A Scanned Synthesis virtual instrument

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Abstract
This paper describes a virtual musical instrument based on the scanned synthesis technique and implemented in Max-Msp. The device is composed of a computer and three gesture sensors. The timbre of the produced sound is rich and changing. The instrument proposes an intuitive and expressive control of the sound thanks to a complex mapping between gesture and sound.

Keywords
Scanned Synthesis, graphics tablet, multi-touch tactile surface, meta-parameters.

INTRODUCTION
We have implemented the Scanned Synthesis in the Max-Msp real-time environment, and linked it to gesture devices. We propose here a concrete example of an instrument based on this technique. We will see how it works, how to use it, and its musical application.

PRINCIPLE AND MAPPING
The Scanned Synthesis was developed by Verplank, Mathews and Shaw [7] and implemented in Csound by Boulanger [4], who has also proposed extensions to the original model [3]. This synthesis technique corresponds to read sounds in a dynamic wave table, thus generating sounds from slow movements of mechanical systems. In our configuration, the dynamical system is a circular string modelled with finite dfferences (simulating a set of masses, springs and dampers). A function scans the string shape according to a frequency that corresponds to the sound fundamental. The scanning function can also receive several frequencies, providing us to play chords. The synthesis model can be represented as on the following figure:

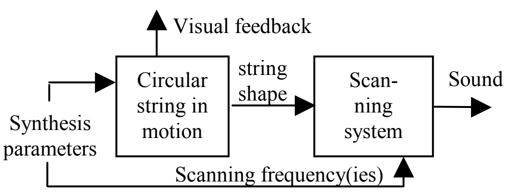

Figure 1. The Scanned synthesis technique: the shape of an object with low-movement is scanned periodically to obtain sounds. The pitch control and the timber control are independents.

The Mapping chain between gesture and sound includes different stages [1]. The gestures are converted in data by the sensors, then the data are transformed to be usable for the program. On the other side, synthesis parameters are controlled by high level parameters called meta-parameters. Those meta-parameters allow controlling a big amount of parameters with a few values. We control here the evolution of pre-established distribution profiles (curves) of the string model parameters with a few parameters. We can also choose which profile we want to use. Finally, simple relations link data from gesture and meta-parameters. This specific mapping provides to create non-uniform parameter distributions and to modify them in real time.

IMPLEMENTATION
The instrument is programmed on a computer. The hardware part of the device consists of three sensors (a graphics tablet [8], a touch surface [6], and a numerical keypad) connected to a Macintosh computer. The sound produced by the computer is connected to an amplifier and speakers. The software part realises the chain between the gesture and the sound in the Max-Msp environment. A C object was developed to realise and control the Scanned Synthesis. This object receives the parameter distributions curves, values to control meta-parameters and pitch. Other objects were created to manage gesture data and to connect them to the meta-parameters of the synthesis model.

CONTROLLING PANEL
The control space consists of three sensors that control several parameters, represented on fig.2:

Figure 2. The Scanned Synthesis instrument. On the right: the graphics tablet. On the left: the touch surface and the numeric keypad. The computer screen gives a visual feedback of the string motion.

The graphics tablet

The tablet is a Wacom Graphire A6 tablet [8]. This sensor outputs the position of the pencil lead on the tablet, the pressure on the lead and the values of two lateral buttons. The pressure is linked to the damping of the string, which is the sound release. The X coordinate represents the string stiffness. This parameter plays on the velocity of the sound timbre variation. The Y coordinate gives us the fundamental frequency of the sound, which is often the pitch. The buttons change the octave of the fundamental frequency. The pitch control is not linear, but the variation range of the tablet is in 12 semitone, and a polynomial function does the transition between the semitones, as was suggested by Kessous [2].

The touch surface sensor

The Tactex MTC Express [6] is a multi-touch surface with 72 pressure sensors dispatched on the surface. The string is represented horizontally on the surface and pressure on it applies forces on the string. The higher part of the surface applies positives forces, the lower one negative forces.

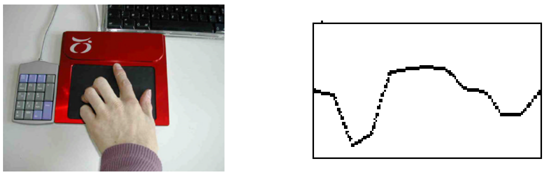

Figure 3. Touch sensor and corresponding force profile along the string. Pressure on the touch sensor applies forces on the string.

The numeric keypad

This pad is used to select a configuration of parameters, among a set of configurations that provide different timbres. We can also choose to play a single note or chords. Finally, the keypad allows starting the sound from an initial pre-definite string shape.

Visual feedback

The computer screen gives us a visual feedback of the string motion, which can be represented in two or three dimensions. This helps the performer to control the sound, because the string motion corresponds to the changes in the timbre.

HOW TO PLAY THE INSTRUMENT?

In order to have sound, the performer must start the sound from a pre-definite position (with the numeric keypad) or press the touch surface. With the last solution, he has to press the pencil lead to allow the string movement. By moving the pencil on the tablet, the pitch (on the Y-axis) and the variation speed of the timbre (on the X-axis) will change. Movements on the touch surface will produce interesting sound variations, which are very close to the gesture intention. If there is no pressure on the Tactex, stop pressing the pencil lead will stop the sound. To instantaneously start a sound, change sound bank or to play chords, the performer should use the numeric keypad.

MUSICAL ASPECT

In the instrument, pitch is controlled by a single gesture and timbre is controlled by numerous gestures: this allows to control efficiently the timbre without be careless about pitch control. The instrument could produce sounds coming from instantaneous excitation gestures, or modulated and/or continuously excited by gestures [5], providing different musical issues. The performer can also change the sound configuration during the performance, and by the way explore others fields of timbre. Though the synthesis method is intrinsically limited to produce pseudo-periodic sounds one can obtain random or perceptively inharmonic sounds.

In interaction with other instruments, our device can be performed independently or connected with other virtual instruments. For example, we have realised a performance with the Scanned Synthesis controlled by a semi-random rhythm generator, where rhythm was applying forces on the string.

CONCLUSION

The present device is one example of instrumental implementation of the Scanned Synthesis object we have developed in Max-Msp. It has been designed with the goal of having a great and intuitive feeling in the control. Therefore, a lot of other mappings with gesture sensors are possible, providing different explorations of the synthesis-sound extended field.

ACKNOWLEDGMENTS

This instrument has been built at the CNRS with the financial help of the “Conseil Général des Bouches du Rhône”.

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