Flow-structure-acoustic interaction in a human voice model

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Normal human voice production arises from oscillations of the two opposing vocal folds within the larynx. The opening between the vocal folds is called glottis. Increased subglottal pressure causes an airstream through the glottis and excites vocal fold oscillations. Hence, the airstream is modulated and forms the primary voice signal. Subsequently, the voice signal is filtered by the vocal tract and emitted as acoustic signal through the mouth.

The vocal fold model was constructed using a three part polyurethane rubber compound. The stiffness of the cured rubber could be varied by adjusting the mixing ratios or the different compounds. Tensile tests on the different rubbers used in the experiments yielded modules from about 30kPa to 6.5kPa. These moduli are in the range of that found in vocal fold tissues. For the experimental investigations different measurements techniques were used. At first the experiments started with visualization experiments. It shows that the flow separated upstream in the glottis from the vocal fold on the right just passed the minimum glottal cross section. The flow remained attached to the glottal wall of the other vocal fold until reaching the glottal exit expansion.

To get information about the complex fluid – structure – acoustic interaction in the glottis the instationary flow field and pressure field were correlated with structure movements and the acoustic sound signals. The results show the aerodynamics and vocal fold dynamics were fully coupled. The regular self-sustained were analysed for different vocal fold configurations. Finally the capabilities and limitations of the models are discussed, and the areas for future developments are identified.