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Coupled 2D-Fluid-Structure-Acoustic Simulation of the Human Voice

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The human voice is a key factor in social life. If the phonation process is disturbed due to a disease as e.g. hoarseness, communication and social life are strongly affected. Therefore, it is necessary to enhance therapies in order to minimize affliction caused by a disease. There exist different approaches to improve therapies. Experimental field studies of different physical parameters, like acoustic pressure or vocal fold displacements are one possibility. Another promising approach to advance insight into laryngeal dynamics is given by numerical simulations. Due to the growing computing power the complexity of numerical phonation models is steadily increasing and full fluid-structure-acoustic interacting models are now feasible. Therefore, we have developed a two-dimensional numerical model for the human phonation process, which includes the complete fluid-structure-acoustic interaction. As discretization method the finite-element method was applied for all possible three physical fields. The fluid-structure and the structure-acoustic interactions are based on general continuum mechanical principles; the fluid-acoustic interaction is based on Lighthill's acoustic analogy. Therewith, the analysis of all sound mechanisms, which consist of the eddy-induced, the volume-induced, and the mechanical-induced sound can be performed. First simulation results will be presented and discussed.