Sensors, Interactive Music and E- Learning: New possibilities and usage in daily musical instrument playing, performing and teaching in an open e-learning environment

TOBIAS GROßHAUSER, RALPH TRAUTNER

ReactiveS Sensor Research Lab, University of Applied Sciences Regensburg
IRCAM, Centré Pompidou, Paris

Tobias@Grosshauser.de, Trautner@Sonarlabs.de

Abstract: The Idea of the following project is a combination of music, interactive parts in audio and score, sensor data and a LINUX based e-learning envirenment like moodle.

As it is more and more expensive for many people to get good and advanced teaching in music, e-learning and online support gets more and more important.

Also objective data of useful sensors show new possibilities to get feedback from personalized knowledge databases.

Free access to most of the knowledge is very important to keep this culture of instrumental music playing alive and supporting as many people as possible, even with small financial skills or 3rd world.

The basic skills are from producing simple music with free tools up to learning instrumental skills, even with bad and cheap instruments, but useful and productive feedback.

Interactive music and scores show a simple way to teach and learn skills "on the play", recognising problems by playing, not by theory or only a teacher is watching.

The sensors also show new ways of playing music and new possibilities in composing music of different styles.

Key-Words: E- Learning, Sensor Array, Standalone Hardware, Musical Instruments, Teaching, Performance, Data Alignment, Technology Enhanced Pedagogy.

1 Introduction

Methods, technics and expression in playing and teaching musical instruments means a lot of analysing of gesture, posture, pressure and movement of several parts of the human body.

For many of these parameters, an interactive score based e- learning System provides a possibility to record and show most of the significant Data. This new possibilities of analysing and recording datasets of audio and sensors will show new ways in technology based pedagogy and even more important: Extended instruments, to create unheard and up to now yet unplayable music.

2 Sensors

Practical experiments show a huge range of new ways to teach, practice and perform with violin, viola, cello, guitar, piano, base and double base. There are used several magnetic field sensors, pressure sensors, position tracking and bending sensors. The following setup records and aligns data to the audio file and the score, making the everyday use simple for musicians, from beginners to professionals.

The developed sensor system aims at the following claims:

- cheap and stable
- easy to use, very low weight
- easy to install and fix on instruments or human body
- no influence on gestures and movements of the musicians or other users
- valuable for pedagogical use and artistic expression
- establish a basis for extended musical playing technics and musical expression
- new simple to use and cheap instruments for beginners and children
- new possibilities for advanced research on musical expression in combination with professional artists in everyday concert situations
- usable with and without computer

- reliable and stable, especially in live performances
- every parameter can be detected autonomous

2.1 Problem of Sensor Data in Music

Sensor data in music often are used for extending the possibilities of exiting instruments. But the measurement configurations are not yet useful for everyday usage. The above mentioned claims are not yet deployed or only used partly. The suggested hardware allows simple plug and play usage and common stereo jacks to connect different types of sensors.

Poepel shows a summarisation of the extended violins, playing with ASDSS sounds, playing with expanded existing instruments and playing with new gestures [1]. Askenfelt already measures bow motion and force with custom electronic devices [2]. A thin resistor wire is among the bow hairs to get position data and bow bridge distance with electrified strings. Paradiso uses the first wireless measurement system, two oscillators on the bow and an antenna combined with a receiver [3]. Also pressure of the forefinger and between the hair and wood. Young received pressure data from a foil strain placed in the middle of the bow [4]. Democron attaches accelerometers to the bow and measures the complete pressure of the bow with sensors connected to the bow hair [5].

Maestre presents a gesture tracking system based on a commercial EMF device [5]. One Sensor is clued on the bottom near the neck of the violin, a second one on the bow. Data of position, pressure by deforming the bow and relating data to this capturing can be calculated. A lot more systems exist, but mostly combined with a camera, which does not seem to be stable and reliable enough for performances.

A different approach is developed at IRCAM by Bevilaqua [6]. The sensing capabilities are added to the bow and measure the bow acceleration in realtime. A software based recognition system detects different bowing styles.

Guaus measures the bow pressure over all [7]. Sensors are fixed on the hairs of the bow on the tip and the frog. This means additional weight on the tip, which could influence professional violin playing, because of the leverage effect.

For the practical everyday use, no easy to use, modular and integrated system exists. This was the aim of the following described research.

2.2 Example Application

The system allows sensing relevant data from all stringed instruments, even partly from keyboard instruments and wind instruments. The basic set up and elaborated data in the following description are from violin. Because of the simplicity of the sensors, offline use is possible, because no complicated calculations have to be done. This means simple use in rough performance situation, even with or without computer, directly connected to computer hardware.

2.2.1 Sensor Set Up

The following set of sensors are used independently:

- ReactiveS high frequency EMF sensor for bow- bridge distance (Violin, Bas, Cello) Plugged on the strings behind the bridge like a damper
- ReactiveS high frequency EMF sensor for bow Position (Violin, Bas, Cello)

  Small box on the right arm, worn like a watch
- pressure sensitive foils on the frog, detecting the pressure of the finger (Violin, Bas, Cello)

  Plugged on the bow with two snatchers
- Pressure Sensor for both hands (Piano)
- pressure sensor foils on the chin and shoulder rest (Violin)

  Plugged on the chin and shoulder rest with 2 snatchers, each
- inclination sensor for bow rotation at the frog (Violin, Bas, Cello)

  Plugged on the end of the bow with hoog-and- loop fastener
- ReactiveS high frequency EMF sensor for right hand movement and position (Guitare)
- ReactiveS position and movement sensors (Drums)

Every sensor acts alone. This implies two advantages. First, only the sensor, which data are needed has to be plugged to the violin. Second, no additional calculations have to be done. They are sending the data autonomously to a small hardware, where several data formats can be calculated. The output can be connected to a computer for recording, calculation, analysing etc. or directly to MIDI or DMX Hardware like synthesizers or mixing consoles. No calibration has to be done. Usage of an existing wireless data transmission would round up the set up, but the radio transmitter would need batteries, which makes the system less reliable and too heavy for a unhindered playing.

2.2.2 The Connector Box

In the connector box, all sensor data are recorded or sent in common file formats to peripherals. This enables the user to simple plug in the output of the box to a synthesizer, mixer console or a computer. Even more, a recording function allows to record the data of the connected sensors during a performance, rehearsal or practicing. A switching matrix allows to change between different MIDI settings. This settings like channel and function of each sensor input is programmed on a PC with a software tool and saved in the connector box. MIDI channels and functions are changed with the switching matrix. This allows a fast and autonomous use of different settings, often needed in performances, regardless of any computers.

2.2.3 Example for Pressure Sensing

The systems for bow pressure sensing mostly are related to the complete transmitted force. The method described here enables the user to measure the force of every finger of the right hand. So the behaviour of each finger is shown in fig. 2 and the position of each sensor in Fig. 1. Fig. 1 also shows the change of the pressure of each finger during a detache stroke. The summation of the data relies directly to the force transmitted to the bow.

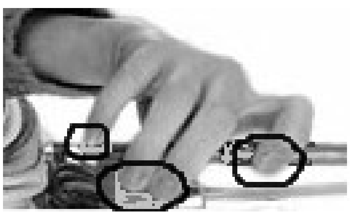

Fig. 1

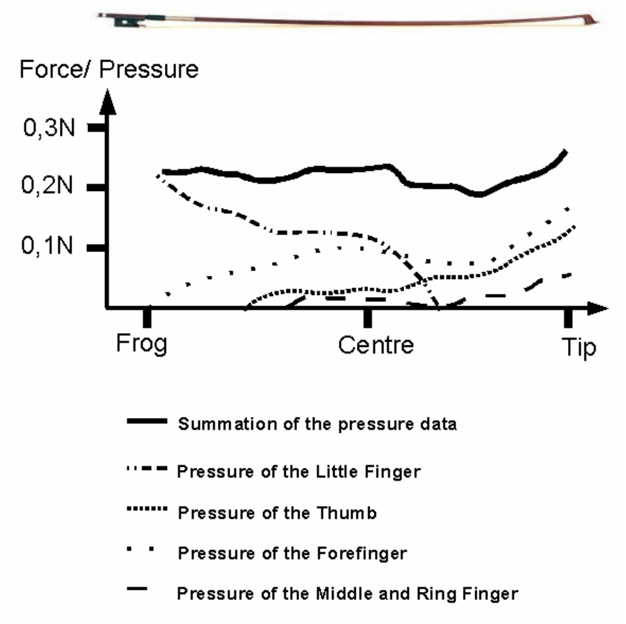

Fig. 2

The force of the Middle and Ring Finger could be used to switch for example sounds of a MIDI synthesizer, because the effect to the pressure is quite negligible. As all measurements are in real time and affect more or less the sound while playing, some data can be used to control additional parameters. This are music related ones like sounds, effects or spatialisation or non music related like light show or illumination. New parameters for composition are simple available and extended pieces like in the Hyperbow project are possible [8].

3 Combination of Data, e-learning and Score

The achieved data are saved in a database. This means, objective Data can be compared with existing one, e. g. from a violin lesson, or from other people or from past sessions.

The next important step is making the data accessable.

3.1 The music e- learning WIKI and interactive Score

GNU PDF will hopefully be able to show scores like this:

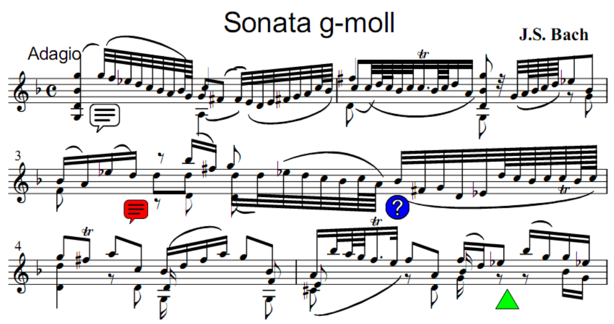

Fig. 3

The colored items show data. This could be coments by teachers or other musicians, sensor data or media data. Html versions in combination with music- xml would look similar, but because of the huge amount of pdf scores in the internet, pdf stabdart is also useful.
The data base also can be used without scores, so a session or lession can be followed just by listening or reading.
This new approach of combining subjective, emotional data with objective sensor data provides a complete new approach of performing together, teachin and learning and last but not least: Sharing the content with everybody, who is interested over the internet or in reality in jam sessions and performances.

In pedagogical scenarios, objective data can represent complex correlations between pressure and sound, one of the most important parameters in instrument playing. Another goal, showing complicated relations simple is also reached.

The combination of traditional instruments, computer and hightech tools like new sensors could motivate a new generation of young musicians to learn with new methods they like and they are more and more used to. The industry recognised this trend, hopefully music schools ans „open music scene“ do it also.

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