3D Computer Simulation of the Human Vocal Tract
Articulatory-based Speech and Facial Synthesis
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Goal:
Create a dynamic 3D computer model of the human vocal tract

Building on the past:
Other researchers have constructed models of parts of the vocal tract, but have not yet successfully integrated these into a complete working 3D model.

Attributes of our model:
- Deformable: changes in position and scale of articulatory parameters
- Animatable: the vocal tract moves in real-time
- Features: allows for the production of speech and non-speech sounds

Applications
- Medicine / Education
- Prosthesis
- Speech synthesis
- Speech analysis
- Research for applications

Communication
- Video phone
- Video conferencing
- Video games
- Virtual reality

Entertainment
- Music production
- Video gaming
- Virtual reality

Model Vocal Tract Dynamics
- Experimental data collection (e.g., MRI, ultrasound, etc.)
- Articulatory animations by morphing data (e.g., lip and jaw motion)
- Model outputs: temperature, flow rate, etc.

Synchronize Acoustic Output
- Virtual microphone (convert from to acoustic signal)
- Resonance-based tube model
- Pressure waves in a spring-mass grid

Model Larynx
- Traditionally described as a noise source
- Current model (2020): deterministic
- Alternately modeled as an acoustic jet (2003)

Integration
- Open source
- Open Framework
- Modular Modeling Library Structure

Face Animation
- Sono, Tissu, and Muscle Model
  - High fidelity (1997)
- Low fidelity (1999), (2001)

Contributions
- Providing a framework for existing speech research
- Importing articulatory experimental data
- Designing appropriate editing, processing, and evaluation tools
- Allowing interaction between independent modules
- Modeling inter-articulatory timing
- Adding nasal passage to vocal tract model
- Moving beyond rigid body modeling to include deformable components

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