"An" evaluation of automatic glottal source analysis

John Kane

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NOLISP
Mons, Belgium

Glottal source analysis

Glottal source analysis

Off with her head!

Glottal source in speech technology

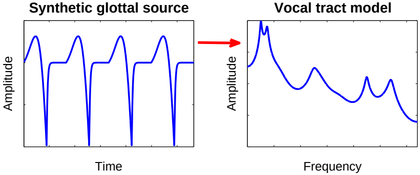
Speech synthesis

Speech recognition

Speaker verification

Evaluating glottal source analysis

Laryngograph/Electroglottograph



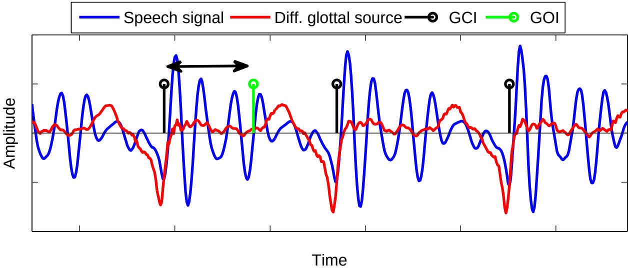
Synthetic speech

Aims

- Quantitative evaluation of glottal inverse filtering and parameterisation methods
- Additionally include model-based glottal parameterisation

Glottal inverse filtering methods -

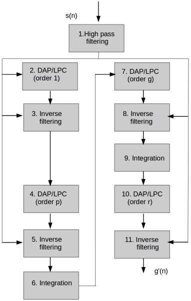
Closed-phase inverse filtering (CPIF)



- Detection glottal opening/closing instants
- Covariance LPC on closed phase (i.e GCI => GOI)

Glottal inverse filtering methods -

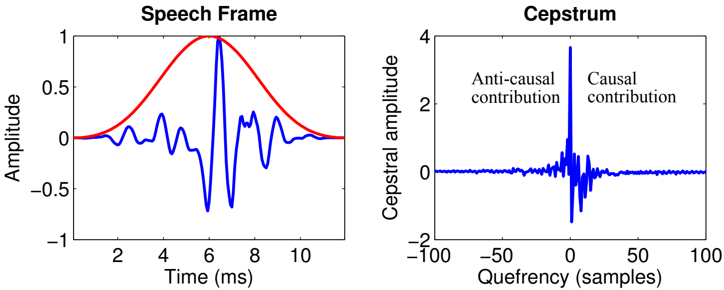
Iterative Adaptive Inverse filtering (IAIF)



- Modelling/inverse filtering of glottal source/vocal tract with increasing prediction order.

Glottal inverse filtering methods -

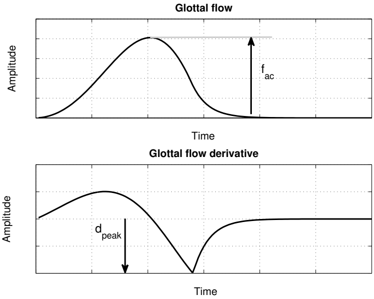
Complex-cepstrum based decomposition (CCEPS)



- Retain only negative quefrency component of the complex cepstrum for glottal source estimation

Parameterisation - Direct measures

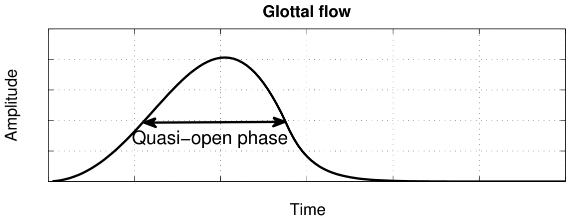
Normalised Amplitude Quotient (NAQ)



- Amplitude based correlate of the Closing Quotient

Parameterisation - Direct measures

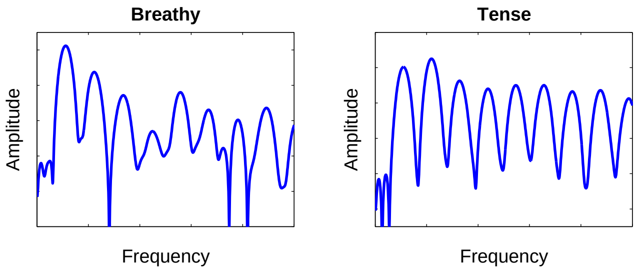
Quasi-Open Quotient (QOQ)



- Amplitude based correlate of the Open Quotient

Parameterisation - Direct measures

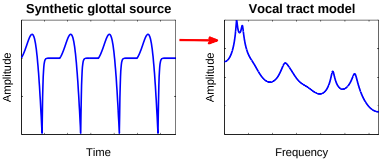
Amplitude difference of first two harmonics (H1-H2)



Parameterisation - Model based methods

- Time domain LF model fitting algorithm (Strik-LF - IAIF)
- Dynamic programming based LF fitting, with time, frequency and transition error criteria (DyProg-LF - IAIF)
- LF model shape parameter (Rd) derived by minimising phase based error criterion (Degott-LF)

Experimental setup - Synthetic stimuli



	GLOTTAL SOURCE				VOCAL TRACT FILTER
	f_0 (Hz)	Ra	Rk	Rg	Vowel
Max	300	0.15	0.5	2.0	8 Vowels settings
Min	80	0.01	0.1	0.6	
Step	10	0.02	0.05	0.1	

=> 198,720 synthetic signals

=> **Relative error:** parameter derived from synthetic source (reference) vs derived following inverse filtering

Experimental setup - Discrimination of phonation types

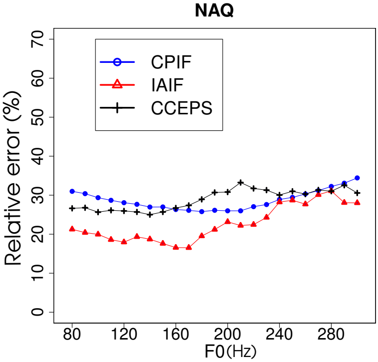
All-voiced sentences

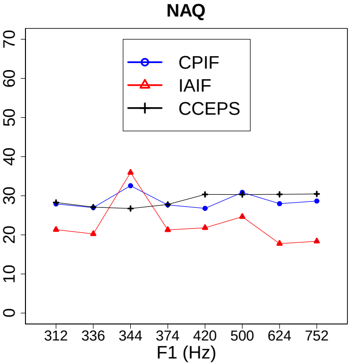
- 6-speakers × 5 -sentences × 3-phonation types
- 3-speakers × 10-sentences × 3-phonation types

Analysis

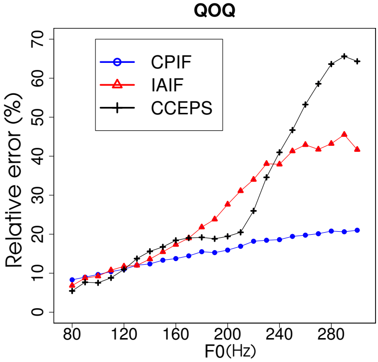
- Parameter contours resampled to 10-samples
- Pearson (R^2): parameter value-*dependent variable*, phonation type-*independent variable*

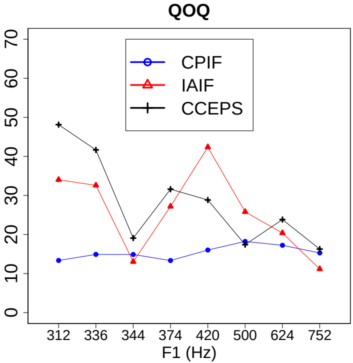
Results - Synthetic stimuli (NAQ)



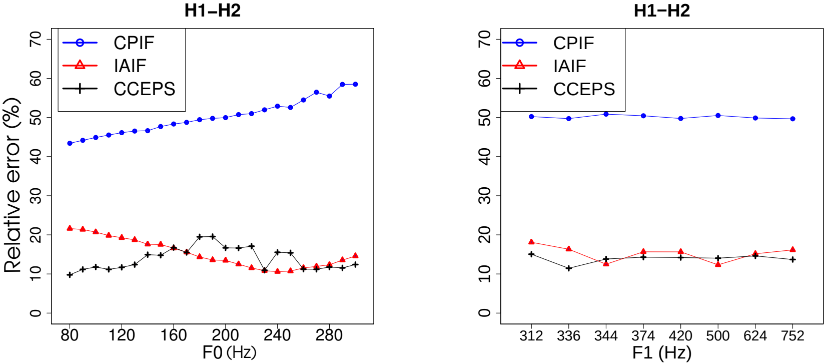


Results - Synthetic stimuli (QOQ)

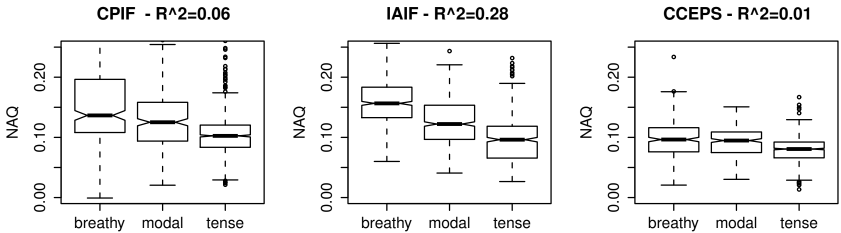




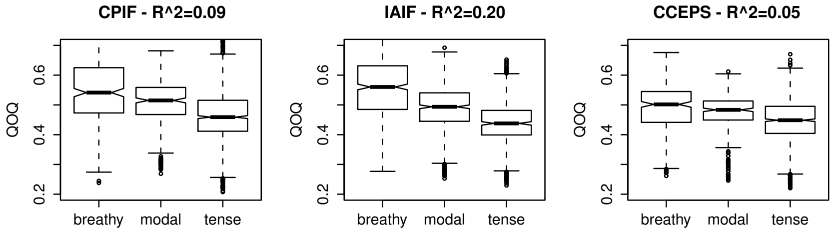
Results - Synthetic stimuli (H1-H2)



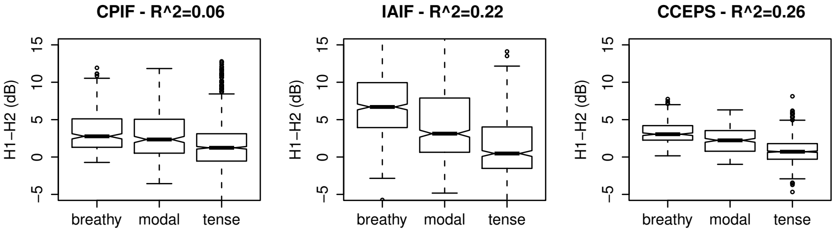
Results - Discrimination of phonation types (NAQ)



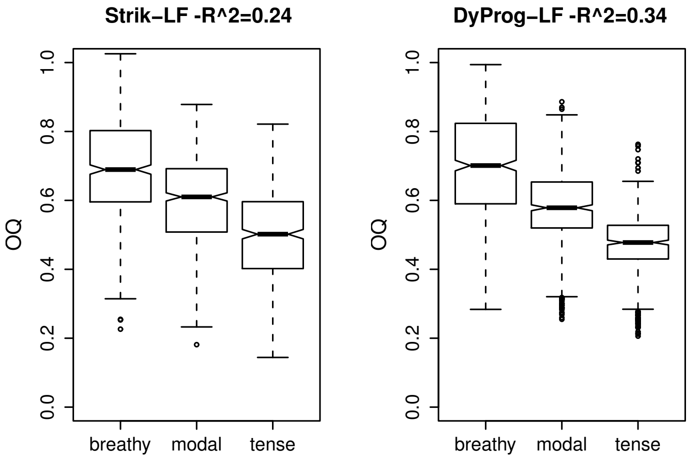
Results - Discrimination of phonation types (QOQ)



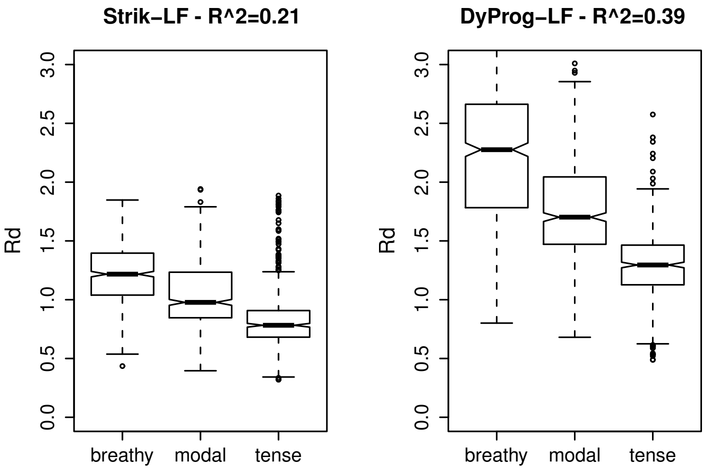
Results - Discrimination of phonation types (H1-H2)



Results - Discrimination of phonation types (model-based-OQ)

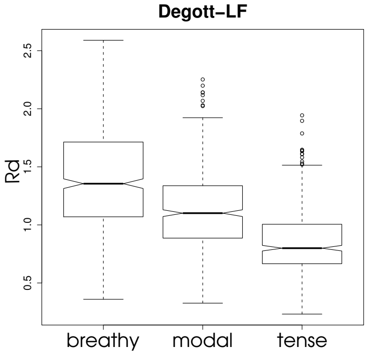


Results - Discrimination of phonation types (model-based-Rd)



Results - Discrimination of phonation types (model-based-Rd)

R^2=0.28



Discussion - Take-home message

- IAIF more robust than in Drugman et al., otherwise results corroborated
- Model based parameterisation better than previously reported (e.g., Airas & Alku, 2007).

Future/ongoing work

- Phonetic feature extraction to determine optimal analysis regions
- Parameterisation and classification of variation in phonation types
- Analysis and synthesis of voice quality variation

Voice Analysis Toolkit

https://github.com/jckane/Voice_Analysis_Toolkit

Thank you!

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