Notesaaz: a new controller and performance idiom

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ABSTRACT
Notesaaz is both a new physical interface meant for musical performance and a proposal for a three-stage process where the controller is used to navigate within a graphical score that on its turn controls the sound generation. It can be seen as a dynamic and understandable way of using dynamic mapping between the sensor input and the sound generation. Furthermore by presenting the graphical score to both the performer and the audience a new engagement of the audience can be established.

Keywords
musical instrument, custom controller, gestural input, dynamic score

1. INTRODUCTION
For most acoustical instruments we cannot make a separation between the interface that is played to generate and control the sound and the resulting sound production. Custom sensor based controllers break with this intrinsic relation resulting in two main differences. First of all the natural complexity of the interface is reduced to sensors which register often only a part of a physical action. Secondly it becomes possible to program relationships between the sensed input and the resulting synthesized sound that would never be possible with instruments where the sound production is inseparable from the interface.
A sensor based musical instrument is often described as a system in which the sensor data gets mapped to parameters of the sound synthesis. Notesaaz places a system in between the two. The data of the interface is used to control two sets of lines that intersect each other and together describe a graphical score. The intersections of the lines control the synthesized sound. This leads to an instrument where the player not only interacts with the physical interface and the sounding result but also with the dynamic graphical score.

2. SIMILAR WORKS
In the field of handheld controllers, the T-stick[1] and the Sonic Banana [2] can be mentioned as similar works. However their similarity is limited to the physical aspects of the controller and does not include sensing methods or mapping strategies. Comparing Notesaaz to Sonic Banana, some similarity can be found in the range of hand gestures that are addressed in both controllers. According to Bongers [3], in most of musical interfaces, including the above-mentioned examples, the active haptic perception is the main sense that is applied in interaction between the performer and the instrument. Notesaaz as a multimodal interface gives feedback and feed forward through the combination of the gestures made with the handheld controller and the visual response of the dynamic score, addressing both visual and haptic senses of the performer.
As a related work, Reactable [5] can be mentioned, where geometric relationships between tangible objects on a tabletop are used to control parameters of electronic sound generation. The Reactable can also be accompanied by a projected visual aid on the tabletop interface. However the projected image has a reactive nature rather than an interactive one.
Among interfaces for sound generation that incorporate visual feedback through dynamic scores, Yellowtail [4] can be mentioned, which is an interactive environment for audiovisual synthesis. However, because of its limitations in input device and sound-image mapping, Yellowtail seems far from being an instrument. Nevertheless, Levin's approach towards dynamic score in form of moving agents and having sound as the result of collisions between two entities are remarkable aspects of Yellowtail, which were inspirational in making Notesaaz.

3. WHAT IS NOTESAAZ?
Notesaaz consists of a physical interface, a dynamic graphical score that is controlled by the physical interface, and sound generation software that is triggered and controlled by the score (Figure 1).
The name Notesaaz is made up of two words: Note meaning the musical score, and "saaz", a Persian word that stands for the suffix "-maker", and also means (any) musical instrument. The combination of the two words means the score-maker, or the score instrument.

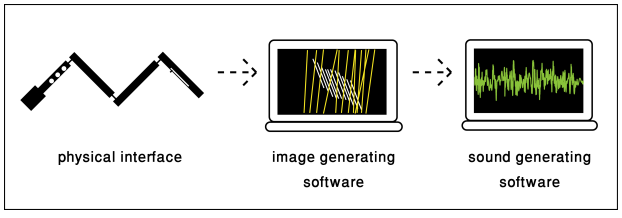

Figure 1. Scheme of Notesaaz

3.1 The physical controller
While exploring the gestural possibilities of our hands and fingers we started to experiment with ways to measure the positional relationships between our hands in three-dimensional

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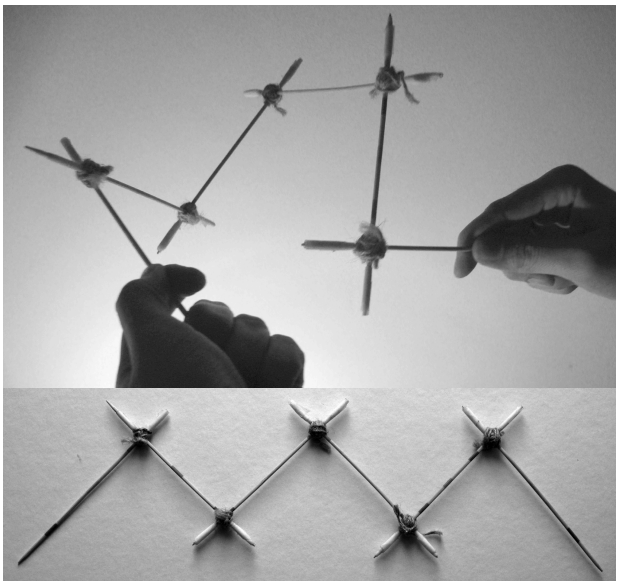

Figure 2. prototype with interconnected sticks

space. This led to proposal for a system of interconnected sticks that can rotate around one another in a perpendicular plane (Figure 2). The result is a system that allows a big freedom of movement and while being aware of the possibilities and limitations of the movements through the feeling of resistance and, if needed, looking at the interface.

The physical interface is a three dimensional controller with a size designed to be used by the both hands of a single performer. It is made out of four segments of PVC pipe. The segments are interconnected with each other in such a way that the next segment has an angle that is perpendicular to the previous segment. The segments have an axis inside of them and it's this axis that connects a segment to the next one. The segments can therefore rotate around each other in a plane that is perpendicular to the direction of the previous segment. The axis inside a segment is equipped with a rotary potentiometer in order to measure the rotation angle of each junction at any moment in time (Figure 3). Simultaneous rotation of the four segments allows one to hold the two ends of the interface, each end in another hand, and completely reshape it with a single gesture (Figure 4). Besides this a number of buttons and knobs are placed on both ends of the interface, which allow control over more parameters using fingers.

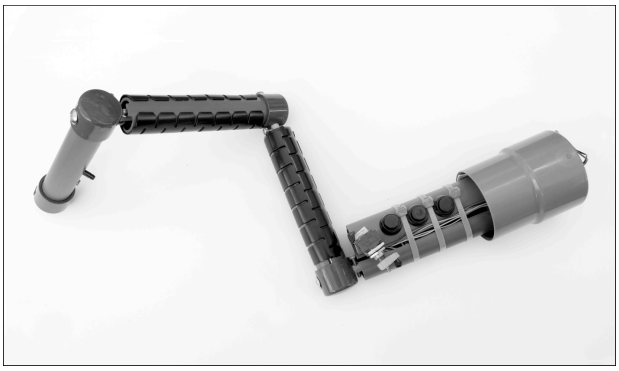

Figure 3. The physical controller

The three dimensional space between the hands has often been of interest for musicians. Different interfaces have been developed to explore this area. The Hands [6] by Michel Waisvisz is a fine example of such interfaces where the distance of the two hands is measured with sensors, giving a spatial understanding of the gestural possibilities of the instrument, yet limiting measurement of the trajectories to the linear parameter of distance; whereas in Notesaaz adding a three dimensional object with multi-parametric modification properties gives more freedom of movement within the same space. Each rotation axis on the physical controller of Notesaaz adds one dimension to the trajectories possible within the three dimensional space, offering a rich space for exploration.

Figure 4. Notesaaz in hands

3.2 The Dynamic Score

The dynamic score is created by using two sets of lines. The length, angle, and spacing of the first set of lines are directly controlled by the values of the angular potentiometers within the individual sections of the interface. The second set of lines has a more static character with patterns that can be modified by the buttons on the interface. This second set is 'played' by the first set of lines. The intersection points of the two sets of lines are continuously being detected, followed and translated into parameters that trigger and control the generated sound. The lines within the first set (which we call actuators) copy each other's movement independently from their mutual spacing. The speed of copying can be anything between immediate and a number of seconds, and result in surprisingly complex patterns. By controlling and interacting with the geometrical arrangement of the lines on the screen, Notesaaz allows complex control over multiple sound parameters using a small number of input parameters (figure 5).

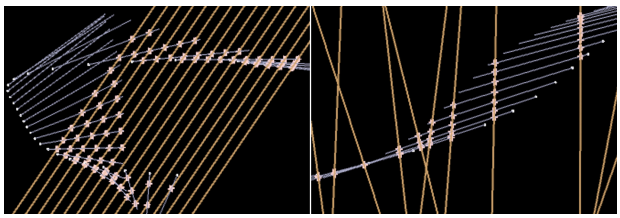

Figure 5. Screenshots from the dynamic score

As a musical interface, Notesaaz deals with the issue of representing and controlling events in time. In the dynamic score, the movement of the actuators and their behavior embodies time. A one to one relationship is maintained between the visual events and their translation into sound. Although the approach of the instrument is very different to playing an acoustic instrument it has a responsiveness and liveliness that is nevertheless comparable. Direct response in combination with gradual modifications in the geometry of the score make it possible to look at present sonic events, while providing an overview of future possibilities.

In graphical sequencers such as Iannix [7], events are represented by moving agents on a screen, while their movement happens in a loop that is modifiable by certain parameters. The score in Notesaaz on the other hand is not based on loops, but on a direct response to the movements of the controller. Therefor in order to repeat a certain sound, one must make exactly the same gesture(s) with the controller. This makes interaction with Notesaaz an experience that is closer to

a musical instrument in the traditional sense rather than that of electronic music.

3.3 The Sound Control and Generation

Notesaaz uses two sets of lines that form readable graphic elements. Complexity arises from the intersection patterns of these lines, either static or in motion. As mentioned earlier, each intersection between the two types of lines in the score creates one sound instance that follows the movement of the intersection point continuously. Each sound instance consists of a set of harmonics around a formant frequency related to a given fundamental frequency. The x coordinate of the intersection point is mapped to the fundamental frequency of the synthesized sound. It is distributed logarithmically on the x-axis of the screen giving lower pitches on the left and higher ones on the right hand side of the screen. The y coordinate of the intersection point determines the formant frequency of that sound. Moreover, the bandwidth of the formant is assigned relative to the position of the intersection point on the actuator. Finally, each actuator has an index that determines the stereo panning of the sound instance, and distributes the generated sound accordingly between the left and right speakers.

The use of a consistent mapping between the points and the sound parameters offers an easy to understand relation between the visual score and the sounding result. Nevertheless the diversity of situations yielded by the geometry brings a wide range of sounds from consonant and dissonant (microtonal) clusters to more noisy sounds, drones and glissandi.

4. EXPERIENCING NOTESAAZ

Interacting with Notesaaz is simple to understand and learn, while playing with it as a musical instrument requires practice. It offers the possibility to compose using the scores or to be surprised by improvising with gestures that result in complex yet readable outcomes.

It is critical for the performer to look at the visual outcome of the interface in order to be able to play the instrument. The audience gets an insight in the performer's actions and possible thought processes by observing the projected dynamic notation. By sharing this thought process visually, an extended form of communication with the audience can be established.

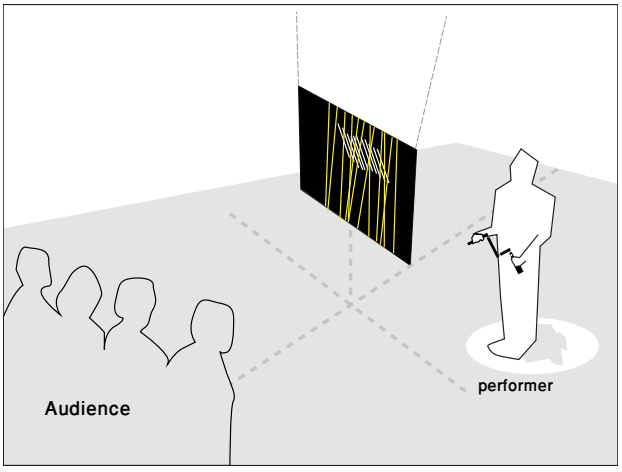

Figure 6. Scheme of presentation setup

5. CONCLUSION

Notesaaz offers a clear alternative for the traditional mapping of sensor data to synthesis parameters. It does so by using an intuitive three-dimensional controller to control a set of lines within a two-dimensional graphical space. These lines intersect with a second set of lines with a more static nature and lead to a complex set of intersection points. Navigating through this space is rather intuitive. The absolute and relative positions of the intersection points are used for the sound generation. This graphical system can be seen as the interpretation and translation of the sensor data that is intentionally made visible. When the second set of lines is completely static one can say that the interpretation and translation are static too. However when this set of lines moves or changes position the interpretation and translation leads to other sonic events simply because the intersection points that were repeatable have changed position. This can be seen as a simple and dynamic form of interpretation and translation of the sensor data.

Notesaaz suggests an alternative way for designing electronic music instruments that creates a new level of engagement for the performer, and shows new possibilities for staging the performer-instrument relationship in live electronic performances. By showing the graphical system to both the performer and the audience, the audience is invited to engage themselves more in what is played and to anticipate on what happens next.

6. ACKNOWLEDGMENTS

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7. REFERENCES

[1] Malloch J., Wanderley M.,"The TStick: From Musical Interface to Musical Instrument", NIME07 proceedings, 2007.

[2] Singer E., "Sonic Banana: A Novel Bend-Sensor-Based MIDI Controller", NIME03 proceedings, 2003.

[3] Bongers, B. "Physical Interaction in Electronic Arts". Chapter for the IRCAM book and CDROM "Trends in Gestural Control of Music", submitted, January 2000.

[4] Levin G., "Painterly Interfaces for Audiovisual Performance", 2000 MIT Media Laboratory M.S. thesis.

[5] Jorda S. et al, "The reacTable: Exploring the Synergy between Live Music Performance and Tabletop Tangible Interfaces", TEI '07 Proceedings of the 1st international conference on Tangible and embedded interaction

[6] Waisvisz, M. "The hands, a set of remote midi-controllers." Proceedings of the International Computer Music Conference, San Francisco, CA: International Computer Music Association. 1985.

[7] www.iannix.org

8. Appendices may follow the references

A video demonstration of Notesaaz can be found at the following address:
http://www.youtube.com/watch?v=DF-3o_DEiNw