TOASTER and KROONDE: High-Resolution and High-Speed Real-time Sensor Interfaces

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ABSTRACT
High capacity of transmission lines (Ethernet in particular) is much higher than what imposed by MIDI today. So it is possible to use capturing interfaces with high-speed and high-resolution, thanks to the OSC protocol, for musical synthesis (either in real-time or non real-time). These new interfaces offer many advantages, not only in the area of musical composition with use of sensors but also in live and interactive performances. In this manner, the processes of calibration and signal processing are delocalized on a personal computer and augments possibilities of processing. In this demo, we present two hardware interfaces developed in La kitchen with corresponding processing to achieve a high-resolution, high-speed sensor processing for musical applications.

Keywords
Interface, Sensors, Calibration, Precision, OSC, Pure Data, Max/MSP.

1. INTRODUCTION
The Open Sound Control (OSC) [1] offers a much faster and more powerful alternative to the MIDI protocol which permits communication between two platforms either on two computers or an outside interface and computer.

This protocol is based on a high-speed communication line (10Mbytes per second for an Ethernet connection and our interfaces while MIDI functions at a rate of approximately 32Kbits per second). Moreover, it has a flexible architecture which allows transmission of different data formats.

Usage of this protocol permits realization of interfaces with a rate and resolution much higher than equivalent MIDI interfaces. Besides the precision and rapidity, these new interfaces would change the traditional means of dealing with interfaces notably in the calibration phase and signal processing.

The approach of La Kitchen consist of doing no pre-processing of information in the interface: Data from the sensors are sent permanently with a constant rate and all processing (calibration, filtering, etc.) is done through platforms such as Pure Data and Max/MSP.

Although most interfaces and controllers are using MIDI protocol, there exist several similar approaches which can be browsed together with their bibliographies in [4].

2. INTERFACES
Using high-speed transmission lines, we would not encounter any problem of data saturation which is common with MIDI interfaces: many interfaces and computers can communicate on the same line without the limitation of line capacity.

The musical control precision depends particularly on the sampling resolution and its speed. With a precision of 16 bits we are able to code audio frequencies of around 0.001 of a tone, which is less than 0.05Hz between the note 'A' and the nearest note.

Here, we describe and demonstrate two such interfaces developed at La kitchen which has been used and tested in several interactive music and dance performances:

2.1 KROONDE
Kroonde is a wireless interface which allows high-speed and high-resolution transmission of a sensor network towards a computer using a high-speed Ethernet cable. Each sensor is sampled in an order of 10 bits and is transmitted to the main box through a wireless connection which is routed to Pure Data or a similar application. The sending rate is 200Hz (equivalent of one sample per 5ms) and it accepts a maximum of 16 sensor entries at the same time.

2.2 TOASTER
In the Toaster, sensor inputs are transmitted directly from the interface with a more precise sampling of 16 bit for each sensor input and the same rate of 200Hz and a maximum input of 16 parameters at the same time.

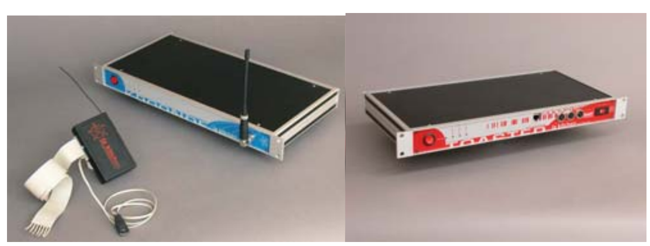

Figure 1. Kroonde (left) and Toaster (right) interfaces

3. APPLICATION

In this demo article, we do not tend to describe the direct artistic aspects of these applications but rather characteristics which make these interfaces desirable for artistic applications.

3.1 Spatial Resolution

3.1.1 Calibration

Using sensors with MIDI, the precision can be very low and the goal is to exploit this precision to a maximum. This will not be the case for interfaces with higher resolutions. So it is possible to amplify the signal, while loosing some precision, but keeping an acceptable resolution. In this manner, calibration of sensors can be undertaken after the digital conversion, that is on the computer.

Concerning a network of sensors, their response can vary significantly as a function of their exact position (as an example on human body) and of their placement. Moreover, in an interactive installation, the response of sensors can change significantly as a function of time at work and also variation of temperature and humidity. All these factors modify the sensor response but do not forcibly make it unusable.

With a dynamic calibration we can obtain responses which lies in the desired domain at all times even with a significant change in the output of the sensor. This operation is implemented by considering the maximum and minimum of the sensor output in an evolutionary manner. Figure 2 shows on the left, the response of a shock sensor as the temperature varies and on the right, the same output after calibration. Note that this dynamic calibration is done in real-time.

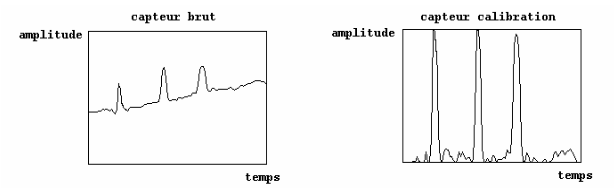

Figure 2. A sensor output before (left) and after (right) calibration

3.1.2 Sensitivity

High-resolution of the interface allows high sensitivity to the change behavior of the sensors. For example, for a percussionist with a sensor on the beater, a bounce can be sensed with a high precision even on the very last hits. Figure 3 shows a recording session of a bounce with the mentioned interface. It is worthy to mention that the sensor is also sensitive to the movement of the percussionist before the hit. Figure 4 demonstrates a gesture recording of a flam.

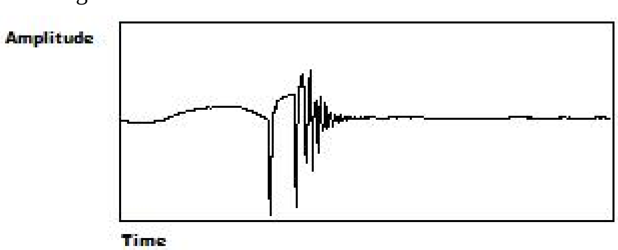

Figure 3. A bounce on the percussion and all the following hits.

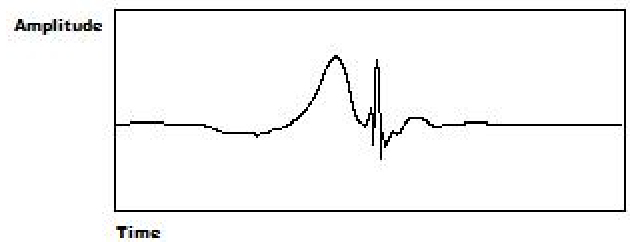

Figure 4. Pre-gesture, hit and return of the beater

3.2 Time Resolution

3.2.1 Filtering

The high and constant time-resolution of the interface allows easy processing of data without adding any latency. In this manner, filtering the data becomes very easy.

3.2.2 Latency

The time resolution of such interfaces allows very precise interactions.

Using an acceptable computing power, a global chain of interaction between the sensors and synthesized or controlled sound can be constructed with a response rate of less than 10ms. In this manner we can arrive near the ear's threshold of hearing even for percussive sounds.

In this manner, it would be also possible to have electronic sound before the acoustic sound by analyzing the data before the attack.

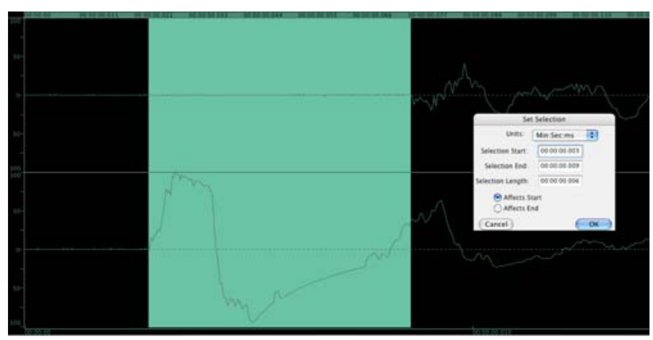

Figure 5. Electronic sound generation before the acoustic sound – Analysis session.

4. REFERENCES

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