An Articulatory and Phonatory Synthesis Model for Production of High Quality Speech and Singing

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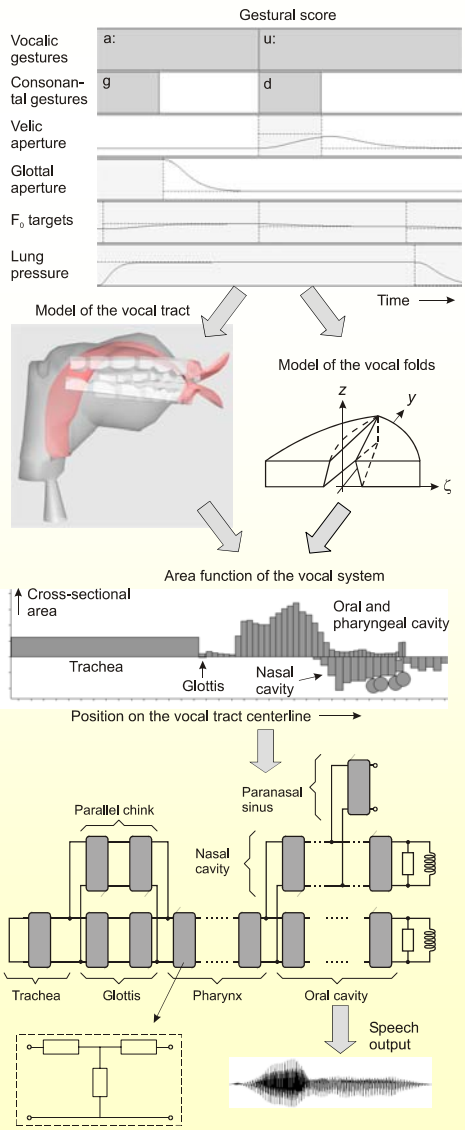
Introduction

- **Software implementation of a full parametric production model (synthesizer) including control modules for speech and singing**
- **Control units: articulatory and phonatory gestures (Birkholz et al. 2006)**
- **Articulatory-acoustic system: lumped element transmittion line circuit including correction for acoustic and aerodynamic losses (Birkholz et al. 2007)**
- **Geometrical part of the glottis model after Titze (1984) and Cranen and Schroeter (1995)**
- **Direct control of glottal area over time (Birkholz 2005)**
- **Geometrical model of nasal tract including paranasal sinuses after Dang and Honda (1994 and 1996)**

The Synthesizer

Fig. 1. Overwiev of the synthesizer. Input: gestural score, calculation of articulatory movements and phonatory maneuvers; calculation of area function; calculation of air flow and pressure within each tube section; calculation of radiated sound wave.



Rule-Based Generation of Gestural Scores

Fig. 2. Example of xml-formated gestural control sequences for "dona nobis pacem"

```
<song octaveOffset="0">
  <note beatsPerMinute="110" pitch="rest" type="1/2" vibrato="0.5" lyrics="" loudness="1.0"
        whisper="0" />
  <note pitch="g3" type="1/8" lyrics="d o:" />
  <note pitch="d3" type="1/8" lyrics="o:" />
  <note pitch="h3"  type="1/2" lyrics="n a:" />
  <note pitch="a3"  type="1/8" lyrics="n o:" />
  <note pitch="d3"  type="1/8" lyrics="o:" />
  <note pitch="c4"  type="1/2" lyrics="b i: s" />
  ....
</song>
```

Pitch-Dependent Vocal Tract Target Shapes for Vowels

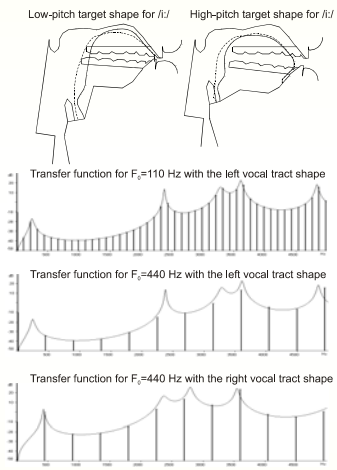
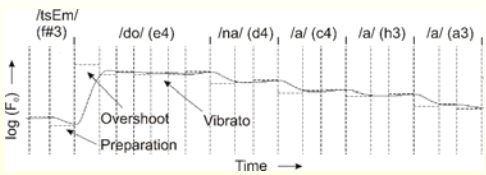


Fig. 3. Low pitch (left) and high pitch target shape (right) for the vowel /i:/and the corresponding spectra for F0=110Hz and F0=440Hz. For the case F0=440Hz the spectrum is given for the low pitch target shape (false) and for the high pitch target shape (right).

Vowels at higher pitches are synthesized with a more "open" articulation. The low-pitch vocalic shapes are just adopted from speech articulation.

Generation of F0-Contours

Fig. 4. F0 contour and F0 targets for "…dona…".



Each F0-gesture for realizing a note compises a "preparation-phase", an "overshoot phase" and the "target phase". During the target phase the F0-contour in addition exhibits vibrato.

References

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Birkholz P, Jackel D, Kröger BJ (2007) Simulation of losses due to turbulence in the time-varying vocal system. *IEEE Transactions on Audio, Speech, and Language Processing* 15: 1218-1225

Cranen B, Schroeter J (1995) Modeling a leaky glottis. *Journal of Phonetics* 23: 165-177

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More information concerning the software and for free download see: http://www.vocaltractlab.de