Numerical simulation of human voice production using aeroelastic model of self-oscillations of the vocal folds and FE model of the vocal tract

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A mathematical model for numerical simulation of vowel phonation is presented.

Aeroelastic model of the airflow-excited self-sustained vocal fold oscillations was developed using the incompressible 1-D fluid flow theory for expressing the unsteady non-linear aerodynamic forces and the Hertz model of the contact (collision) forces between the vocal folds. The equations of motion for rotation and translation of the vocal fold-shaped vibrating element are based on an equivalent three lumped-mass dynamic system on two springs. The vectors for aerodynamic and collision forces define the excitation forces.

The output signal from the aeroelastic model of vocal fold vibration (either intraglottal pressure or derivative of the glottal airflow volume velocity) in time domain is used for excitation of the *finite element model* of the acoustic spaces of the human vocal tract obtained from magnetic resonance images. Transient analysis is used for simulation of phonation when the supraglottal spaces are excited at the position of the vocal folds. The output acoustic pressure signals from the simulations in time domain are converted into sound samples.

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