

Video and audio recordings for a new interactive method to teach instrument and room acoustics

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Introduction

Musicians usually do not have the opportunity to listen to their own instrument's sound in other conditions than at their usual place during rehearsal or performance. In a larger **e-learning** project (see contribution of M. Kob et al.) [1] the sound of orchestra instruments is auralized and visualized at selected locations in the orchestra and the audience area. In this paper we present a set of video and audio recordings of orchestra instruments that are used as source signals for the auralization and visualization.

The target group of the interactive orchestra sound project are music teachers and students, composers, sound designers, audio engineers or acousticians. This method provides a better understanding of instrument's acoustical properties such as sound spectrum, formant structure and directivity, and also serves teachers in acoustics as a reference of recordings and analysis methods of musical instruments and performance spaces. Various pitch ranges, registers, playing styles and radiation patterns are recorded and - in a cooperation with the Network of Universities of Music (Netzwerk Musikhochschulen) - arranged for educational use.

Objectives

Our motivation for this project is;

- to create an online, **interactive user interface** (see Fig. 2) that shall offer access to a comprehensive analysis of instrument sounds,
- to facilitate a better understanding of different acoustical properties,
- to enable users to identify visual and aural changes in timbre depending on playing style and listening position of an instrument,
- to create an instrument sound database both for directivity analysis and convolution with different room impulse responses,
- to provide an 'easy to reach' online platform both for teaching and learning purposes.

Therefore, the examples were selected carefully considering the most beneficial combinations for a better comparison between instruments and playing styles.

Material and Method

Audio and video recordings were held in the WFS room of the Erich-Thienhaus-Institut. A spherical construction was covered with a molton textile aiming for a better anechoic sound. Musicians were asked to sit in the center of the sphere [2] and play an arpeggio, a chromatic scale and a short melody varying - among other things - in dynamics (piano, mezzo-forte, forte, sforzato) and articulation (legato, non-legato, pizzicato, staccato, vibrato) (see Fig. 5). The chromatic scale was modified according to the pitch range of each instrument.

In total, eight omnidirectional and two cardioid pattern condenser microphones were used for the audio recordings (see Fig. 1) using a 24-bit quantization and 48.1 kHz sampling rate. For directivity measurements, six omnidirectional microphones (NTi M 2010) were positioned in the horizontal axis and two Brüel-Kjaer microphones (DPA 4006 P48) in the vertical axis of the instrument. In addition, two Neumann microphones (KM 184) were located depending on the instrument's features to obtain intended recordings for the sound auralization [1], [3].

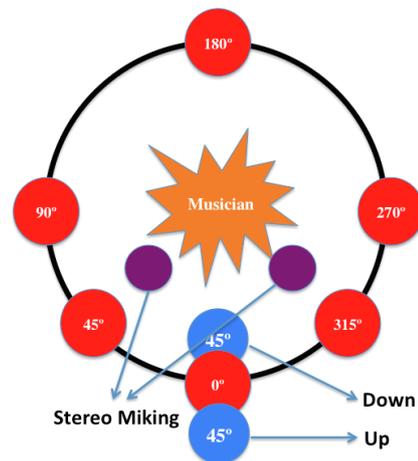


Figure 1: Microphone setup

The microphone setup for the directivity measurements was chosen by taking into account the most effective configuration with available equipment [4], [5], [6]. Six NTi microphones were placed with an angle of respectively 0, 45, 90, 180, 270 and 315 degrees, 90 cm from the center and 105 cm from the ground. Two Brüel-Kjaer microphones were placed with an elevation angle of -45 degree and 45 degree and 0 degree azimuth. They were both positioned 90 cm from the center, the bottom one

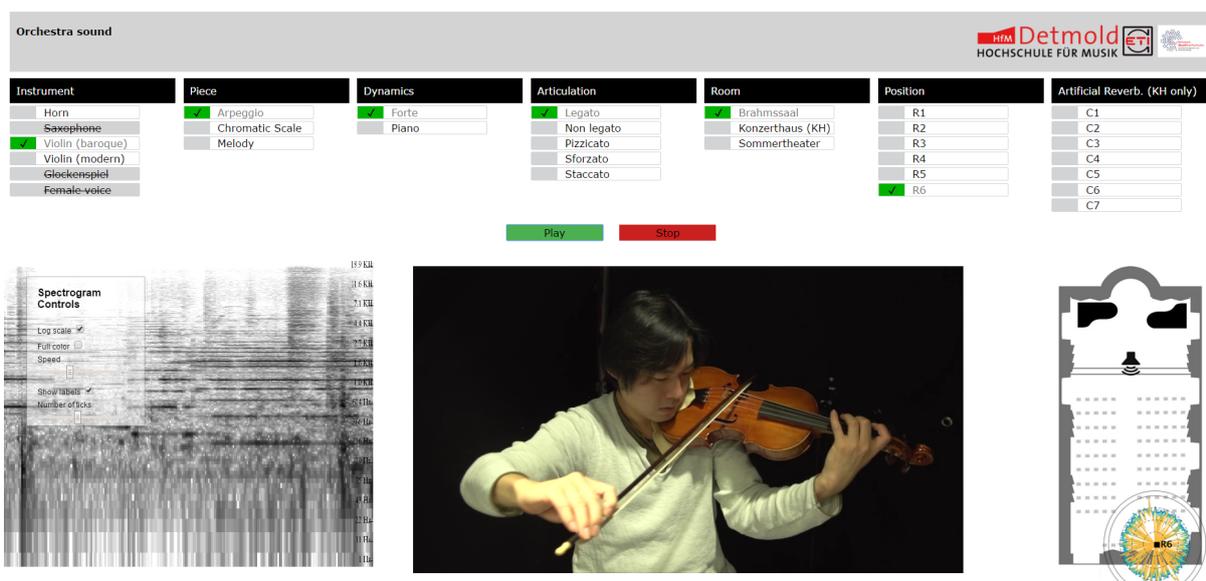


Figure 2: Screenshot of the interactive user interface showing Tetsuro Kanai, playing violin

20 cm from the ground and the upper one 175 cm from the ground. Additionally, a video recording was held simultaneously using a Sony HD Camera. For each video recording, different positions were sought for the best pictures, capturing both, instrument and musician.

Audio recording and editing equipment:

- RME: Micstasy preamp
- RME: UFX soundcard
- RME: Madiface XT
- 6 x NTi M2010 microphones
- 2 x Brüel-Kjaer DPA 4006 P48 microphones
- 2 x Neumann KM 184 microphones
- Pro tools 11
- Reaper 5

Video recording and editing equipment:

- Sony NEX-FS100 HD Camera
- Sachtler Tripod
- Final Cut Pro 10

Instruments

Recordings include eight instruments from five different instrument families (woodwind instruments, brass instruments, string instruments, keyboard instruments, percussion) as well as female and male voice. The glockenspiel (shown in Fig. 3) was recorded both, with hard and soft mallets, to provide further sound distinctions.

List of the recorded instruments and musicians:

- 1- Clavichord - Maria Saulich
- 2- Glockenspiel - Kazuyo Tsunehiro

- 3- Horn - Anton Langer (shown in Fig. 4)
- 4- Saxophone - Dustin Eddy
- 5- Violin-Barock - Tetsuro Kanai
- 6- Violin-Modern - Tetsuro Kanai
- 7- Voice-Female - Amanda Kyrie Ellison
- 8- Voice-Male - Manuel Grunden

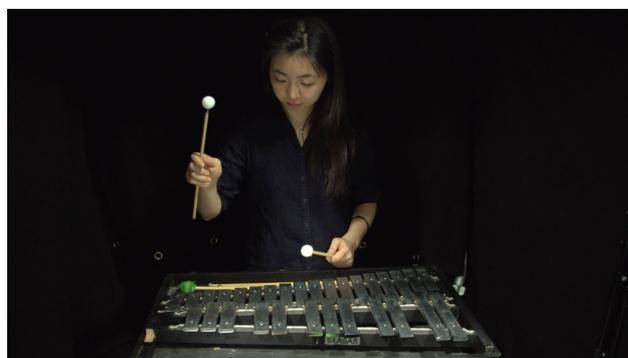


Figure 3: Recording session with Kazuyo Tsunehiro, Glockenspiel



Figure 4: Recording session with Anton Langer, Horn

Aufnahmen Musikinstrumente

Skalen und Kanon

Kanon zu 4 Stimmen:
Paul Ernst Ruppel 1938

The figure shows four staves of musical notation. The first staff is an arpeggio in G major, 4/4 time, with notes G2, B2, D3, F3, A3, C4, E4, G4. The second staff is a chromatic scale in G major, 4/4 time, starting on G2 and ending on G4. The third staff is a short melody in G major, 4/4 time, with lyrics: 'Vom Auf - gang der Son - ne bis zu ih - rem Nie - der - gang sei ge -'. The fourth staff continues the melody with lyrics: 'lo - bet der Na - me des Herrn, sei ge - lo - bet der Na - me des Herrn.' The score is in G major and 4/4 time.

Figure 5: The arpeggio, the chromatic scale and the short melody played in the recordings.

Discussion

Since the WFS Room has been used by also other students and projects, it was a very big challenge to keep the recording environment the same for each recording. The most time consuming part of the recordings was installing and uninstalling the audio and video recording setup. We solved these problems by changing our method after violin recordings. Instead of recording an instrument each week as planned, the rest of the six instruments were recorded in one day. Another challenge was creating separate synchronised video and audio samples as a material to be used for the interface. Video samples need to have a low resolution for the streaming issues while the audio quality shall remain unchanged. Furthermore, in comparison with the other instruments, the clavichord produced a very low sound level due to its resonator quality that pose a challenge to the evaluation of the directivity data.

Conclusion

At the end of the audio and video recordings we derived over 1200 audio and video samples of eight instruments. All audio samples were bounced to wav format. In a resolution of 854-480 all video files were exported in mp4 format. The samples were used for the creation of an interactive online tool, which is being developed further. Sound auralization, which allows users to listen to audio samples in any desired room or location, will be refined as well. We are happy to present the first version of the interface which will soon be available online.

Acknowledgements

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