



The importance of the haptic feedback in musical practice – Can a pianist distinguish a Steinway through listening?

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ABSTRACT

Multisensory interaction and integration are important capabilities of our brain and play significant role on the everyday event and object perception. Music playing and listening combine in most cases auditory and haptic perception. For example in live concerts whole body of the concert-goer is excited by airborne sound or seat vibrations. During music instrument use, the musician is exposed to many forms of vibration at his fingers, shoulder, or chin. Auditory haptic interaction is important to control the musical instrument and enjoy the music. New kind of digital musical instruments brings pioneering possibilities to give haptic feedback and improve the communication between the musician and the music instrument. This talk discusses the importance of the audiohaptic interaction in musical practice based on the recent investigations from the literature.

Keywords: Sound quality, Vibration induced effects, Music, Haptic. I-INCE Classification of Subjects Number(s): 63.2, 63.7, 49.2.1

1. INTRODUCTION

People are exposed to many forms of airborne and structureborne sound by playing a music instrument or listening a music concert. In our recent studies, the sound and the seat vibration recordings show that perceivable vibrations exist during the classical or jazz concerts and the frequency contents of the airborne sound and vibrations are very similar [1]. Similar observations are reported for musical instruments. The vibrations of the musical instruments are in most cases clearly perceivable [2, 3, 4].

The study on hand and whole-body vibration has a long history. However most of the literature based on the perceived annoyance of the vibrations. Recently some researchers started to investigate positive aspects of the vibration for the musical practice and try to bring the haptic feedback to the new type music instruments. Because of the limited frequency range and lower frequency resolution, the haptic perception is neglected for a long time. This paper discusses the importance of the haptic feedback in musical practice.

2. MUSIC LISTENING AND AUDIO-HAPTIC INTERACTION

During a pop or classical concert, whole-body of the concert visitors is exposed to the vibration. This vibration can be caused by airborne and/or structureborne sound. Various studies investigated the role of audio induced vibration on the perceived quality of audio reproduction systems. The exemplary measurements at a church and an opera show that the seat vibration levels are higher than whole body perception thresholds, with other words, they are perceptible [1]. The frequency content of the vibrations show big similarities with the frequency content of the airborne sound as expected [1, 5]. Therefore in most studies the low pass filtered audio signal was used as vibration signal [5, 6, 7]. The results of a study showed that whole-body vibration reproduction can improve the perceived quality of the action oriented DVD movies [8]. In our former studies [5, 6, 9], we noticed that it is possible to improve the quality of audio reproduction system for music using whole-body vibration reproduction. In another study, we tried to apply different signal processing algorithms to generate the whole body vibration signal and investigate the influence on the overall quality. The results of this study shows

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that low frequency filtering is a very good approach to generate the vibration signal. Compression of frequency range of the audio signal (octave shift) has some additional advantages. It reduces the high frequency components which can be audible because of the shaker and at the same time, it obtains very good quality ratings. The correction of the Body Related Transfer Functions of the listeners improve somehow the reproduction quality.

A fundamental research study on the influence of the whole-body vibration on the loudness perception show that participants of the experiment perceive the audio tactile stimulus loudness on average one decibel higher than for the audio only condition [9, 10]. It means that whole-body vibration reproduction can play an important role for the noise reduction (control). Particularly it is possible to reduce airborne sound pressure level at discos. However visitors will have same intensity impression because of the vibration reproduction, although the sound pressure level is low. This aspect is also useful for the car audio systems that low frequency music information can be delivered to the car driver using vibration reproduction rather than audio system. This will cause that the car driver will reduce the sound pressure level of the audio system.

3. THE INFLUENCE OF THE HAPTIC FEEDBACK ON THE CONTROL AND THE PERCEIVED QUALITY OF THE MUSIC INSTRUMENT

Some of the research studies measured the vibration behavior of the musical instruments and investigated, if these vibrations are perceivable or not. Most of the studies are concentrated on the violin vibrations. The results of these studies show that the acceleration level of the vibrations at the contact points between the musician and the music instrument, such as the shoulder, the chin, the left and right hands, are higher than perception thresholds (Figure 1). These vibrations are helpful for the musicians to control their instrument, which is a quite complex task [2].

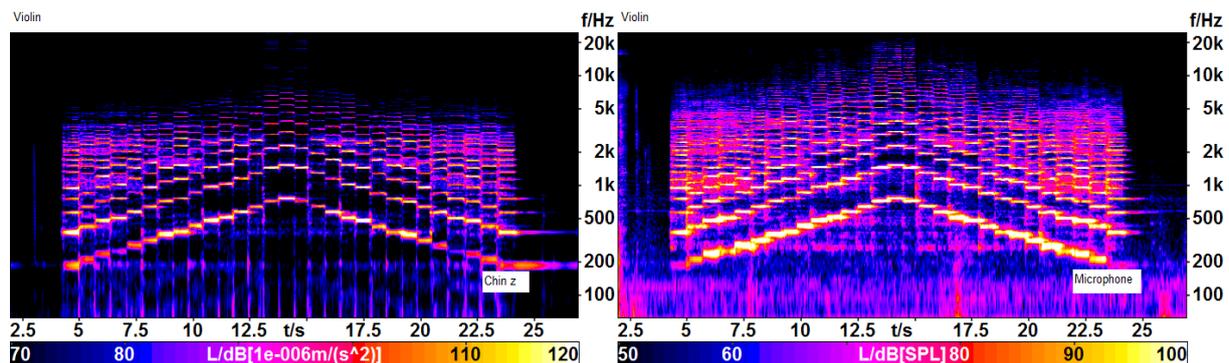


Figure 1 – The short-time Fourier transform (STFT)-based spectrograms of the microphone recording (airborne sound) and acceleration on the chin (z-axis) and the spectrogram. The frequency contents of both recordings show big similarities.

Galemo [11, 12, 13] reported a study which investigated, if 12 professional pianists from Leningrad Conservatory can identify a Steinway piano in between of three pianos (Steinway, Bechstein and Leningrad-made) using their auditory or haptic sense. The results show that the percent of the identification of the Steinway piano is much higher at haptic feedback condition in comparison to the auditory feedback condition.

Taking into account the above mentioned studies, some researchers are started to develop new type digital music instruments with haptic feedback. For example Birnbaum has developed a new type vibrating flute [14]. New gestural sensing techniques allow better parametrical control of sound. This study shows that subtle haptic feedback can improve the performance of the musicians. The Force-Stick and the Marble Box were introduced as new haptic supported musical instruments by Sinclair [15]. The importance of the vibrotactile feedback at the player's fingers during interaction with a piano keyboard was investigated by Avanzini et al. [3]. The results of the study showed that piano key vibrations produce significantly perceivable vibrotactile cues in the lower range of the piano keyboard, with perceptual cut-off around the middle octave [3]. The authors equipped a piano with

shakers and investigate the influence of the vibrations on the performance of the musician and the quality perception. The results show that the vibration has no significant influence on the musician performance but it has significant influence on the perceived quality of the musical instrument.

The vibration behavior of the violins and their perceived quality were subject of different studies [2,]. They could show that the generated vibrations are perceivable and are important for the perceived quality. In our recent study [4] we integrated a vibrotactile feedback system into an electric violin to investigate the influence of the vibration feedback on the perceived instrument quality. Four violinists joined in the experiment. They judged that designed vibration feedback increases the perceived quality of the instrument. The results show that the vibration level has a little influence on the perceived quality.

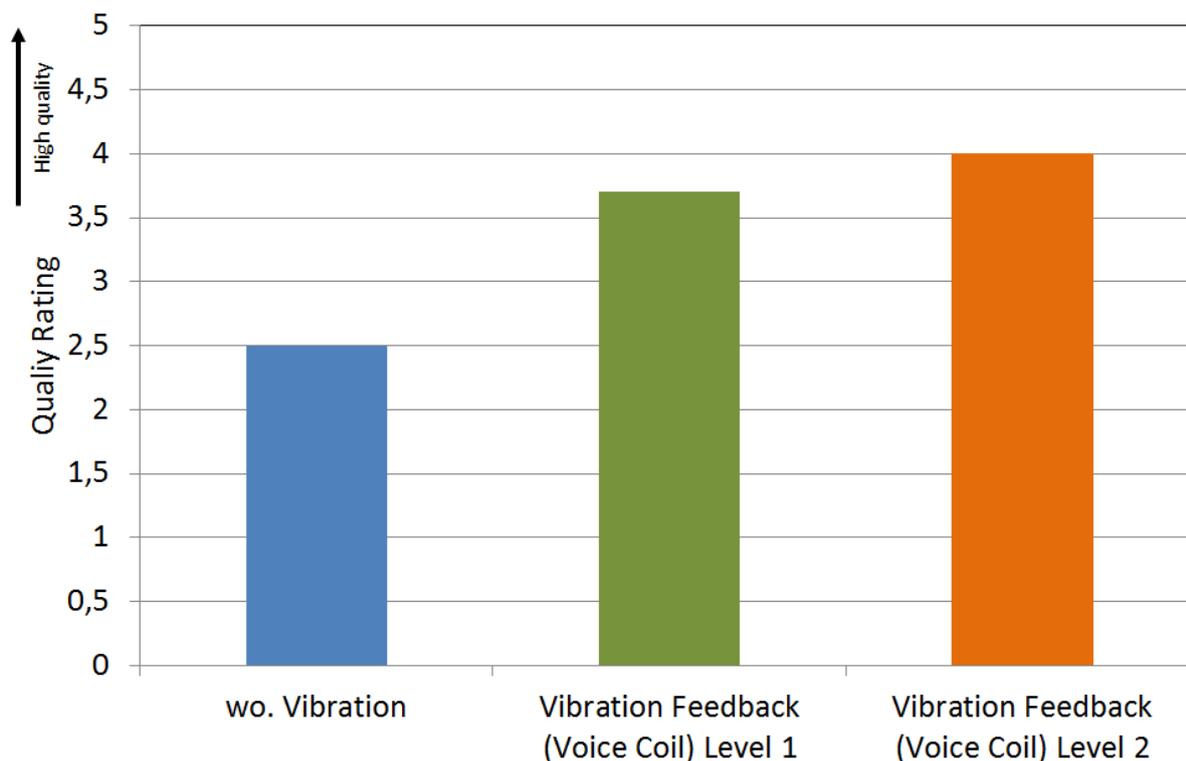


Figure 2 – The quality ratings of the participants with and without vibration feedback (two different levels) [4]. 4 professional musicians were participated in the experiment.

4. CONCLUSIONS

When playing musical instruments or listening the musical events, a good designed haptic feedback can improve the perceived overall quality. The results of the research studies show that haptic feedback can additionally improve the performance of the musicians (such as timing, intonation, etc.). Furthermore the vibration reproduction can play an important role for the noise control.

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