronic music. For noise modulation usually filters or granular synthesis methods are used. With TouchNoise, a digital musical instrument that is introduced in this chapter, we want to provide a new approach for interactive noise modulation. The chapter summarizes the work that was previously presented by Al-Kassab (2013, 2014), Berndt, Al-Kassab & Dachselt (2014, 2015). The main idea behind TouchNoise is interaction with a generative process that creates a stochastic sound signal via additive synthesis. The sound synthesis derives from the behavior of a particle system. Each particle is connected to a sine oscillator. A particle's position on screen determines the frequency of the corresponding oscillator and its position in the stereo panorama. Multitouch interaction provides several possibilities for manipulation of the particle system, including direct interactions, such as the attraction of particles to a touch point, and indirect interactions, such as the manipulation of the particles' motion characteristics. A special interface was developed in order to control TouchNoise via bimanual multitouch gestures.

This chapter gives an overview of digital musical instruments that are conceptually related to TouchNoise in section 2.2, followed by a detailed description of TouchNoise itself in section 2.3. Therefore, a first insight into the user interface is given in section 2.3.4. Single control elements are explained with their assigned functionality in further sections. The underlying principle of TouchNoise's sound generation is described in section 2.3.1. Section 2.3.2 outlines the particles' autonomous behaviour and the possibilities of influence. Various opportunities of direct manipulation on the particle system are demonstrated in section 2.3.3. Section 2.3.5 gives an impression of TouchNoise's sonic design space and corresponding playing techniques. Therefore, the effects of the different manipulations are gathered and combinations, sequences or setups are demonstrated. Experiences with TouchNoise are discussed in section 2.4. Section 2.5 summarizes this chapter.

2.2 Related Work

Digital musical instruments (DMIs) such as TouchNoise stand out from classical instruments due to the possible independence of sound generation from physical laws. Their sound is rather a result of more or less complex algorithms. Mastering a DMI requires the musician to have basic knowledge of these procedures. An intuitive user interface can help building a mental model of this and to manipulate its parameters. Multitouch screens offer the possibility to

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ping manually by pinch gestures. Frequency bands are organized with the two following buttons. The first of them gives access to different (musical) scales (linear, pentatonic, pythagorean, and chromatic), and the second button activates a slider to adjust the activation time of the frequency bands.

2.3.5 Playing TouchNoise

TouchNoise's sound output derives from the particle system. Every particle creates a sine signal. All signals are added and produce the sound of TouchNoise. The distribution of the particles on the playground and the particle system's dynamics define the stereophonic frequency spectrum that is output. When the particles are equally distributed, white noise-like output is generated. When there are only few particles active on the playground, the single sine signals become distinguishable instead of a diffuse noise spectrum. The number of particles and their (initial) distribution can be influenced by the user. Particles can be added and deleted by touch gestures directly on the playground and, thus, they can be placed at explicit positions which allows the definition of an initial distribution and noise shape, respectively.

Another influencing factor on the number of particles is their lifetime. A short lifetime allows the user to create short sonic clusters at only a few frequencies, just like seeding sonic energy. The further behavior of this nest can be determined by advanced motion settings, which control the agility of the particles and the way they spread out over the playground. A vector field defines the direction, flocking keeps the cluster together, Brownian angle and particle speed affect the volatility.

The clustering of particles puts emphasis on certain frequencies and on specific positions in the stereo sound field. Particle accumulations can be induced by flocking, magnetic and drag interaction, and by limiting the area of particle motion. Repellent interaction and accentuations with an accentuation level set to 0 create holes in the spectrum, which also emphasizes the remaining frequencies. The particle system reacts with a continuous behavior to each touch and frequency band interaction. The motion settings specify the pace of reactions. Just as the typical behavior of any instrument, this makes up TouchNoise's peculiarities with which the user can play creatively. TouchNoise's strengths lie in the interplay of the different behavioral possibilities of the particle system and the various interactions. We can only pinpoint some of these productive combinations here to give an impression of the range of possibilities.

Even though the basic sound is noise, TouchNoise can also create tonal spectra. In quantization mode, the frequency domain is discretized to only those frequencies that derive from certain scales. Not all frequency bands have to be set to quantization mode, mixtures of quantized and "glissando" bands are possible, too. The different musical scales reduce the micro tonality of TouchNoise and create various harmonicities and tonalities. Again, the combination with limited particle lifetime and flocking creates musically interesting, very harmonic and even melodious effects.

A very useful combination of direct interaction modes is the drag and magnetic mode combination. Thereby particles are collected by attractive forces and can then be dragged over the playground. The extreme accumulation and the different speed compared to the unaffected particles make the affected particles and the gestures they perform clearly audible. The adjustment of the radii while exerting an effect leads to interesting sonic structures. As an example, adjusting the repel radius leads to new transition sounds, while retreating or coming closer again.

Playing with the priorities of the interactions, that influence the particle motion, is another approach of creating interesting sound effects. Dragging particles out of a magnetic frequency band, and releasing them, leads to the particles heading directly back to the frequency band, i.e. straight glissandi. The particle speed specifies how fast these glissandi are performed. When the same frequency band is also accentuated with a zero accentuation level, the particles disappear at the moment they enter the band.

Interesting sound effects are not only caused by the exertion of the different functions, but also by their termination. Releasing a magnetic touch causes the very narrow sound cluster—which often has a whistling sound—to expand and gradually fade back into an increasingly broad, noisy spectrum. Even though this is conceptually similar to opening a bandpass filter on a noise signal, the momentum of the particle system and the precise sine signals lead to a very unique sound, that cannot be replicated with filters.

Some functions can be used to pass particles to other functions, e.g. dragging, attracting or adding particles to the starting point of a flow path. Particles can also be added to the path by using the MIDI Add mode to create sweep sounds.

Musically very interesting, especially for creating pad sounds, is the assignment of the magnetic function to the MIDI keys. Now "magnetic chords" can be played into a noise spectrum. The noise fades into the tonal sound played, and when the keys are released, back into noise. Again this invites to experi-

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2.5 Summary

With modern technology a new generation of digital musical instruments evolved. Their sound is not directly generated by a physical process, as in case of traditional musical instruments, but it is generated by algorithms. Multitouch screens are one possibility to visualize these algorithms and control them. Various musical applications for mobile devices exist, many of them feature a certain autonomy in their functionality. The degree of interactivity of these instruments varies. Often, a particle system is a key element of these applications. Sometimes, these particle systems are based on flocking behavior.

TouchNoise is a fully-fledged multitouch-driven digital musical instrument. It offers a new interface for noise modulation through the interaction with a particle system. Each particle represents an oscillator that generates a sine signal according to the particle's position on the playground. Its frequency derives from the vertical position, and its position in the stereo sound field from the horizontal position. The sum of all sine signals produces TouchNoise's sound output. The particles feature autonomous behavior according to several principles, including Brownian motion, flocking behavior (align, separate, follow, cohesion) and a flow field. Besides the character of motion, the sound depends on various factors, such as the number and distribution of particles or the frequency mapping (linear, logarithmic, quantized, etc.).

The user can interact directly with the particles by dragging, attracting, repelling, or accentuating them. These functions can also be assigned to frequency bands. Interactions with frequency bands are basically complex operations, but in TouchNoise they are directly accessible and easily executable by bimanual gestures. Several new interface widgets were developed (effect range and toggle widget, the piano bar, flip back panel). The graphical user interface has been designed under consideration of the high priority of each interface element. This layout pays off with faster, more direct, and fluent interaction. The extension of TouchNoise with MIDI controllers represents an additional input modality, which introduces familiar musical concepts to the TouchNoise interface.

During a yearlong series of practical test and demo sessions with TouchNoise, we gained many inspirations for future directions and further development. The aim now is to gain more detailed experience through the cooperation with composers and musicians, who acquire practical and artistic experiences with TouchNoise.

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