

EFFECTS OF VOCAL TRACT GEOMETRY SIMPLIFICATIONS ON THE NUMERICAL SIMULATION OF VOWELS

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Abstract

Three-dimensional numerical approaches are currently being explored for the analysis of vocal tract (VT) acoustics [1] and for the generation of synthetic voice [2]. Typically, very detailed VT geometries obtained from Magnetic Resonance Imaging (MRI) are used for the numerical simulations [3]. Alternatively and for simplicity, VTs with circular cross-sections can be built [1,2,4] using standard area functions [5]. However, a large amount of options exist between the intricate MRI-based geometries and the very rough circular approximations, which may provide a better balance between voice quality and degree of geometry details. In this work, an MRI-VT geometry for vowel /a/ [6] is progressively simplified and analyzed by using the Finite Element Method (FEM) [4] and a multimodal (MM) approach [7]. Three configurations for the cross-sectional shape are considered, namely the realistic, elliptical and circular ones, which are combined in turn with bent and straight configurations for the vocal tract midline (see Fig. 1). The obtained results show that cross-sectional shape and bending variations have a strong impact in the high frequency range above 5 kHz, where high order modes can propagate. Below 5 kHz, plane waves dominate and the examined simplifications do not significantly influence the vocal tract acoustics, although some small formant deviations occur. Simplified vocal tracts turn out to be very useful because low cost computational methods, like the MM, can be applied to them with confidence. Whether the observed high frequency discrepancies will play a relevant role from a perceptual point of view will require further research.

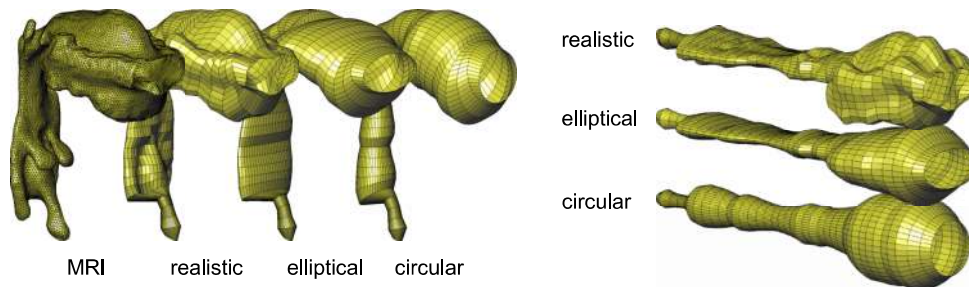


Fig. 1 – Vocal tract geometries. (a) Bent and (b) straight configurations.

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