Current Challenges in Speech Science: On Acoustic-Articulatory Relations in Speech Production

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Comprehension of the mechanisms that underlie the production of speech is, progressively, becoming deeper and wider, thanks to the development of knowledge in areas such as acoustics, dynamics, motor control, neurophysiology and human physiology in general. In this talk, we are going to see a brief history, the state of the art, and the challenges that remain to the understanding, modeling and reproduction of the complete process of speech production.

We start with an acoustic description of sound generation, propagation and radiation from the vocal tract based on articulatory information. The fundamentals of the source-filter model are presented. Next, physical models for the production of oral and nasal, voiced and unvoiced, fricative and plosive sounds are explained in the time and frequency domains. Finally, the limitations imposed by assuming the vocal tract in static configurations are explained.

The second part of the presentation approaches the problem of measuring and modeling articulatory gestures. First, techniques to measure the motion of tongue, jaw, lips, head and face are described. Next, it is shown how to represent the motion measured with same number of dimensions as the number of degrees of freedom of the speech production process.

In the last part of the talk, the inverse problem of inferring vocal-tract, face, and head position from speech acoustics is presented. The one-to-many nature of the speech production inverse problem is explained and exemplified. Then, it is shown how to impose anatomical constraints to restrict the space of possible solutions to plausible articulatory configurations. The presentation is concluded with demonstrations of talking-heads driven by speech acoustics.

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