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EXTENDED PERFORMANCE TECHNIQUES FOR A VIRTUAL INSTRUMENT.

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ABSTRACT

In this paper we explore extended techniques for a physical model of a bowed string instrument controlled using the metasaxophone.

1. INTRODUCTION

Physical models of musical instruments are interesting from different perspectives. The scientist, being able to reproduce the sound of a particular instrument, shows that its physics has been understood. The performer can take advantage of the virtual instruments which are usually easier to play then the real one. The composer can take advantage of the computer to create sonorities that cannot be obtained in reality.

In this paper we explore the boundaries of a physical model by abstracting a bowed string physical model from its analog material controller, and implementing this model within another instrumental controller, the metasaxophone.

We focus on different effects that can be obtained through extending the possibilities offered by a physical model of a bowed string instruments through the use of alternate controllers.

2. EXTENDING THE VIRTUAL BOWED STRING

We built a waveguide physical model of a bowed string instrument ([4]), running in real time in Max/MSP ([6]).

The timbral space of the model is controlled using the metasaxophone, a tenor saxophone custom fitted with an on-board computer microprocessor and an array of sensors used to control live electronics.

The virtual bowed string instrument is able to reproduce many of the phenomena that appear in its real counterpart.

We are interested in extending the model, in order to create sonorities that cannot be obtained with a real instrument, and which are interesting from a compositional prospective.

We expanded the physical properties of the strings in order to have the possibility of bowing ”strings” of different materials. Parameters like string diameter, Young’s modulus, tension, length, allow to calculate the amount of inharmonicity of strings, which can be efficiently modeled using allpass filters. Interpolating between different filter’s coefficients allows the performer to perceive the sensation of bowing strings of different materials.

We furthermore modified the frictional properties of the bow string interaction, in order to obtain waveforms that, starting from the well-known Helmholz motion, i.e. the ideal motion of a bowed string, move toward chaotic oscillations.

Another extension consists on accounting for the common structure of nonlinear oscillators. As McIntyre, Schumacher and Woodhouse showed in 1983 ([3]), all self-sustained oscillators can be seen as nonlinear excitations that drive linear resonators. Taking advantage of the common structure of these instruments, we show how the model is able to smoothly move between one instrument to another, interpolating between the characteristics of the resonator and the excitation.

3. THE METASAXOPHONE

In an effort to explore extended techniques of the physical model we perform it with an alternate controller, the metasaxophone ([2]), shown in figure 1.

Figure 1: The metasaxophone

This allows the physical model to be controlled from within a different haptic space – that of a wind instrument. This in turn opens new expressive potentialities of the model.

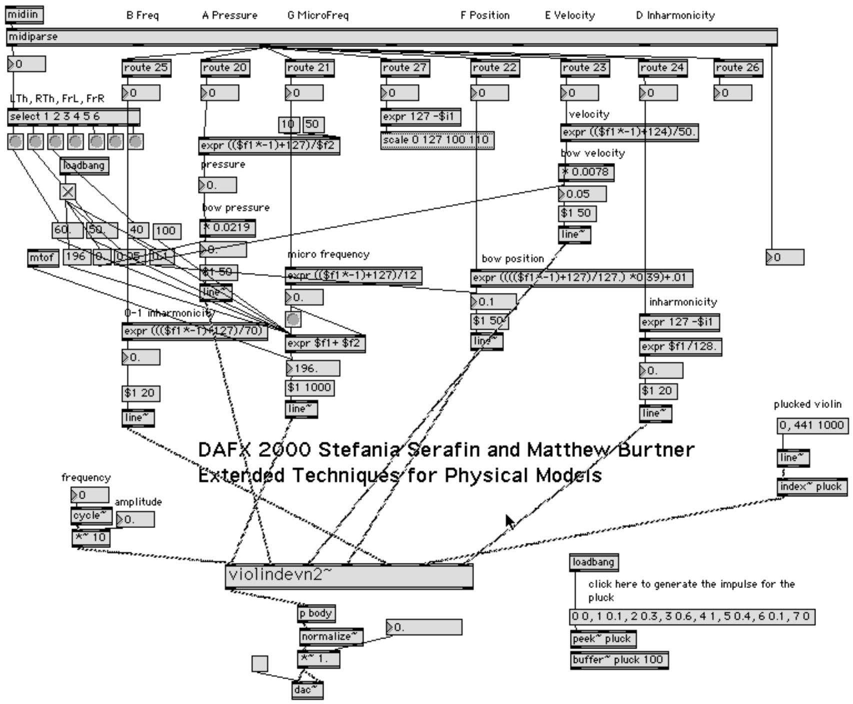

Figure 2: Max/MSP patch that maps the metasax to the inputs of the bowed string model.

The metasaxophone tracks data from eight continuous controller force sensing resistors (FSR), five triggers, and a two dimensional accelerometer chip. The FSRs are located on the front B, A, G, F, E and D keys, and on the two thumb rests. Three triggers are located on the bell of the instrument, and one below each of the thumb rests. The accelerometer chip measures left/right, up/down tilt of the saxophone bell.

The data from these sensors are collected via a 26 pin serial connector by a microcontroller fixed to the bell of the instrument. The computer chip is a Basic Stamp BIISX microprocessor. Analog pressure data from the performer is converted to a digital representation and passed to the Basic Stamp through an RC circuit design. Trim potentiometers calibrate the sensitivity of each circuit. The microprocessor is programmed in PBASIC and the software converts the sensor data into MIDI messages.

The circuit board and a 9 volt battery are fit into a black box with openings for the serial cable inputs, a MIDI output, and a power switch. MIDI messages from the metasaxophone can be sent to any MIDI device and used as control data for live electronics.

In addition to sending MIDI information, the metasaxophone sends an audio signal through a microphone located in its bell. Both MIDI and audio data are sent to some external computer or device for processing. Currently we are using an interactive interface programmed in Max/MSP ([6]).

The continuous controller MIDI messages sent from the metasaxophone are used to control digital signal processing and synthesis algorithms. Similarly, the audio is used as a control signal to alter the function of the MIDI data or to control other sonic parameters. This interactive interface lends itself to circular data constructs – MIDI/audio, saxophone/electronics – because it was the intention for the electronics to function as a clear extension of the performer.

4. MAPPING BETWEEN THE PHYSICAL MODEL AND THE METASAXOPHONE

Continuous controller MIDI messages from the metasaxophone are used to drive the bowed string physical model controlling each parameter of the physical model by degrees of finger pressure performed on the different metasaxophone keys.

We implemented a bowed string physical model as an external extension to the Max/MSP program. The input parameters of the physical model, i.e. bow pressure, bow velocity, bow position, string inharmonicity, frictional properties, center frequency, and microtonal frequency variation are controlled by different sensors on the metasaxophone, as shown in figure 2.

By assigning each finger of the saxophone to a different parameter of the complex bowing action, the bowing is broken into a series of isolated tasks. This creates a reallocation of the parameters of a complex haptic action – the bowing – to another complex action, the fingering of keys. Consequently simple bowing actions such as the convergence of parameters occurring as a bow is drawn across the strings can become difficult to execute, while impossible bowing actions, such as for example dynamically linking the material transformation of the string to decreasing bow velocity, become possible.

The Max/MSP performance interface (see figure 2) allows for communication between the metasaxophone and the violin physical model described as follows.

- MIDI continuous control data is received from the Metasaxophone.

- Data is routed into separate paths and mapped into a new range of values to be sent to the bowed string external object.
- B key controls one type of inharmonicity that is mapped by the expression object into a range of 0-1.81.
- A key controls pressure and is remapped in this example from 0-2.54
- G key controls micro-frequency, in a range of 0-10Hz.
- F key determines bow position (0-0.4)
- E key controls velocity, operating in a range from 0-2.48.
- D key controls inharmonicity in a range from 0-.99
- 5 triggers are programmed to send note-on values that are used to reset
- the center frequency to different values, and to switch between settings

5. PERFORMANCE TECHNIQUES AND SOUND EXAMPLES.

The following examples illustrate ways in which this process is applied by the metasaxophone controller.

In the first example (figure 3), the stroke starts with extreme bow pressure but zero velocity. The bow is then moved quickly across the string and simultaneously the pressure is dropped. The pressure is then increased again and cut off abruptly. During this action, the overtones can be controlled by the degree and cut-off rate of the bow pressure.

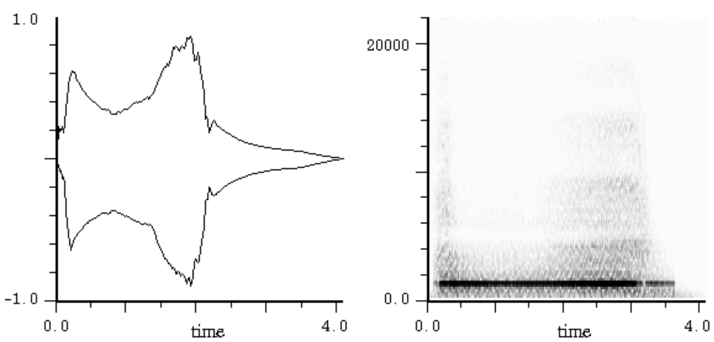

Figure 3: Variation of bow pressure and velocity. Right: time domain representation, left: sonogram.

The second example (figure 4) illustrates a situation that would be impossible on a violin controller but that is idiomatic for the metasax controller. Extreme pressure is applied to the string and a very slow velocity is maintained. But simultaneously, the bow position changes rapidly from a location very near the bridge to a location high on the fingerboard. The rate of oscillation is accelerated steadily.

The third example (figure 5) reveals attempts to isolate the inharmonicity parameter of the string by attempting a regular bowing action while simultaneously changing finger pressure on the D key of the saxophone. The result approximates a case in which the string is transformed from nylon into glass during the bowing. The normal change of inharmonicity causes a drop in frequency,

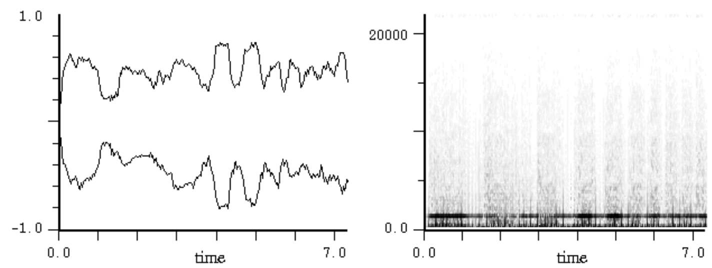

Figure 4: Fast movements from the bridge to the nut. Right: time domain representation, left: sonogram.

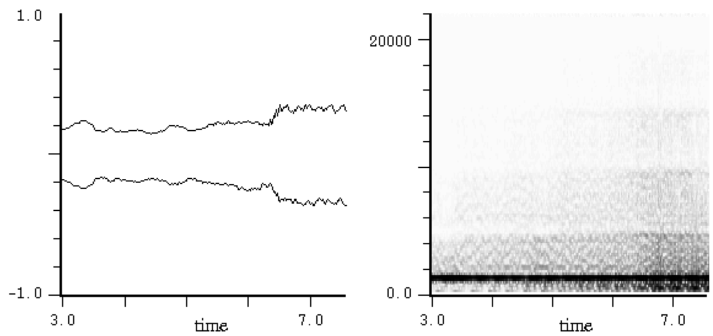

Figure 5: Variation of the inharmonicity of the string.Right: time domain representation, left: sonogram.

and this tendency is compensated for in the example by raising the micro-frequency of the pitch.

The fourth example (figure 6) utilizes transformations of inharmonicity, bow pressure, bow speed, frequency, and micro-frequency. In this example, the complex changes in all parameters are combined in order to present a rich and expressive musical gesture. The example illustrates that extended techniques for physical models can arise naturally from the remapping of performance date from one controller action to another.

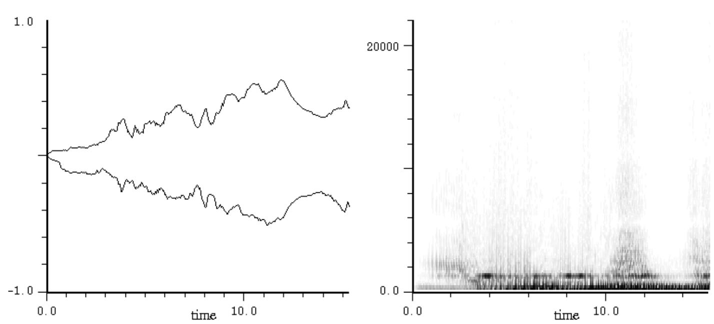

Figure 6: Transformations of different parameters of the string.Right: time domain representation, left: sonogram.

6. CONCLUSIONS

In this paper we explored the integration of an extended violin physical model and metasaxophone alternate controller as a means of opening new possibilities for sound exploration.

Through morphological combinations of this sort we hope to discover a hyper-chamber music, in which the sonic end result is a consequent of the re-mixing of physical model and meta-instrument.

7. REFERENCES

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