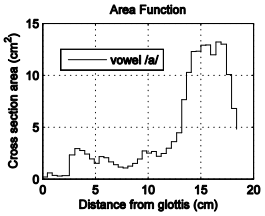
Simplification of Vocal Tract Shapes With Different Levels of Detail

Saeed Dabbaghchian[1], Marc Arnela[2], Olov Engwall[1]

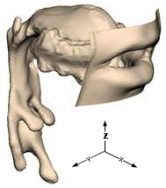
[1]Department of Speech, Music, and Hearing, KTH Royal Institute of Technology, Stockholm, Sweden
[2]GTM Grup de recerca en Tecnologies Mèdia, La Salle, Universitat Ramon Llull, Barcelona, Catalonia

saeedd@kth.se, marnela@salleurl.edu, engwall@kth.se

Vocal Tract (VT) Model



vowel [ɑ:]



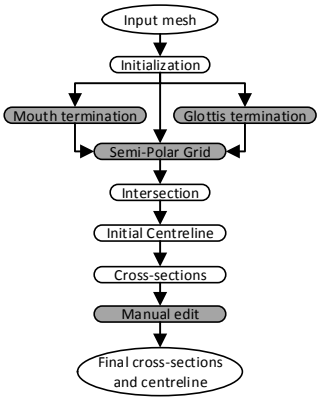
Area Function
- Simple and compact representation
- Useless for high frequencies analysis

Detailed 3D geometry
- high level of details (necessary?)
- computationally inefficient

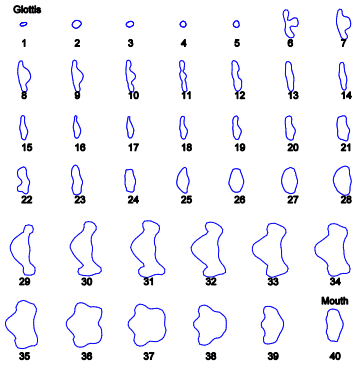
What are the other alternatives?

Shape Analysis

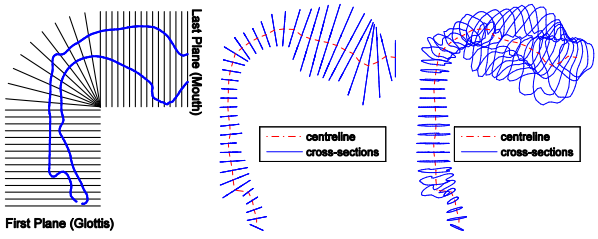
- Shape Analysis extracts the centerline and perpendicular cross-sections, which are the basis for shape simplification.
- The semi-polar grid is a set of 3D planes (gridplanes) which has two Cartesian and one polar section.
- Glottis and Mouth termination planes are respectively the lowest and front-most planes for which the intersection with the VT is a closed contour. These planes are calculated by the user's help.
- Lips, sinus piriformis and vallecula are removed for the shape analysis.
- Initial centerline: intersect gridplanes with VT surface mesh, connect center of cross-sections, do Bézier smoothing
- Final cross-sections: intersect VT with planes having normal equal to tangent of the initial centerline.
- Final centerline: connect center of final cross-sections.



Block diagram for shape analysis



2D view of final cross-sections



(a) (b) (c)

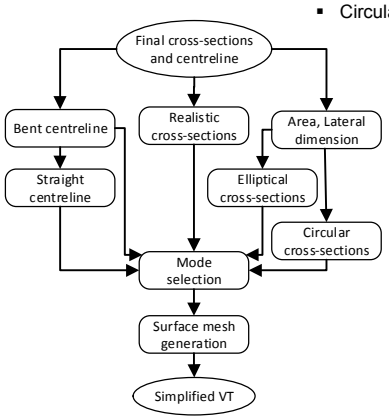
(a) 2D (XZ) view of semi-polar grid and VT midsagittal boundary
(b) 2D (XZ) view of final centerline and cross-sections
(c) 3D view of final centerline and cross-sections

Acknowledgement

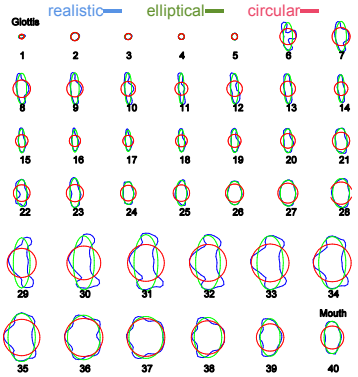
This research has been supported by EU-FET grant EUNISON 308874.

Shape Simplification

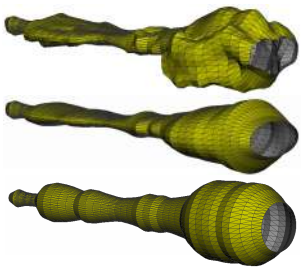
- Shape simplification calculates the angle, center, area, length, and lateral dimension of each cross-section. This information is used to regenerate centerline and cross-sections in different configurations.
- configurations for centerline:
  - Straight
  - Bent
- configurations for cross-sections:
  - Realistic
  - Elliptical
  - Circular



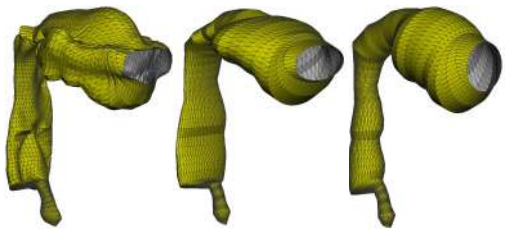
Block diagram for shape simplification



2D view of final cross-sections and corresponding simplifications



Straight configurations, from up to down: realistic, elliptical, circular



Bent configurations, from left to right: realistic, elliptical, circular

Conclusion

- A method was proposed and implemented to regenerate the VT geometry (surface mesh) in simplified versions with different levels of detail.
- Simplified geometries may be used to
  - study the acoustic effects of simplification
  - study the acoustic properties in physical replicas
  - study dynamic sounds such as diphthongs
  - study wave equation using multimodal methods
  - study the acoustic effects of geometrical perturbation
  - decrease the computational cost

Saeed Dabbaghchian
Tel: +46 8 790 7564
Email: saeedd@kth.se
Web: http://www.speech.kth.se/~saeedd/