A Pilot Study of Vibration Pattern Measurement for Facial Surface during Singing by using Scanning Vibrometer

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Motivation

Expert singers can express their somesthesis during singing in their unique expressions.

Methods

• Scanning laser Doppler vibrometer: Polytec PSV-400-M4
• Participants: 3 female expert singers  
  Singers A and B: Classical singers  
  Singer C: Musical singer
• Data acquisition  
  100 Hz to 10 kHz of the vibration velocity  
  Triggered by singing voice  
  One measurement point was probed within 1 s.
• Experiments  
  Vowels: /a/ ↔ /i/ (falsetto, at their confortable pitch height)  
  Pitch height: A4 ↔ F5 (falsetto)  
  Falsetto ↔ Modal

Results

1. Vowels (falsetto)

The amplitude of the vibration velocity for the vowel /i/ was larger than that for the vowel /a/.

Vibration velocity pattern at each frequency (singer A, vowel /a/)

219 Hz  438 Hz  657 Hz  875 Hz  1,094 Hz
2. Pitch height (singer A, falsetto)

- Pitch height (singer A, falsetto)

A4 ≈ 438 Hz  
\(0 \text{ dB} = 1 \text{ m/s}\)

Vowel /a/

F5 ≈ 694 Hz  
\(0 \text{ dB} = 1 \text{ m/s}\)

Vowel /i/

I vocalized so that the voice went through the top of my head when I sang in a high pitch.

Conclusions

- We proposed a novel method of measuring the vibration velocity patterns of skin surfaces during singing.
- The results showed clear contrasts between the patterns for the vowels, pitch frequencies, and vocalization methods.
- This method can be used
  - to evaluate singing voices
  - as a visual feedback of a singing exercise
- We need to confirm the reproducibility of the measurement.
- The vibration patterns may be easier to relate to the somesthesia than the spectra of the speech sounds or trainer’s comments using unique expressions.

This study was supported by JSPS KAKENHI (nos. 21300071 & 24650088) and Hyogo Foundation for Science and Technology.