BODY VIBRATIONS AS SOURCE OF INFORMATION FOR THE ANALYSIS OF POLYPHONIC VOCAL MUSIC

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1. INTRODUCTION

Recordings have always played a central role in ethnomusicology. Although recording techniques and recording strategies have changed considerably in the course of time, the focus of interest in the past has been dominantly on acoustical sound and more recently on video. In the present study we are investigating the use of body vibrations of singers as additional source of information for the analysis of polyphonic vocal music. This was motivated by the observation that body vibrations generated during the phonation process contain an enormous amount of information of analytical interest (e. g. regarding the vocal sound spectrum) while at the same time being essentially unaffected by the signals of other singers. As a consequence, individual voices but also the interaction of voices can be analyzed in great detail using digital signal processing tools. As a demonstration of this concept, we are presenting examples of the application of pitch analysis software for the documentation of the individual voices in different types of polyphonic oral music.

2. MEASUREMENT OF BODY VIBRATIONS

The investigation of phonatory vibrations in singers is not new, but for most of the second half of last century the main interest in this topic seems to have been related to its use as feedback signal for phonatory control (Sundberg, 1992; Verrillo, 1992). The results in this context, however, stayed behind expectations (McAngus-Todd, 1993) which may explain the decrease in the number of recent publications on this subject. In the context of speech pathology, however, e. g. related to the measurement of the sound pressure level (SPL) of the voice, the investigation of chest and neck vibrations has become of increasing interest (Svec et al., 2005; Lamarche et al. 2008). The present work started from yet a different perspective, namely as part of a wider study aimed at the application of seismological analysis techniques to the study of the generation and propagation of audible acoustical signals in the human body. In this context we started a still ongoing comparison of the performance of a variety of piezo-based accelerometers, pick-ups, as well as bone and larynx microphones for these kind of measurements.

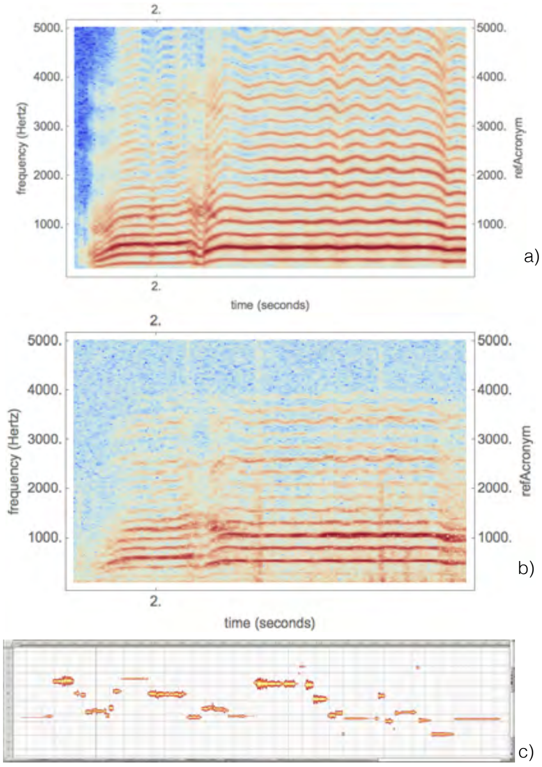

Figure 1. Sonograms of the start of the neck and ankle recordings (a and b), and the result of the pitch tracking the first 25 s of the ankle signal in Melodyne3 (c).

Fig. 1 shows the results of recordings of one of us (F.K) singing the Abchazian song Varado recorded on two slightly modified Albrecht AE 38 S2 larynx microphones, one mounted on the neck and one on the ankle. On playback, the song is clearly recognizable, even from the ankle signal. This can also be seen in the results of the pitch tracking (Fig. 1c) which cleanly picks up the melody. The relative phase delay between the neck and the ankle signal is roughly .4 msec, which corresponds to a propagation velocity between ankle and neck of 3.4 km/s. Obviously, the ankle signal has propagated primarily through the bones. The relative depletion of high frequency components in the ankle signal might also be useful as a measurement of bone consistency (attenuation).

3. ANALYSIS OF POLYPHONIC VOCAL MUSIC

Encouraged by these results, we investigated the usefulness of larynx microphone recordings for automatic pitch analysis of multiple voices in polyphonic vocal music. The first group of singers (Ingrid Hammer, Ursula Häse, Ursula Scribano) performed four songs of different genres and dynamic characteristics (Akaeli, a pygmi song; Heida, a Georgian krimanchuli (yodel); as well as Büchel and Summersberger, two alpine juuz). The results of the analysis of the song Heida is shown in Fig. 2.

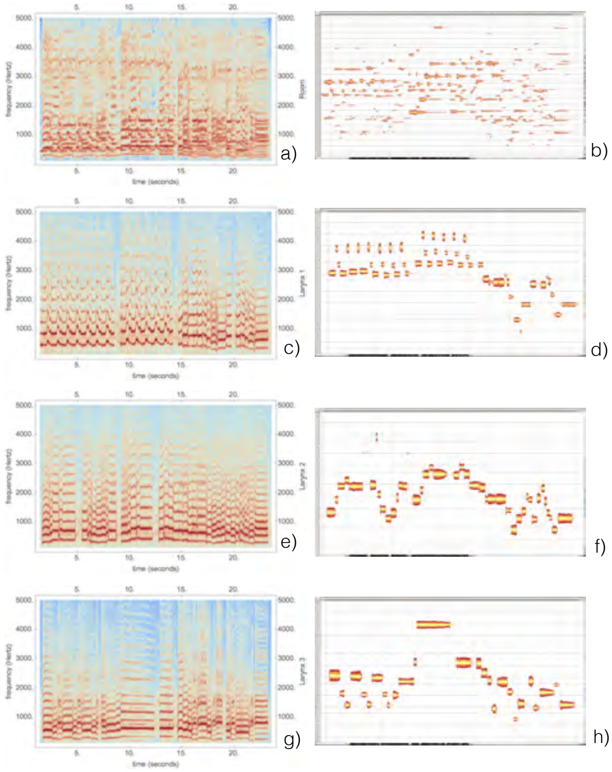

Figure 2. Sonograms (left panels) of the room mic (a) and the larynx mic neck recordings of the three singers (c,e,g) singing the song Heida. The right panels show the results of the pitch tracking in Melodyne3 to the signals in the left panels.

Despite the large dynamic of the song and the rapid jumps between chest and head register for singer 1 (c, and d), the melodies of individual voices are cleanly tracked on the larynx mic recordings. In contrast, the attempt to pitch track the room mic recording leads to numerous artefacts and renders this attempt useless. In this respect, the results for the other songs (not shown) are the same.

The second group of singers (Deniza Popova and Katya Tasheva) performed three Bulgarian diaphonic songs (Zamraknalo stado, Marta Marta, and I slanceto treperi). For this singing style, close interaction between singers is essential. The results for the song Marta Marta are shown in Fig. 3.

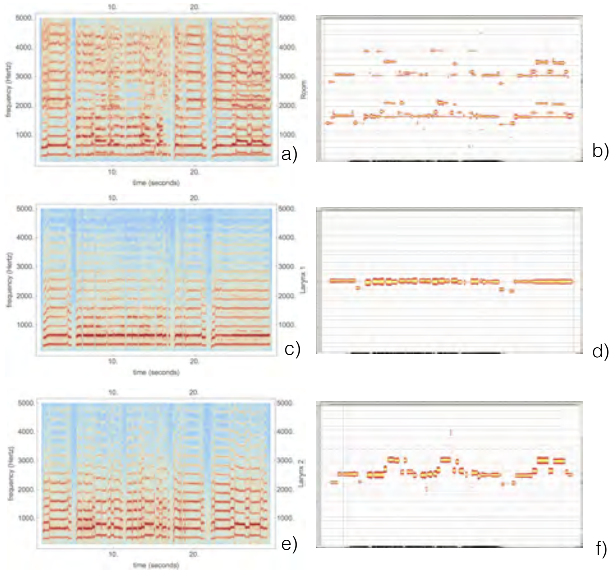

Figure 3. Sonograms (left panels) of the room mic (a) and the larynx mic neck recordings of the two singers (c, e) singing the song Marta Marta. The right panels show the results of the pitch tracking.

Again, the individual voices are cleanly pitch tracked on the larynx microphone recordings while the attempt to pitch track the room mic recording is severely flawed.

4. CONCLUSIONS

The results of the present study suggest that body vibrations can be a valuable source of information for the analysis of polyphonic vocal music. Recordings with larynx or bone microphones (as an add-on to regular acoustic recordings) could be quite useful for the documentation of the performance of individual singers, their interaction (as in interferential diaphonia or in studies of entrainment), or for a semi-automatic transcription including any microtonal structures.

5. REFERENCES

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