Comparison of External Photoglottogram and Electroglottogram

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Introduction

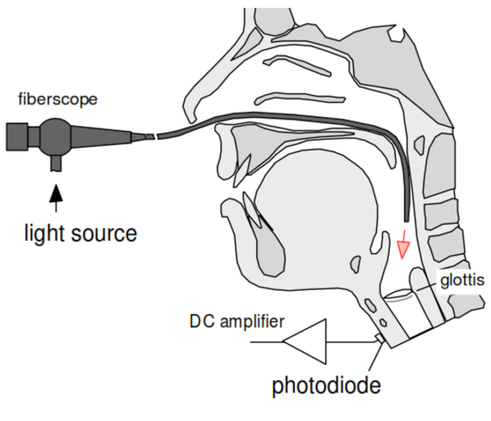
Glottogram is a real-time trace of vocal-fold vibration. There are two well-known recording methods, the electroglottography (EGG) and photoglottography (PGG). For EGG, a pair of electrodes are placed on both sides of the neck near the glottis, and the variation of electrical conductance is recorded to represent changes in contact area of the vocal folds. As for PGG, a light emitter and photoelectric sensor are placed above and below the glottis, and variation of transglottal light intensity is recorded to monitor glottal aperture changes.

A **combination of EGG and PGG** has been suggested to report the cycles of vocal-fold vibration in detail. This study is such an attempt employing **non-invasive PGG** to obtain PGG signals.

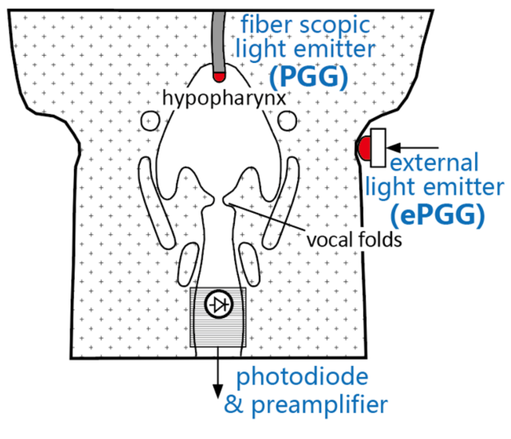
Introduction of ePGG

ePGG: external lighting and sensing **p**hotog**l**ottog**r**aphy

Conventional PGG



Comparison of PGG and ePGG



[1] K. Honda, & S. Maeda. Non-invasive photoelectroglottography method and device, U.S. 2010/0256503, U. S. P. A. Publication, 2010.

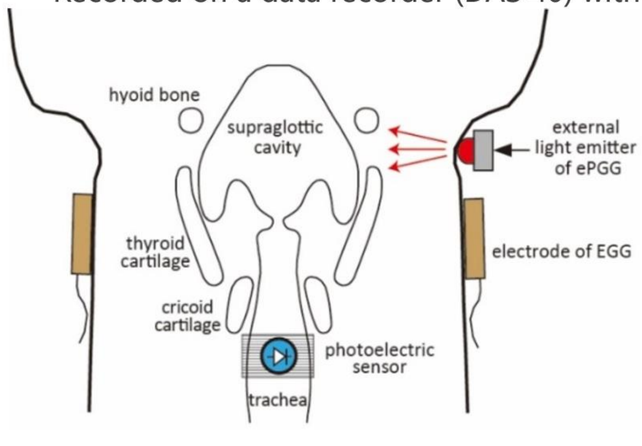
[2] J. Vaissière, K. Honda, A. Amelot, S. Maeda, & L. Crevier-Buchman. Multisensor platform for speech physiology research in a phonetics laboratory. *Journal of the Phonetic Society of Japan*, 14(2): 65-77. 2010.

Methods

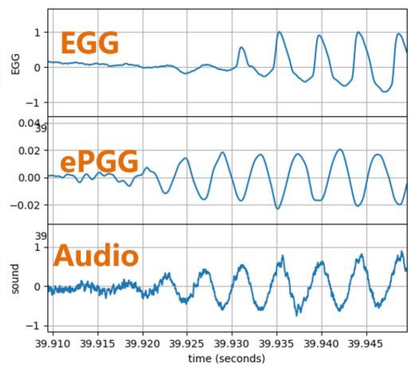
Target:
Characterizing ePGG waveforms in comparison to EGG waveforms

Experiments:
Two subjects (male, 25; female, 28) speaking standard Chinese.
[yi sa sa], [yi si si] and [yi su su] in Chinese. All in high level tone.

Devices:
ePGG device of our own design
EGG device (Glottal Enterprise)
Recorded on a data recorder (DAS 40) with audio.

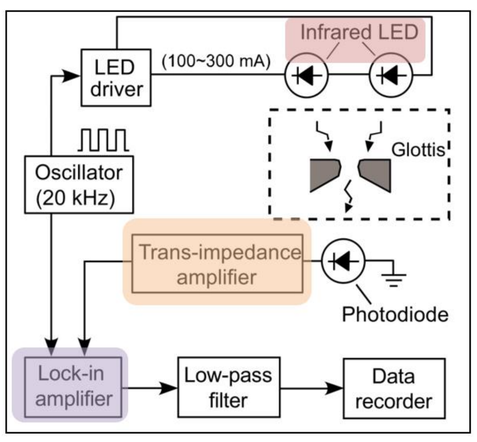


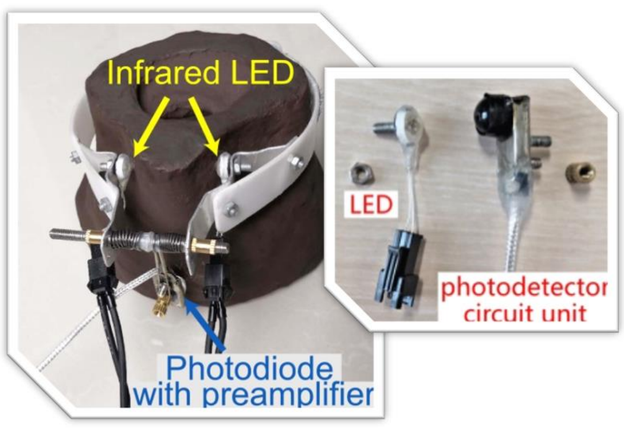
Example of voice onset



Improved ePGG

Block diagram of the improved ePGG



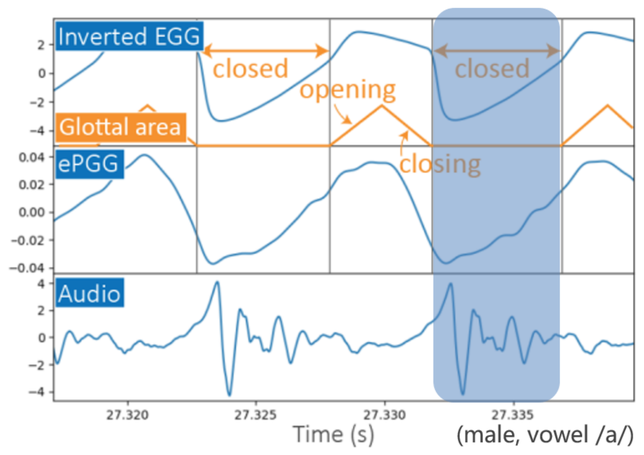


[1] Chi, Y., Honda, K., & Wei, J. Glottographic and Aerodynamic Analysis on Consonant Aspiration and Onset F0 in Mandarin Chinese. Paper presented at ICASSP2019.

[2] Chi, Y., Honda, K., & Wei, J. Portable Photoglottography for Monitoring Vocal Fold Vibrations in Speech Production. Paper submitted to ICASSP2021 (unpublished).

Results

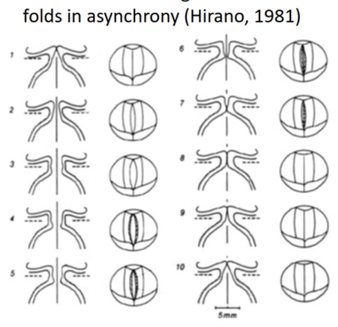
Glottal cycles in EGG, ePGG and speech waveforms



During the closed phase, the glottal area should be zero,

while the ePGG waveform shows a brief dip followed by a gradual rise.

Vibration of two edges of the vocal folds in asynchrony (Hirano, 1981)



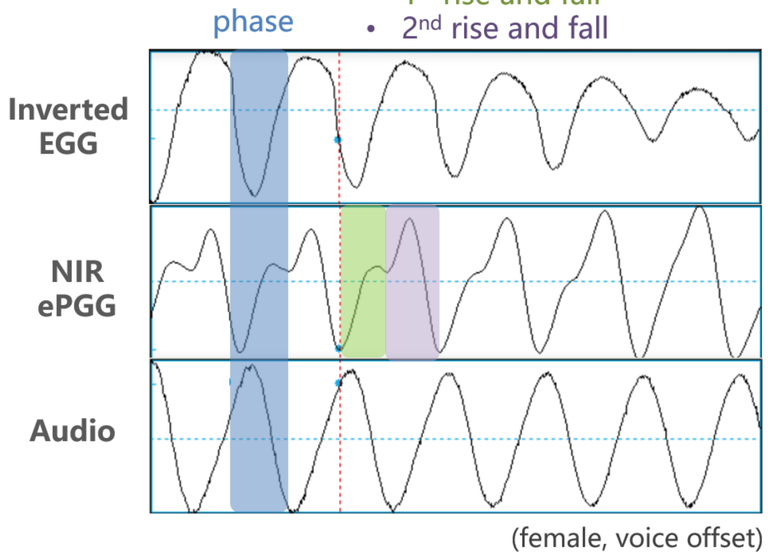
Possible reasons:

- Temporary thickening of vocal-fold edges at their collision;
- Displacement of the internal muscular layers due to the NIR transparent nature of the mucosal layers.

Latest Recordings and Results

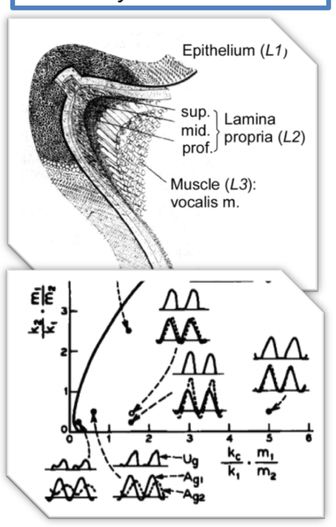
Transglottal light intensity :
- 1st rise and fall
- 2nd rise and fall

Closed phase



(female, voice offset)

Anatomy of the vocal fold



- NIR ePGG waveform indicates the phase difference of the mucosal layer in glottal vibrations. (refer to the two-mass model, Ishizaka & Flanagan 1972)
- More experiments are still necessary to explore ePGG signal characteristics.

Summary

Both EGG and ePGG are non-invasive techniques to monitor glottal states during phonation. In our comparisons, the ePGG waveforms show patterns somewhat resembling the inverted EGG waveforms in the closed phase. The downshoot of ePGG waveforms after the closure may be due to the thickening of vocal-fold edges at their collision, or the displacement of the internal muscular layers.

In sum, ePGG could be a noteworthy device to explore vocal fold vibrations. Further examinations are still necessary to quantify ePGG signal characteristics.