Sormina – a new virtual and tangible instrument

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ABSTRACT
This paper describes the Sormina, a new virtual and tangible instrument, which has its origins in both virtual technology and the heritage of traditional instrument design. The motivation behind the project is presented, as well as hardware and software design. Insights gained through collaboration with acoustic musicians are presented, as well as comparison to historical instrument design.

Keywords
Gestural controller, digital musical instrument, usability, music history, design.

1. INTRODUCTION
Sormina is a new musical instrument that has been created as part of a research project in the University of Arts and Design Helsinki, Media Lab. Sormina uses sensors and wireless technology to play music. Its design is guided by traditional instrument building.

In new wireless technology, the instrument loses part of its traditional character. The physical connection between the sounding material and the fingers (or lips) is lost. The material does not guide the design, which puts the designer in a totally new situation with new questions. This study tries to answer these questions by exploring the design of a new instrument that is intended for use in the context of a live symphony orchestra.

The research has started from the concept of the interface, which traditionally is held in hands or put in the mouth. The playing posture of the musician, the delicate controllability of the instrument and the ability to create nuances are considered as the key phenomena of the new design. Visual aesthetic and usability are of equal importance.

Sormina aims to take the musician on a tour to the ancient world, where tools were built to fit the fingers of human beings, and where technology was to serve humanity. The technological tools have changed during centuries, but the idea of music making stays the same. Using the most modern technology for music making does not have to result in underrating our common heritage.

2. MOTIVATION
The motivation for this innovation is the desire to create totally new musical instruments in the context of classical music by using computers and sensors. We are interested in designing digital instruments that could be accepted as part of the standard symphony orchestra. We believe that classical music can benefit from the current developments in digital technology.

The symphony orchestra has been quite stable during the last century, although there have been some experiments using electronics. Sormina aims to encourage the symphony orchestra to develop further to meet the challenges of the digital era. A handheld computer interface is operated very close to the body, which makes the user experience quite intimate. By offering new modes of sensory engagement and intimate interaction, sormina contributes to a change in the digital world, from disembodied, formless, and placeless interaction to materiality and intimacy.

This project participates in a long tradition of similar innovations, starting from the Theremin, which is a rare example of a musical innovation to become part of classical music practise. In addition to Theremin, one of the most influental to the current research has been Rubine and McAvinneys article in Computer Music Journal 1990, where they presented their VideoHarp controller and discussed issues related to its construction [1]. Also Michel Waiswisz and his Hands has been a great inspiration [2]. Recently, Malloch and Wanderley have proposed the Tstick [3]. Important questions concerning parameter mapping have been discussed in Hunt, Wanderley and Paradis [4].

3. CONSTRUCTING THE INSTRUMENT
3.1 Hardware, sensors
Structurally, the Sormina is built using a Wi-microdig analog to digital encoder, a circuit board for the wiring, and 8 potentiometer sensors with custom-made, wooden knobs. The Wi-microDig is a thumb-sized, easily configurable hardware device that encodes up to 8 analog sensor signals to multimedia-industry-compatible messages with high resolution and then transmits these messages wirelessly to a computer in real-time for analysis and/or control purposes [8]. The custom-made circuit board takes care of the wiring. The potentiometers are mounted in the circuit board in an upright position, and the encoder unit is also attached to the circuit board. The knobs of the potentiometers are arranged in a straight line on top of the instrument.

The manufacturer of Wi-microDig promises that the 8 inputs of 10 bits resolution each can sample at up to 1500 Hz with only milliseconds latency [8]. The wireless transmission complies with the Bluetooth v2.0 standard, which is claimed to be a reliable protocol and, at 115, kbs much faster than MIDI speed. The wireless range is guaranteed up to 100 meters without obstructions, since it is a Bluetooth class 1 device. With the prototype there was considerable problems with the connection range. The encoder in question was, however, an older model than Wi-microDig.

The construction of the controller is open: it is not put in a box or cover. With the help of this arrangement, the visual design appears light and spacious. However, the decision to use no cover is subject to change in the forthcoming prototypes, as the openness makes the construction vulnerable to dust and moisture.

The Sormina makes use of 8 potentiometer sensors, which is the maximum number of sensors to be connected to the encoder. The choice between sensors was made on the basis of three main arguments: stability, precision and tangibility. The Wi-microDig encoder comes with only one potentiometer, which did not fit the standards set for the instrument design. The suitable potentiometers were purchased separately.

The first argument for the selection of the sensor type was stability. In order to attain a stable instrument, the sensors also have to provide this characteristic. Stability in this context means a sensor that would preserve its state when not touched. Most of the available sensors are built accoeding to a convention that does not give support to this demand. Potentiometer sensor changes its state only by intentional action. Stability is also required for an instrument in the sense of durability and robustness. Potentiometers proved to be stable also in this sense.

Figure 1. Sormina is a virtual instrument with wooden knobs

3.2 Software

The software for Sormina has been programmed using Max/MSP and Reaktor. It consists of three parts: one handles the communication with the encoder through bluetooth, the second takes care of the user interface, and the third produces the sound. In addition, external software, Sibelius, was used for the notation.

The Wi-minidig comes with its own software, which actually is not used in this project. This software is meant to take care of the bluetooth connection and let the user decide the interpretation of the sensor data, which is then sent forward as MIDI information. In addition to this rather laborious software, the company alsso offers on the web site for the same purpose a Max/MSP patch, which proved to be handier for the purpose of the project. The wi-microdig patch for Max/MSP appeared to handle the communication through bluetooth with the encoder quite reliably. The Max/MSP programming environment was also favored for its usefulness in other parts of the project.

The wi-microdig patch outputs the sensor data as 7-bit information, which was found to be sufficient for the purpose of the project. According to the tests made, it was not possible to produce any larger resolution with the finger movements using the small potentiometer knobs of Sormina.

A visual user interface was programmed using Max/MSP, which also handles the connection to the encoder. One purpose of the interface is to give the musician visual cues in controlling the instrument. This proved to be beneficial especially in the learning phase. In addition to the feel in the fingertip, it was helpful to see the state of all the sensors at one glimpse on the screen.

The visual interface comprises sliders, number boxes, and basic notations for the sensor input. At the same time the interface is capable of recording a control sequence, which was found useful for learning to play the instrument. While the recorded sequence is playing back, the visual information about the state of the sensors is shown on the interface.

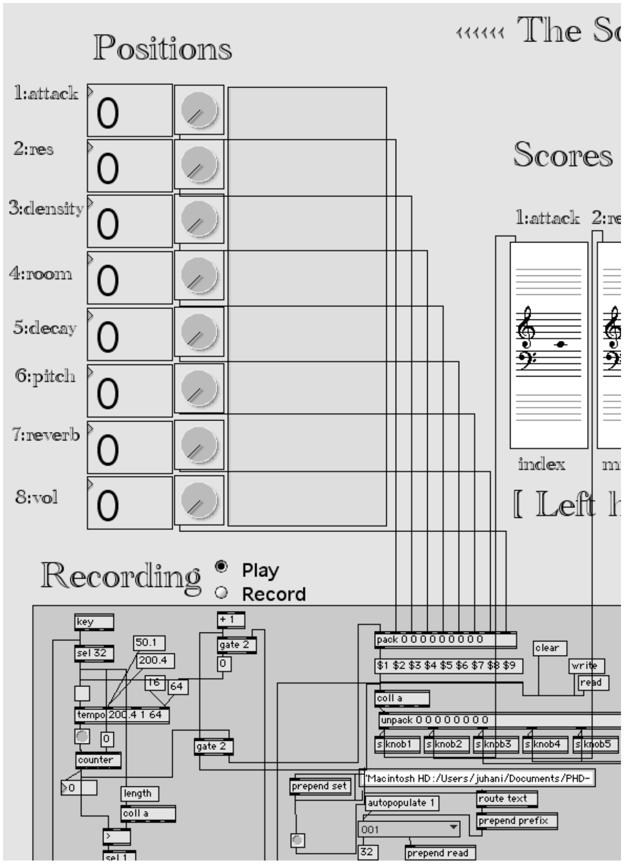

Figure 2. Part of the visual interfafe

The sound is created using a sound synthesis patch created for the Reaktor software. The patch allows the control of several features of sound synthesis. The mapping of the sensors to the sound synthesis software appeared to be of crucial importance.

Mainly due to the capabilities of the encoder, it was decided that there should be 8 sensors. Nevertheless, it was found to be a very useful restriction. It was assumed that a human being cannot handle too many controls at the same time. Too many options could result in indeterminacy. Also, with 8 sensors, nearly all of the fingers could still be utilized for controlling purposes.

The Reaktor software was chosen as the sound engine for the project, although the use of two different pieces of software instead of only one has its drawbacks. Reaktor was found to be more amenable than Max/MSP for the purposes of this project.

The sound synthesis patch in Reaktor comprises a 96-voiced noise generator with filters and reverb. The patch has 26 controls for mapping but because of the restrictions of the hardware, only some of them were possible to choose. One solution for the mapping problem could have been to use one sensor for several controls on the sound software but it was found that this would be unwise on a large scale, although some sensors are connect to two parameters.

3.3 Notation

One important part of the new instrument design was the attempt to notate the music created with the Sormina. It was challenging to put up a link with Max/MSP and notation software for notating eight parameters in the same score.

The Sibelius software was chosen for this purpose. The note heads were changed to triangles in order to distinguish them from normal pitched notes. A number was added near the note head to be more precise.

Figure 3. Notation of the parameters of the Sormina

4. IN PERFORMANCE

Much of the development of the Sormina has been conducted through collaborations with other musicians. The sound synthesis software and especially the mapping of the parameters has been open to change, so the insights of other performers has been welcome. Still, for the purpose of creating a stable instrument, it would have been preferable to fix the mapping at a very early stage of development. This conflict has been one of the most challenging features of the project.

The sound created by the Sormina seems to fit quite well with string instruments, especially the cello. The reason for this fact was considered to be the use of noise generators as the main sound source. The sound of acoustic instruments has many characteristics of white noise. Singing voices showed a similar resemblance to the Sormina sound, also.

4.1 Concerts

There have been several public concerts during the first year of the instrument's existence. In addition, the Sormina has been presented to researchers and students, and in seminars. The first concert, in November 2006, was given with the cellist Juho Laitinen and soprano Tuuli Lindeberg. In November 2007 the Sormina was played with the chamber choir Kampin Laulu. The last performances of 2007 were in December in Los Angeles, where the instrument was being presented for the art students in the California Institute for the Arts, Calarts. Two concerts were also given in art galleries and jazz cafes in the area.

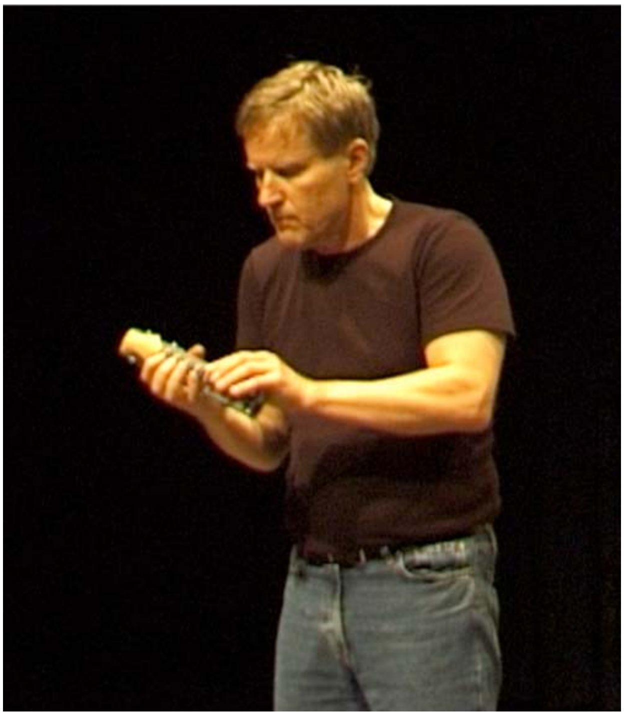

Figure 4. The author playing the Sormina in a concert

5. DISCUSSION

The aim of the Sormina project was to explore the main principles of the instruments in classical music, from the musician's point of view, and with these findings to create a new, stable electronic music instrument that could be accepted in a symphony orchestra. The results suggested the importance of three layers in the design of new instruments. The first layer is the sound-synthesis that defines the audible response. The second is the mapping of the gestures to the sound parameters, which constitutes the instrument in a conceptual manner to the musician. The third layer, often overlooked in the creation of new digital music instruments, DMIs, is the materiality and usability layer of the controller.

Much weight in the research has been put to the human hand and its capabilities. The author has followed Curt Sachs' findings about the hands and feet being the first intstruments [5], and Malcolm McCullough, as he praises our hands as a best source of personal knowledge [6]. A remarkable source for understanding the importance of music playing has been Tellef Kvifte, who formulates a classification of instruments using playing techniques, not based on the way the musical sound is produced [7].

The Sormina research suggests that the touch and feel of the interface is important to take into account when designing new instruments. The musician uses subtle, almost intuitive and unconscious movements of her body. The fingers, for example, have developed through evolution to take care of the most sophisticated and precise actions. Therefore it is reasonable to use the fingers for playing music. In the culture of the human being, the fingers have been crucial for surviving. Even today, they are used extensively, to express our thoughts, by writing with a pen or a computer.

In the course of history, traditional instruments have matured to be well adapted to the human body. Their long evolution has given them power to survive even in the era of computers. Through careful examination of their principles, it is possible to learn from their pattern and use the results in the design of totally new electronic instruments. In the present research, the role of the physical interface has been found to be fundamental for such a design. It appears that attention should be paid to the physical appearance of the instruments in order to build stable instruments.

Sormina aims to be more than a controller. As Rubin and McAvinney formulate, a musical instrument may be thought of as a device that maps gestural parameters to sound control parameters and then maps the sound control parameters to sound [1]. By binding together a fixed set of sensors with a stable sound source, we have developed Sormina into an instrument, not a controller.

Sormina attempts to be engaging to new musicians, but also rewarding for the professionals. Based on the current evidence, these goals have been reached to a large extent.

The Sormina has been played in concert situations, both solo and with acoustic musicians. Playing with an acoustic cello has been rewarding, but an a cappella choir also made a good combination with the electronic sounds of the Sormina.

The experience of concerts with acoustic instruments and singers point out that the sound quality and playing techniques of Sormina are well adaptable to classical music orchestra. The possibility to notate the playing brings another useful characteristic for use with a symphony orchestra.

6. FUTURE DIRECTION

The current research has used the observation of traditional musical instruments and their user experience for the design of a new electronic music instrument. Still, the scope of the exploration has been narrow, concentrating primarily on the author's experience of acoustic instruments. In the future, a more systematic inquiry will be accomplished, where professional musicians will be observed and interviewed about their playing habits. Also, perceiving the learning process in the study of classical music instruments can reveal qualities that could then assist in new instrument design.

One direction in the development of the instrument is to combine the sound output with a live visual output. This is especially attractive because of the readiness of Max/MSP/Jitter to process and produce video and other moving image. Using the same parameters in video processing brings up interesting questions about the connection between auditory and visual sensory systems.

To enhance the usability of the instrument, its robustness needs more attention. Also, in order to compete with traditional instruments, the Sormina should be developed more in the direction of a consumer product.

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