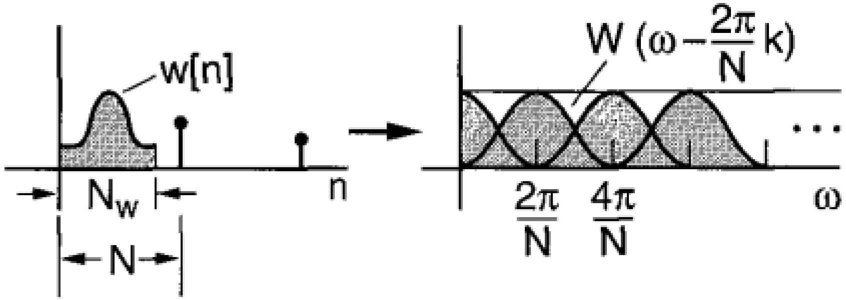
FBS Method

$$y[n] = \left[\frac{1}{Nw[0]}\right] \underbrace{\sum_{k=0}^{N-1} X(n,k)\, e^{j\frac{2\pi}{N}kn}}$$

Adding Frequency Components For Each n

FBS Constraint: $$\sum_{k=0}^{N-1} W\left(\omega - \frac{2\pi}{N}k\right) = Nw[0]$$

For $N_w < N \rightarrow y[n] = x[n]$



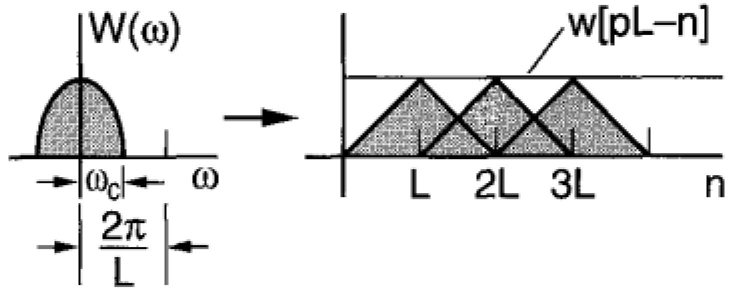
OLA Method

$$y[n] = \left[\frac{L}{W(0)}\right] \underbrace{\sum_{p=-\infty}^{\infty} x[n]\, w[pL-n]}$$

Adding Time Components For Each n

OLA Constraint: $$\sum_{p=-\infty}^{\infty} w[pL-n] = \frac{W(0)}{L}$$

For $\omega_c < \frac{2\pi}{L} \rightarrow y[n] = x[n]$



Patterns in spectrogram

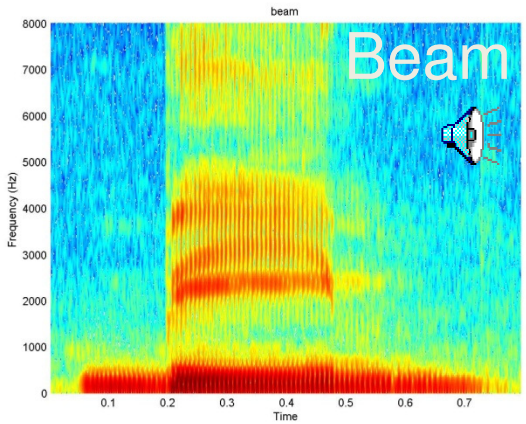
Signature of phonemes in spectrogram

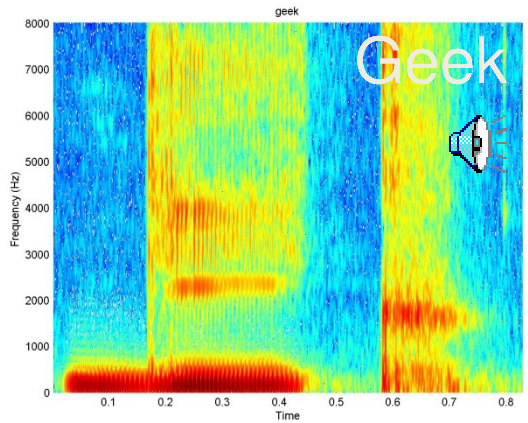
Typical signatures

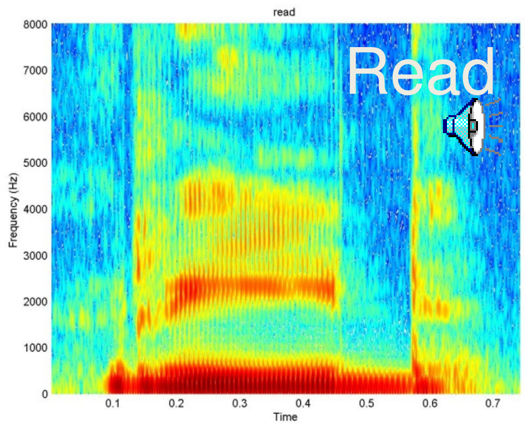
Changes in variety of conditions – speaker, noise, context, language, emotion

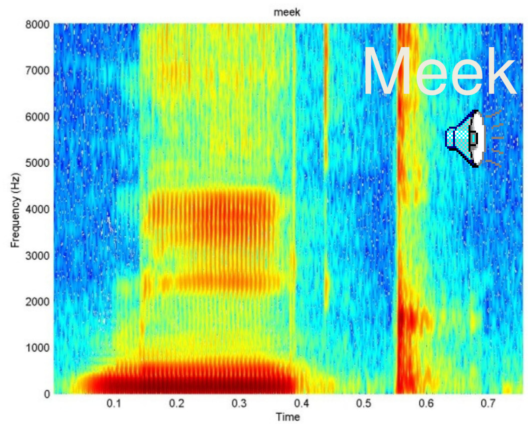
Spectrogram reading

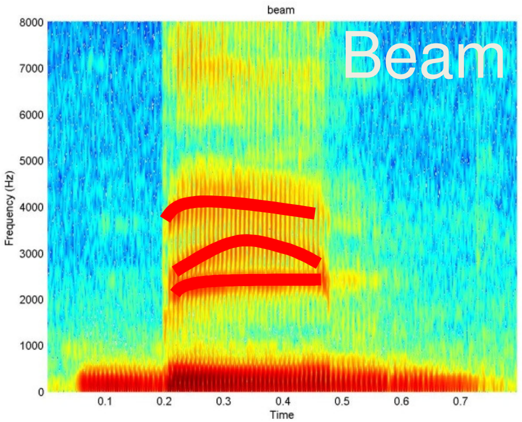
http://www.cslu.ogi.edu/tutordemos/SpectrogramReading/spectrogram_reading.html

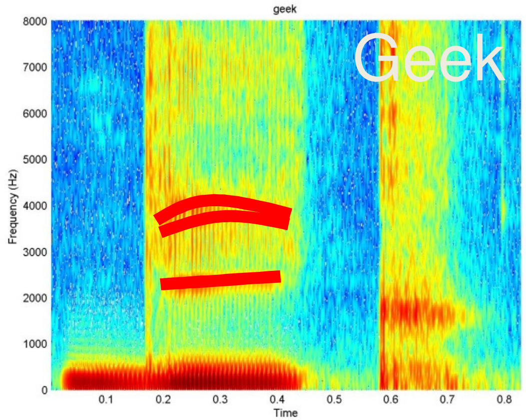

beam
Beam
Frequency (Hz)
Time

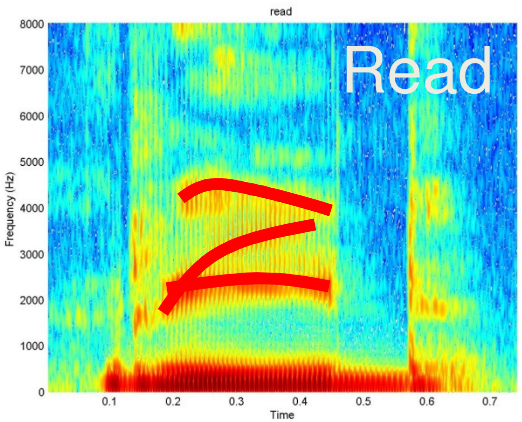

geek
Geek
Frequency (Hz)
Time

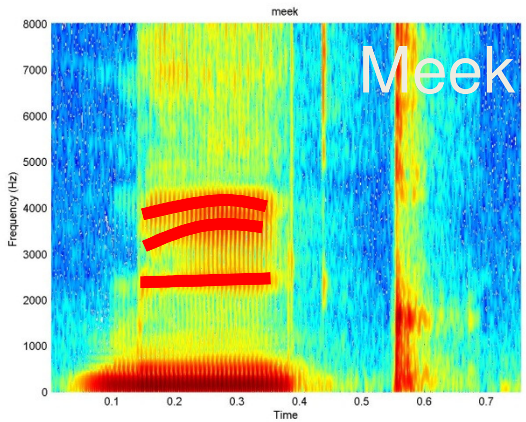

read
Read
Frequency (Hz)
Time


meek
Meek
Frequency (Hz)
Time

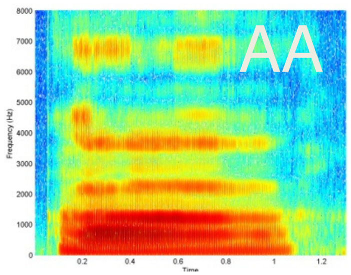

beam
Beam
Frequency (Hz)
Time

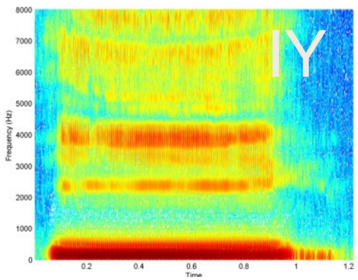

geek
Geek
Frequency (Hz)
Time

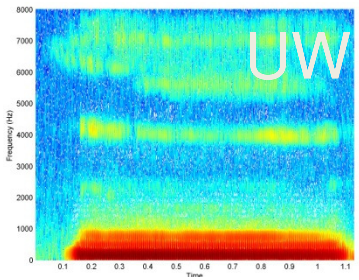

read
Read
Frequency (Hz)
Time

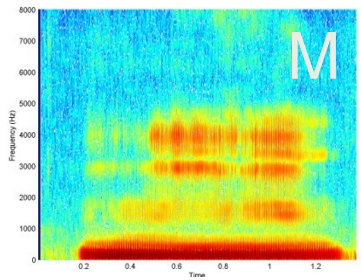

meek
Meek
Frequency (Hz)
Time

- Every phoneme has a locus
  - The spectral shape that would be observed if the phoneme were uttered in isolation, for a long time

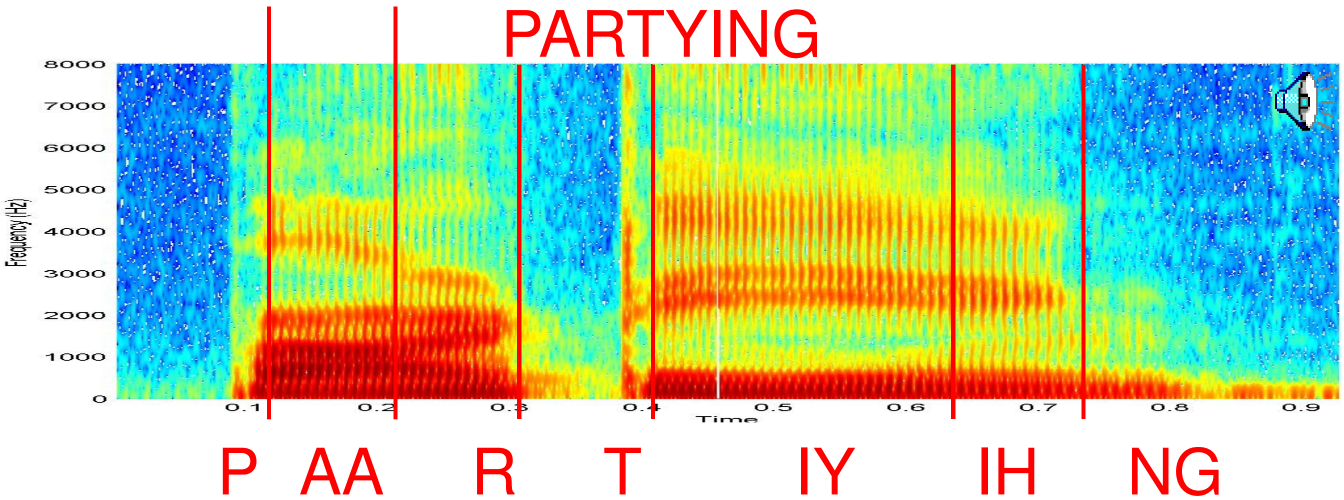








  - In continuous speech, the spectrum attempts to arrive at locus of the current sound

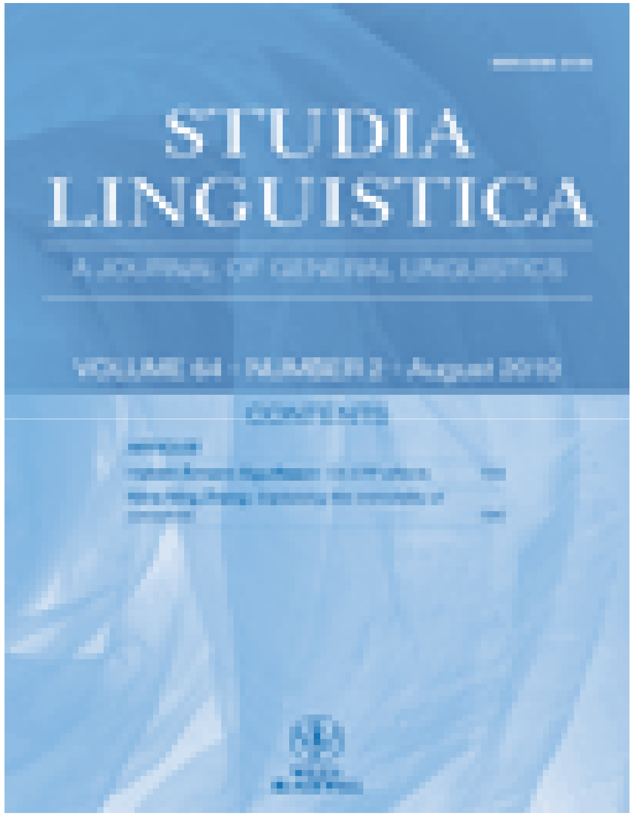


COARTICULATION AND THE LOCUS THEORY

Pierre Delattre

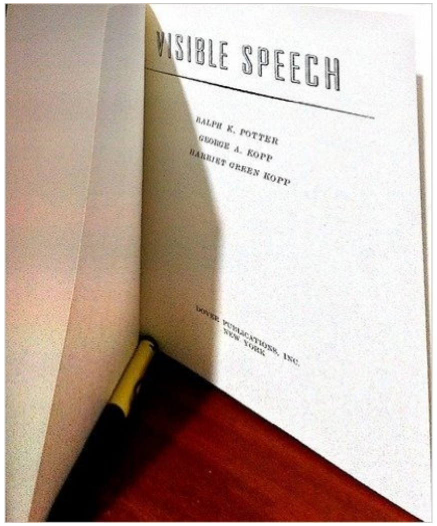
Studia Linguistica

Volume 23, Issue 1, pages 1–26, June 1969

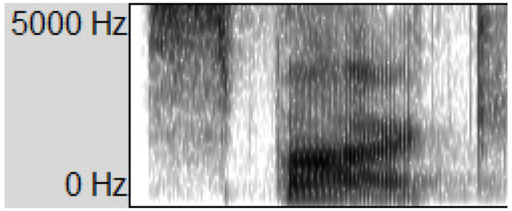


The visible speech

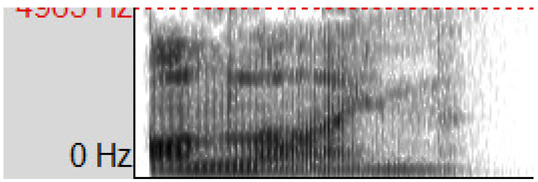
by Ralph Kimball Potter , George A. Kopp , Harriet Green Kopp



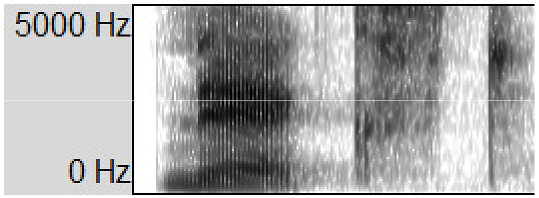
Online



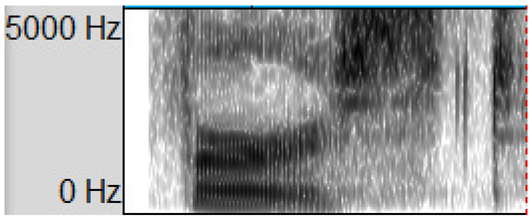
Next



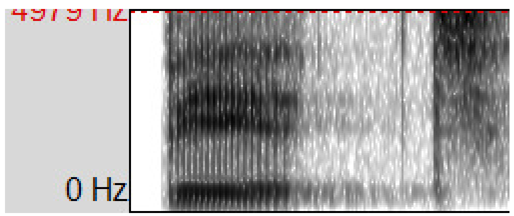
First



Bit



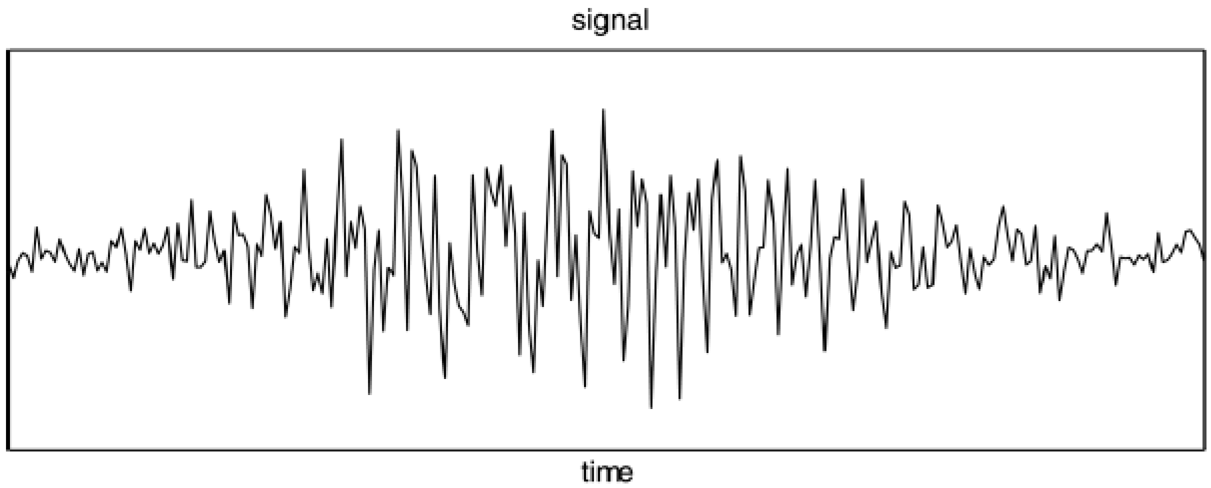
spark



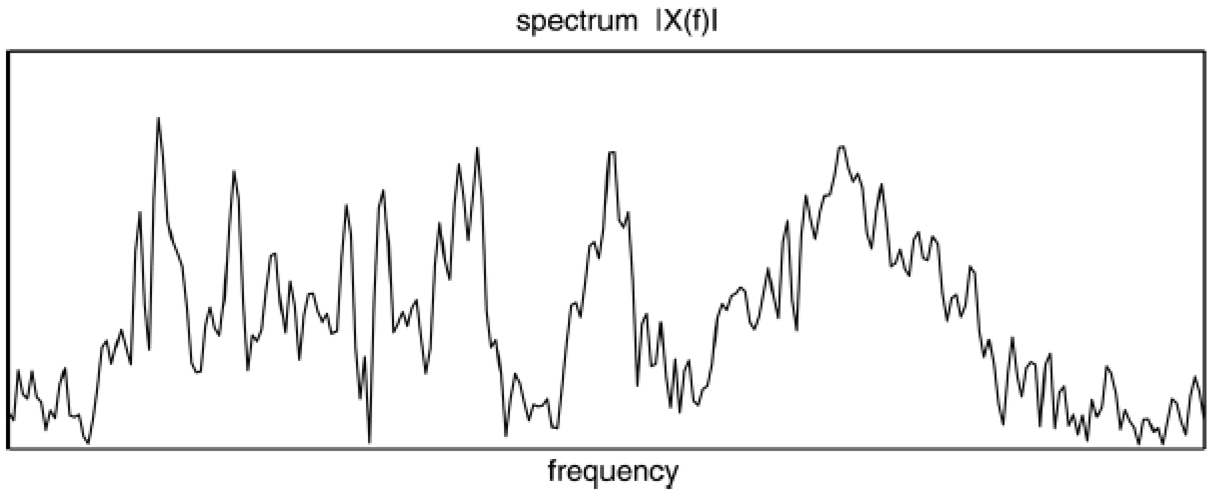
weighted overlap-add

[8] Portnoff, M.R. 1980. "Time-Frequency Representation of Digital Signals and Systems Based on Short Time Fourier Analysis," IEEE Trans on ASSP, vol 28(1), pp. 55-69.

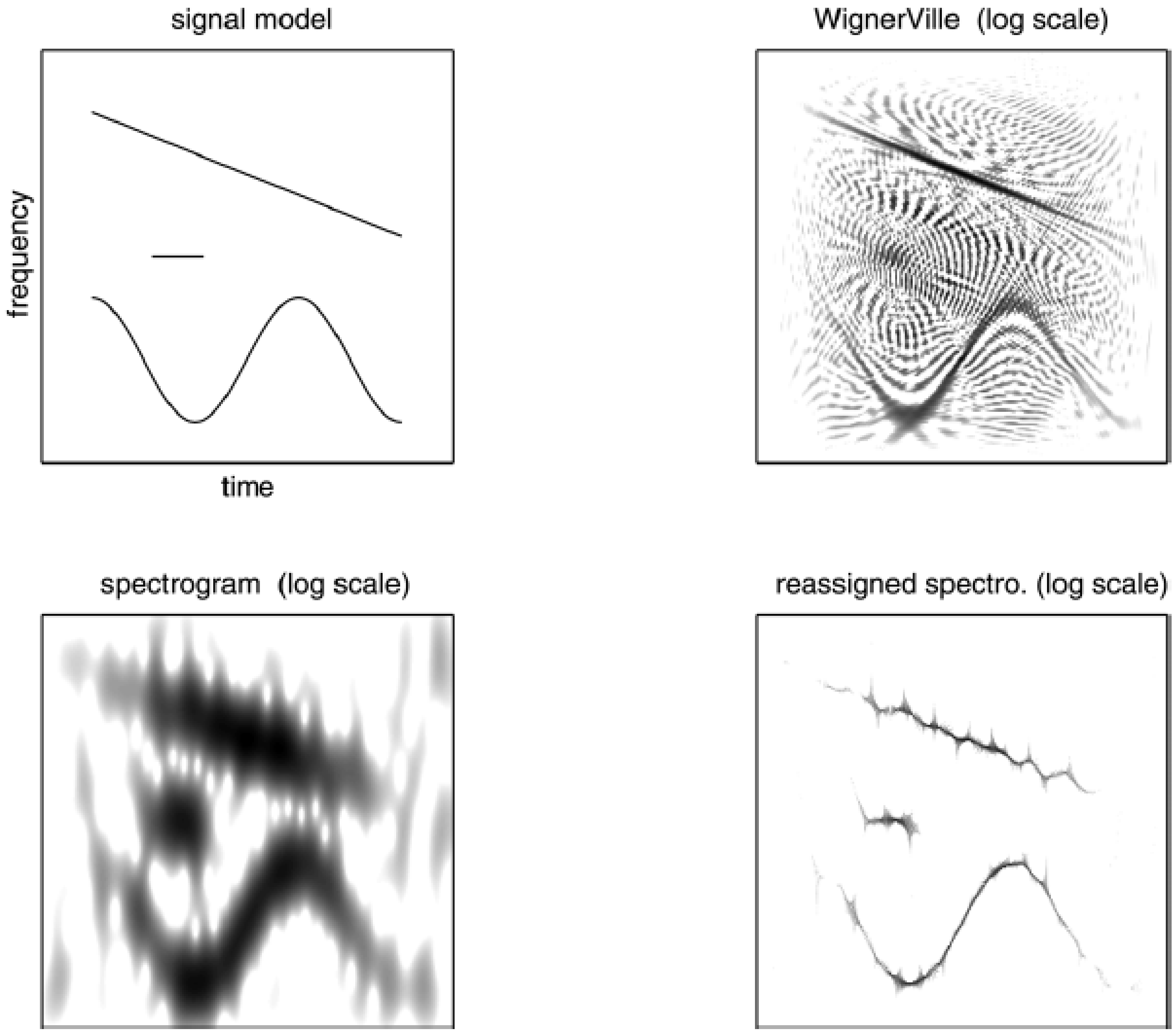
[9] Crochiere, R.E. 1980. "A Weighted Overlap-Add Method of Short-Time Fourier Analysis/Synthesis," IEEE Trans on ASSP, vol 28(1), pp. 99-102.



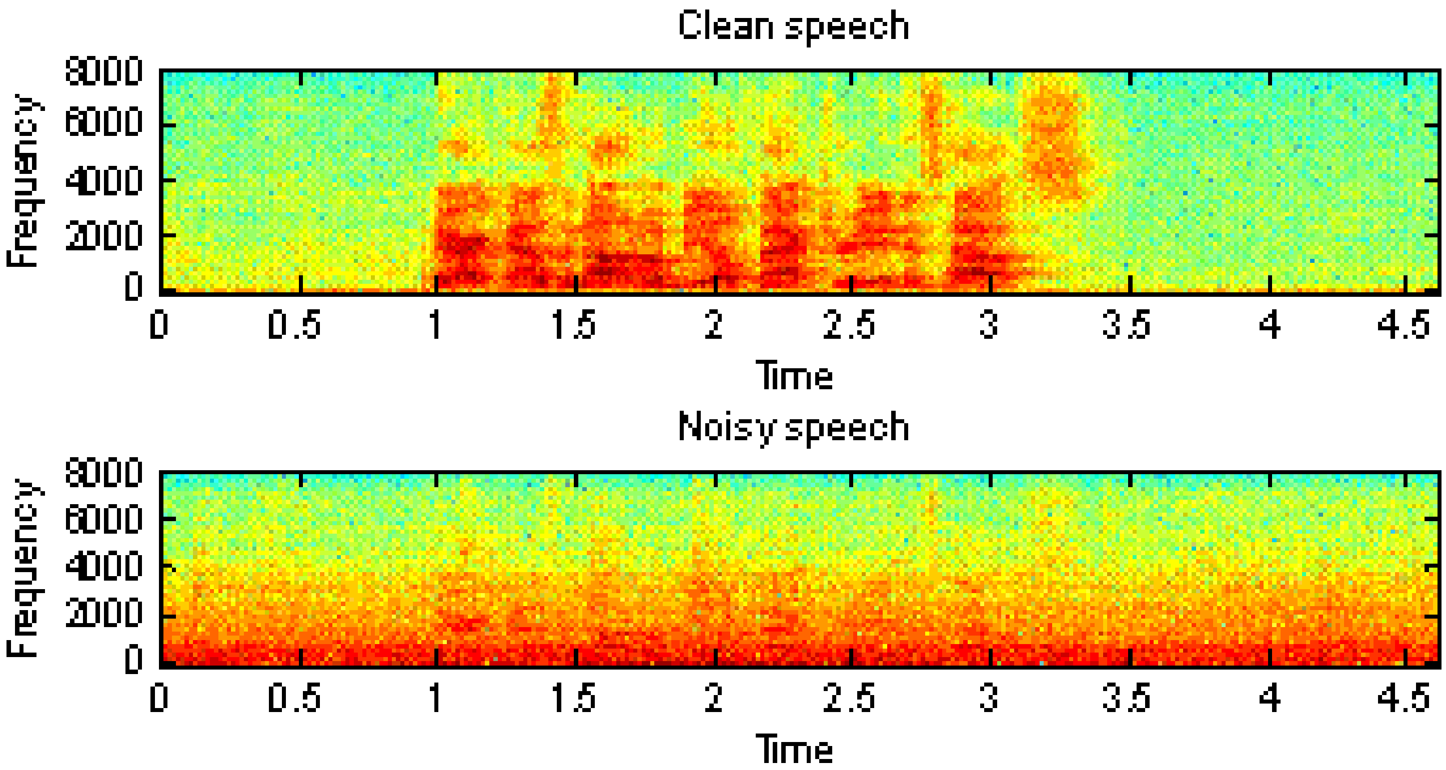
signal
time



spectrum |X(f)|
frequency



signal model
frequency
time
WignerVille (log scale)
spectrogram (log scale)
reassigned spectro. (log scale)



Clean speech
Frequency
8000
6000
4000
2000
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Time
Noisy speech
Frequency
8000
6000
4000
2000
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Time

Morphological Processing of Spectrograms for Speech Enhancement

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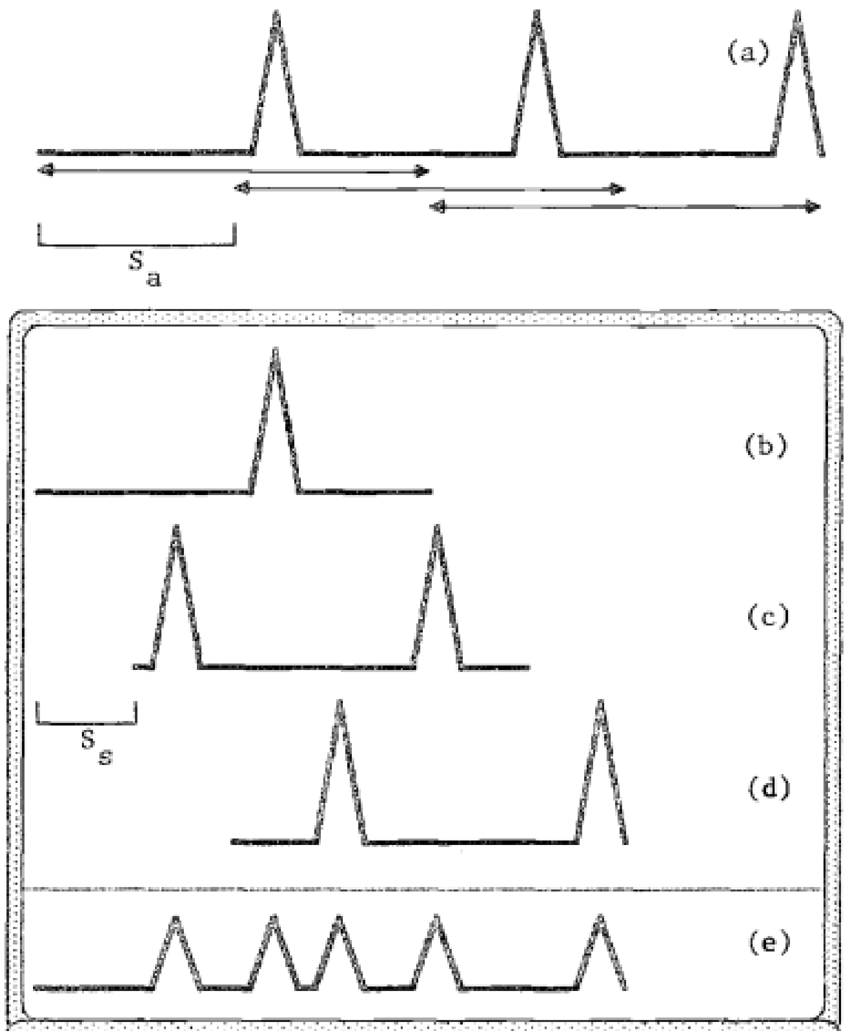
http://gpm.tsc.uc3m.es/

Abstract. In this paper a method to remove noise in speech signals improving the quality from the perceptual point of view is presented. It combines spectral subtraction and two dimensional non-linear filtering techniques most usually employed for image processing. In particular, morphological operations like erosion and dilation are applied to a noisy speech spectrogram that has been previously enhanced by a conventional spectral subtraction procedure. Anisotropic structural elements on gray-scale spectrograms have been found to provide a better perceptual quality than isotropic ones and reveal themselves as more appropriate for retaining the speech structure while removing background noise. Our procedure has been evaluated by using a number of perceptual quality estimation measures for several Signal-to-Noise Ratios on the Aurora database.


(a)
S_a
(b)
(c)
S_s
(d)
(e)

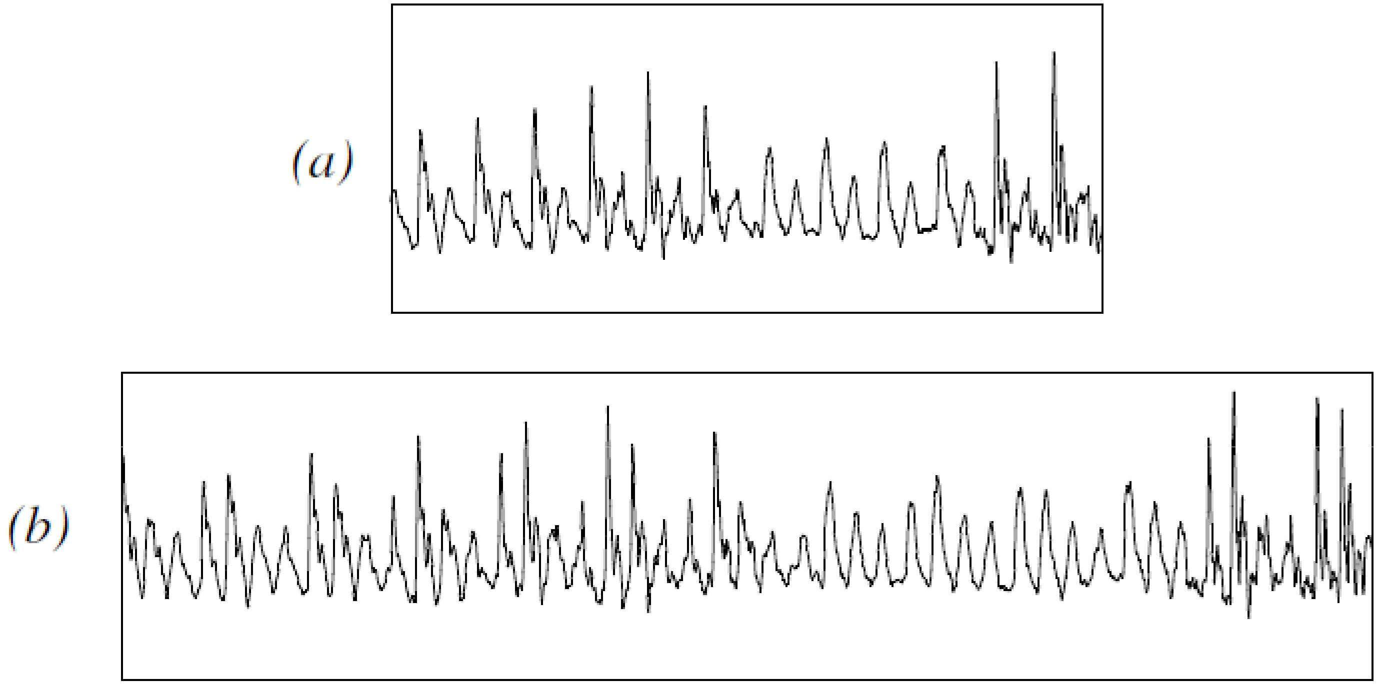
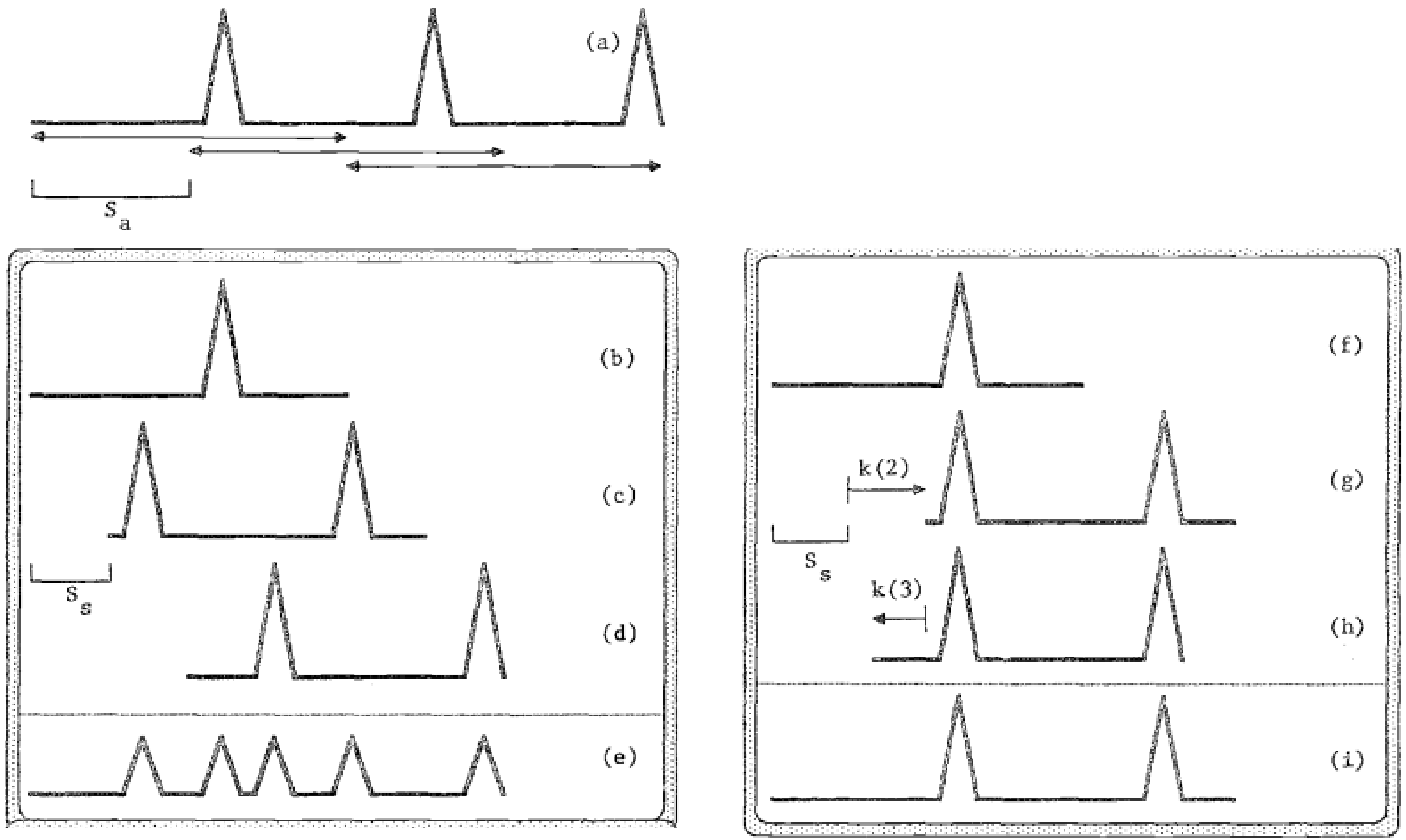


Fig. 1. *OLA-synthesis from the time-warped STFT does not succeed to replicate the quasi-periodic structure of the original signal (a) in its output (b).*


(a)
S a
(b)
(c)
S s
(d)
(e)
(f)
k(2)
(g)
S s
k(3)
(h)
(i)