Physically informed glottis models with real flow waveform matching properties.

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A low-dimensional physically informed model of the glottal source is presented. The model relies on a lumped mechano-aerodynamic scheme based on the mass-spring paradigm. The vocal folds are represented by a mechanical resonator plus a delay line which takes into account the vertical phase differences. First, a simple flow model based on Bernoulli's law is assumed, and the properties of the system are discussed. The synthesis of different modal and non-modal phonatory regimes is addressed. Both symmetric and nonsymmetric configurations are considered. The class of models under consideration is shown to be able to reproduce a broad range of phonation styles, and to provide interesting control properties. Examples of non-modal phonatory regimes, such as lax, tense, breathy, harsh, and bifurcated, are provided. Secondly, an extended flow model is introduced with the aim of reproducing realistic glottal source waveforms obtained by inverse filtering. The new flow model is based on a general parametric nonlinear model. For this new scheme, the principal characteristics of the flow-induced oscillations are retained, and the overall model is suited for an identification approach where real inverse filtered glottal flow signals are to be reproduced. A data-driven identification procedure is outlined, where the parameters of the model are tuned in order to accurately match the target waveform. A nonlinear regression algorithm is used to train the nonlinear part. A set of inverse-filtered glottal flow wave forms with different pitch, open phase/closed phase ratio, and shape of the glottal waveform period, are used to test the effectiveness of the approach. The results demonstrate that the model can reproduce a wide range of target waveforms. Moreover, the flow waveforms generated by the trained model are characterized by spectral richness and are perceived as natural.

References

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