Recorderology - development of a web based instrumentation tool concerning recorder instruments

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ABSTRACT

In this paper, we describe our instrumentation research for recorder instruments and its documentation method developed to operate as a web application. Our aim is to propose an application that enhances the knowledge and experiences of musicians, especially composers, about the recorder family and to encourage their creative activities. Furthermore we suggest proper notations, which enable composers to illustrate their musical ideas precisely and increases the efficiency of communication between musicians and composers. In our research, we analyze the correlations between the mechanisms and the actual results of sound production by means of four primary components (instrument model - air - mouth - fingers). This project is carried out through an interaction between artistic research involving collaborations with composers and musicians and scientific research including audio analysis, e-learning and data-mining. In our web application, we employ a large audio database to describe the mechanism of the playing techniques of recorders along with a graphic user interface with the aim of simplifying the navigation.

1. INTRODUCTION

During the last twenty years, the way in which people use computers has changed immensely. The use of computer and web based environments is integrated into the daily life for diverse purposes, such as communication, learning and leisure. Nowadays, the educational systems include the use of computers and internet into the teaching and learning environment as a means of extending or supplementing the face-to-face instruction.

Especially in the case of music education/training, diverse musical researches report especially concerning instrumentation have been distributed or documented using internet technology. The technology is able to distribute the documentation resources by employing varied interfaces to present the different data. Many of these web implementations are applied as an extension of a book or CD media and therefore, these web-sites have relatively simple structures.

It is easily predictable that sound examples possibly give us a profound knowledge and precise imagination of the timbre (sound color or sound quality) which is not sufficiently covered by the standard western notation system. However, when the instrumentation research involves more complicated issues and seeks to clarify questions of sound phenomena and their mechanisms, more advanced audible demonstrations are requested by musicians, both instrumental players and composers for artistic purpose. Furthermore, we assume that the design of an interface combining literal and audible documentation is significant and it could be more effective when it contains a familiar description system for the musicians, for example notation.

Our instrumentation research concerning recorder instruments, known as Recorderology [1] , aims to provide versatile musical experiences without meetings or rehearsals with musicians depending on the users demands. Our goal is to interpolate self-study into the exchange with other musicians and to expand creative possibilities by optimizing the time and energy used for instrumentation study.

In our instrumental research, we target the mechanism and timbres of various playing techniques. The recorder family consists of significantly more different sizes and models compared to other families of instruments [2] . Generally, this factor strongly increases the complexity of the correlations between their sound productions, playing methods, notation and composition. Therefore, it is important to discuss an efficient way to organize the diversity and complexity of the recorder family in a clearly structured interface combining music notation with sound samples.

In a further step, we address the development of a web documentation method by using an interactive user interface, a web Application with Web Audio API, which enables us to build an advanced signal processing program and an interactive audio sampler in hypertext documents without any plug-in. In our web application, we employed a large audio database and interactive data retrieval system in order to describe the details of our research results.

[1] The research project Recorderology is the second step of the project Recorder Map http://www.recordermap.com

[2] The recorder family consists of diverse sizes and types of instruments. Each single recorder generally produces a significantly different timbre due to the different inner bore and voicing (construction of the wind way and labium). The Medieval, Renaissance, and Baroque eras had their unique types of recorders and in each epoch they could come in up to nine different sizes.

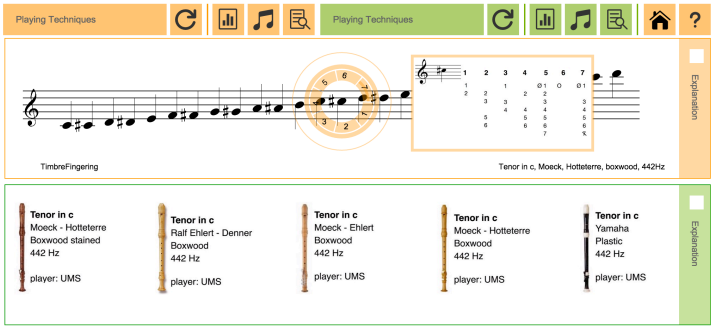

Figure 1. This figure illustrates the layout of the web-application Recorderology on Google Chrome browser

2. OVERVIEW OF THE WEB DOCUMENTATION METHOD

We designed the web application Recorderology after an evaluation of its potential and effectiveness and inspecting existing web documents. We realize the importance of studying the expectable effect of a web documentation and of analyzing actual examples.

2.1 The effectiveness of e-learning

Some applications of internet technology in educational/ training modules are known as e-learning (electronic learning such as computer-based learning, online learning or distributed learning). Compared to Face to Face (FTF) instruction or paper based documentation, e-learning modules are more interactively adapted towards a particular goal depending on learner's demands.

Several research projects have already evaluated the effectiveness of e-learning. Tyechia (2014)[1] evaluated the comparative level of proficiency of learning between FTF learning and e-learning by comparing the scores of a candidate's paper test. His results suggest that both methods are equally effective or in some cases slightly positive for e-learning under his conditions.

Karachi and Ambekar (2015)[2] analyzed the effect of e-learning and attested a positive impact concerning the two facets Explanation and Interpretation, which are the two most fundamental of the six facets of understanding [3] .

Although the researchers noted that the effectiveness of e-learning is significantly influenced by the design of websites or applications, we can expect that e-learning can reach the same level of effectiveness as FTF learning, especially concerning fundamental understanding levels. The advantage of e-learning is its high responsiveness to different purposes and demands. As musicians tend to have unique demands in their creative work, the element of versatile and adaptable instruction is an important factor in musical studies.

2.2 Related examples

A comparable effect can be expected in the case of musical study concerning topics such as instrumentation, composition, organology and sound analysis. Here we survey

[3] Grant Wiggins and Jay McTighe: the model of six facets of understanding consisting of Explanation, Interpretation, Application, Perspective, Empathy and Self-Knowledge

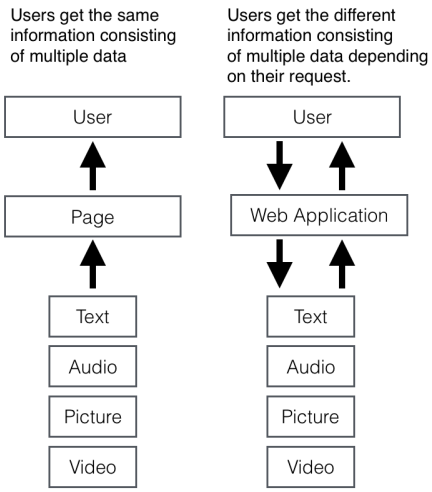

Figure 2. This figure represents the differences between the functionality of the mentioned web-sites and our web-application

examples of audio techniques used in web documentation of musical research as the implementation/presentation of audio data is a crucial factor in music study..

Flash player is one of the most often used plugins to present audio samples with or without a graphical user interface, for example in PRIME-project [4] , clarinet- multiphonics [5] , "The Techniques of Saxophone Playing"[3] [6] etc. Clarinet multiphonics employs Flash player to produce an interactive multiphonics chart. It presents fingering charts with their generated multiphonics specifying dynamic levels, pitch information, difficulty of performance, and sound examples. Users can select the specific multiphonics information by its fundamental pitch.

The HTML5 tags <audio>and <video>are also used as one of the simplest ways to present audio samples. Con Timbre [7] and the Academy page of Vienna Symphonic Library [8] provide two examples. Users need to load an individual audio file each time they listen to it.

Video is used to present the relationship between physical movements of a music performance and its sound result. In this case, video sharing services such as YouTube, Vimeo, etc. are often used to deliver a stable data flow and save on server storage. The videos are especially beneficial when they present extended or unusual playing techniques. One remarkable example is CelloMap [9] , by E. Fallowfield[4], which demonstrates the actions of a cello player and their sound results.

Figure 2 shows the functionality of most of the other mentioned cases compared to our case.

3. RECORDEROLOGY

Basing our work on fundamental artistic needs from collaborations with composers, we intend in our research project

[4] http://www.primeresearch.ch
[5] http://www.clarinet-multiphonics.org
[6] https://www.baerenreiter.com/materialien/weiss_netti/saxophon/multiphonics.html
[7] http://www.contimbre.com
[8] https://vsl.co.at/de/Academy
[9] http://www.cellomap.com

Figure 3. Waveform on Google Chrome browser

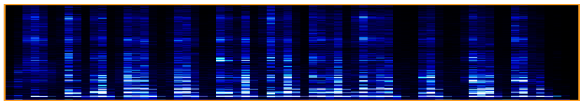

Figure 4. Spectrogram FFT analysis on Google Chrome browser

"Recorderology" to construct a database consisting of a large amount of material concerning various playing techniques using diverse recorder instruments (see Figure 1).

In our first step, we break down the playing methods into four main components [10] (model- air - mouth - fingers) and secondly analyze these components individually. Subsequently, we investigate the relationships between the components and the sound results and then determine how the diverse sounds produced are associated with the combinations of different components.

For example, the following list indicates the playing conditions for recording the samples using the playing technique "timbre fingering".

- fixed tuning pitch to equal temperament A4 = 442 Hz
- select desired instrument (referring to component model)
- blowing pressure adapted to achieve the exact pitch (referring to component air)
- articulation adapted to get the fingering sounding at the used blowing pressure (referring to component mouth)
- several preselected timbre fingerings (referring to component fingers)

Although the diversity of instruments indicates the huge artistic potential of the recorder, it is simultaneously an obstacle for comprehensive documentation. The web application of Recorderology provides a Graphical User Interface for studying the possible variations of several playing techniques. This web application presents the collected sample database arranged by the different instruments and components. Furthermore, the user can access score examples of the selected sound samples, playing instructions, notation and other descriptions. When the user selects one specific note, the program shows its possible variations of

[10] Wolfe, Almeida et al.[5] described that musical performance involves the interaction of the principal acoustical components in a wind instrument-player system:
source of air: the airflow is generally controlled by muscles of the torso and in some cases the glottis (referring to the component air). On the very short time-scale, the airflow is also controlled by the tongue, which can cease the flow by contact with the roof of the mouth (represented by the component mouth)
vibration element: the edge-tone produced at the labium (represented by the component model)
the downstream duct: the bore of the instrument (represented by the combination of the components model and fingers)

Table 1. The process of our Web application

process	GUI	behaviour
1	Select a PlayingTechnique from the menu	Show available instruments
2	Select a instrument	draw notes, description and load all requested audio data from database
3	Select a note	show a dynamic or variation menu
4	Select a dynamic and a variation	play a specific audio data
5	Close or Select Another PlayingTechnique or Select another instrument	delete loaded audio data and go back to **2**
6	Open Analysis window	draw waveform of previously played audio data and show analysis results

the playing technique as if a loupe is magnifying the details of the timbre. The selection menu appears in a circle around the note, which increases the visual focus to the standard notation, and at the same time the user can navigate around it to access different options of its timbre.

In the main page, two players are installed in parallel on the same window, and the user is able to assign a set of samples of different playing techniques or instruments to each player in order to investigate the sensitive differences between them.

4. SAMPLER SYSTEM - WEB AUDIO API IMPLEMENTATION

We defined a labeling rule, which identifies each audio file and illustrates its information about pitch, instrument, dynamic and so on, in order to simplify the data retrieval from our database.
The labeling rule:
instrument number_tuning pitch reference (Hz)_pitch number (Midi)_playing technique number_variation number_ dynamics (p or f)

Following the labeling rule, the name of audio file and buffer object in Javascript are defined as shown in the following examples:

An example of audio file name
15_442_77_3_1_p

An example of buffer object in Javascript
Audio_15_442_77_3_1_p

Each audio file is stored on the server in mp3 format in order to reduce the cost of internet communication and server storage. The files are then requested by using XMLHttpRequest and are decoded to raw data by AudioContext.decodeAudioData(). A bunch of audio files of a particular playing technique for each instrument is loaded to each corresponding buffer object at once [11] (in process 2,

[11] The multiple sound file loading/converting system was based on

Table 1) and are stored until they are discarded (in process 5). Therefore, the web application does not need to load an individual file for each time of playing and this enables users to access the same group of audio files instantly and to easily inspect the detailed distinctions or variations of different audio files. The program illustrates the waveform (Figure 3) of the loaded audio data and its spectrogram (Figure 4).

5. PROVISORY TEST RESULTS

Although the web application Recorderology is still in the development process, it is being tested by several composers over the world in a number of projects. The composers use it for investigation of recorder instruments and to prepare sketches of their new compositions before the first meeting with the musicians.

The first feedbacks show, that the presentation of the audio samples in context with the notation improved significantly the understanding of the various timbres of the instruments.

The figures 5-7 are score examples extracted from actual compositions written during this project. Variable playing techniques introduced in Recorderology are applied and developed within these compositions. Their notation is also based on our suggestions.

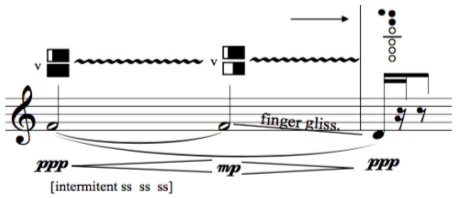

Figure 5. Luis Codera Puzo: Oscillation ou interstice (2013)

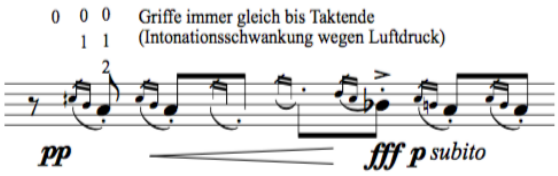

Figure 6. Christophe Schiess: Once estaciones (2014)

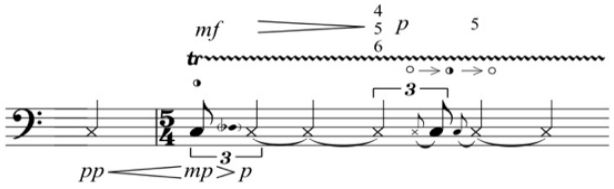

Figure 7. Keitaro Takahashi: surge (2014)

6. CONCLUSIONS

Our web application offers an interface covering individual playing techniques broken down into the components and their possible variations. We expect this application to enable users to develop their understanding and increase their experience of the instruments in a way that will eventually stimulate them with new artistic ideas.

So far, we have attempted to describe the differing playing techniques based on the combination of the components. However, our sampler system does not cover all of the small variations and users have to investigate these by themselves.

In a further development of this application, we intend to implement an automatic data retrieval module, which represents related playing techniques, variations, and score examples from various contemporary compositions, based on the criteria of audio analysis and audio categorization. This step is intended to interpolate detailed sound variations modified by the different combinations of components in a fast and convenient manner.

The Recorderology has the potential to be applied to other instrument families such as strings, keyboards, brass instruments etc.

The current version of our web application is available from the link below:

http://recorderology.com

7. ACKNOWLEDGMENTS

We give thanks for support to the Forschung und Entwicklung Dept. of FHNW Basel and gratefully acknowledge the financial support of Maja Sacher Foundation for the RecorderMap project during 2013-2014.

8. REFERENCES

[1] Tyechia, V.P. "An Evaluation of the Effectiveness of E-Learning, Mobile Learning, and Instructor-Led Training in Organizational Training and Development", *The Journal of Human Resource and Adult Learning* Vol. 10, Num. 2, December, 2014

[2] Kamatchi, R. and Ambekar, K. "Analysis of e-learning web application's alignment with six facets of understanding", *International Conference on Advances in Computer Engineering and Applications (ICACEA)* IMS Engineering College, Ghaziabad, India, 2015

[3] Weiss, M. and Netti G. "The Techniques of Saxophone Playing", *Bärenreiter-Verlag* Kassel, Germany, 2010

[4] Fallowfield, E. "Actions and Sounds - An Introduction to Cello Map", *dissonance 115*, p. 51-59, September, 2011

[5] Wolfe, J.and Almeida, A.and Chen, J.M. and George, D. and Hanna, N. and Smith, J. "The Player-Wind Instrument Interaction", *School of Physics, The University of New South Wales, Sydney, 2013*

[6] B. Smus "Web Audio API", *O'REILLY* p. 11 - 12, 2013

[7] Arkorful, V. and Abaidoo, N. "The role of e-learning, the advantages and disadvantages of its adoption in Higher Education", *International Journal of Education and Research* Vol. 2 No. 12 December, 2014

"Putting it All Together" written by B.Smus [6]