Large eddy simulation of sibilant [s] aeroacoustics

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ABSTRACT

A sibilant fricative [s] is generated when the turbulent jet in the narrow channel between the tongue blade and the hard palate is deflected downwards through the incisors' gap and impinges the inter-space between the lower incisors and the lower lips. The flow eddies in that region become a source of direct aerodynamic sound, which is also diffracted by the upper incisors and radiated outwards. The numerical simulation of this phenomena is complex. The spectrum of an [s] typically peaks between $4 - 10$ kHz, which implies using very fine computational meshes to capture the eddies producing such high frequencies. In this work, a large-scale computation of the aeroacoustics of [s] has been performed for a realistic vocal tract geometry, resorting to two different acoustic analogies. A stabilized finite element method that acts as a large eddy simulation model has been adopted to solve the flow dynamics. Also, a numerical strategy has been implemented which allows determining, in a single computational run, the separate contributions from the direct turbulent sound and the sound diffracted by the upper incisors, to the radiated sibilant [s].

Results are presented for points located close to the mouth exit showing the relative influence of the sources of sound depending on frequency. Their good fitting with available experimental data validates the suitability of this numerical framework for simulating unvoiced phonemes.

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