DECOMPOSING VOCAL TRACT CONSTRICTIONS INTO ARTICULATOR CONTRIBUTIONS USING REAL-TIME MAGNETIC RESONANCE IMAGING

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Real-time magnetic resonance imaging provides information about the dynamic shaping of the vocal tract during speech production. We present a method for decomposing the formation and release of a constriction in the vocal tract into the contributions of individual articulators such as the jaw, tongue, lips, and velum. The contours of speech articulators were identified in the real-time magnetic resonance imaging videos and tracked automatically over the course of their motion. We quantified the formation and release of constrictions by measuring the distance between the opposing structures (i.e., upper and lower lips for [p], tongue and alveolar ridge for [t], tongue and hard palate for [i], tongue and soft palate for [k], tongue and rear pharyngeal wall for [a]). Our method decomposed change in constriction degree into the contributions of individual articulators. We estimated the forward kinematic map, a nonlinear function which maps a vocal tract shape to the corresponding constriction degrees. The jacobian of the forward kinematic map quantifies how a small change in vocal tract shape changes the constriction degrees. By parameterizing vocal tract shape as the linear combination of jaw, lip, and tongue components, the jacobian mapped jaw motion, lip motion, and tongue motion to the corresponding changes in constriction degree at the phonetic places of articulation. The change in a constriction degree due to the jaw, lips, or tongue is the contribution of that articulator to the total change in constriction degree. The proposed method allows vocal tract constrictions to be decomposed into the contributions of individual articulators using real-time magnetic resonance imaging.

References

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