

7T2: Sinusoidal plus Residual Modeling

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Sinusoidal plus residual model

$$y[n] = \sum_{r=1}^R A_r[n] \cos(2\pi f_r[n]n) + xr[n] = ys[n] + xr[n]$$

R : number of sinusoidal components

$A_r[n]$: instantaneous amplitude

$f_r[n]$: instantaneous frequency (Hz)

$ys[n]$: sinusoidal component

$xr[n] = x[n] - ys[n]$: residual component

Spectral view

$$Y_l[k] = \sum_{r=1}^{R_l} A_{(r,l)} W[k - \hat{f}_{(r,l)}] + Xr_l[k] = Ys_l[k] + Xr_l[k]$$

$W[k]$: spectrum of analysis window

R_l : number of sinusoidal components

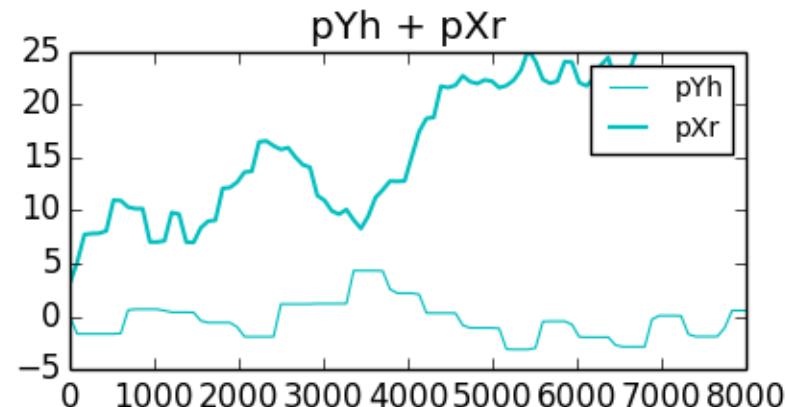
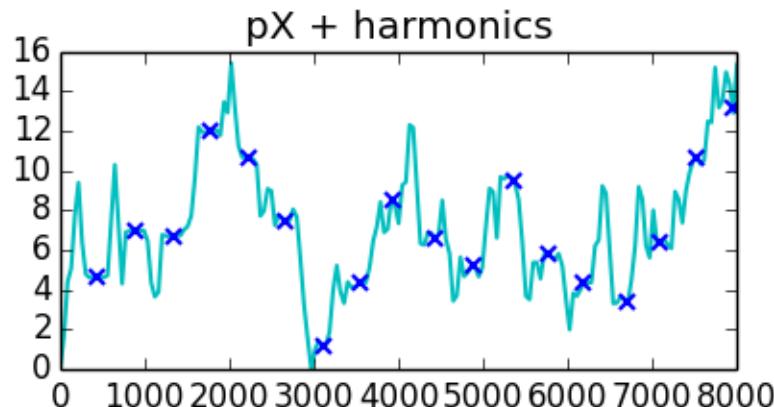
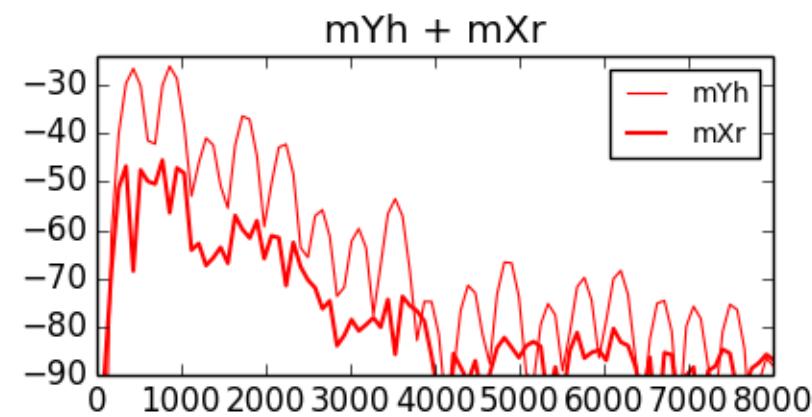
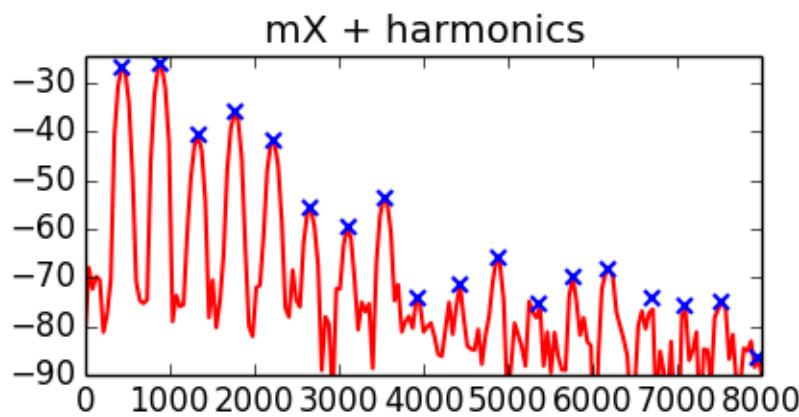
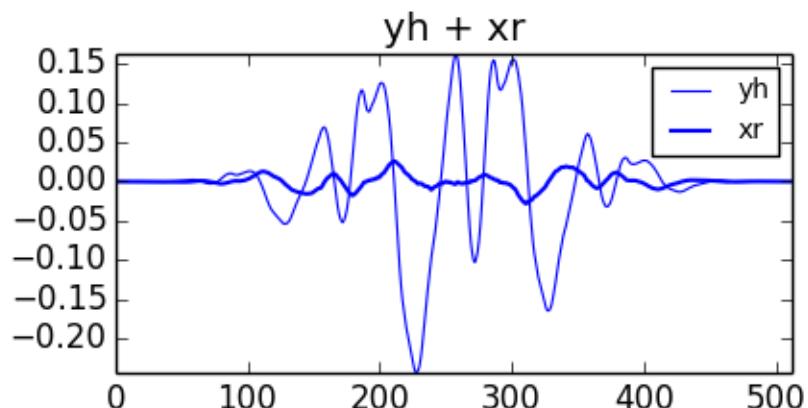
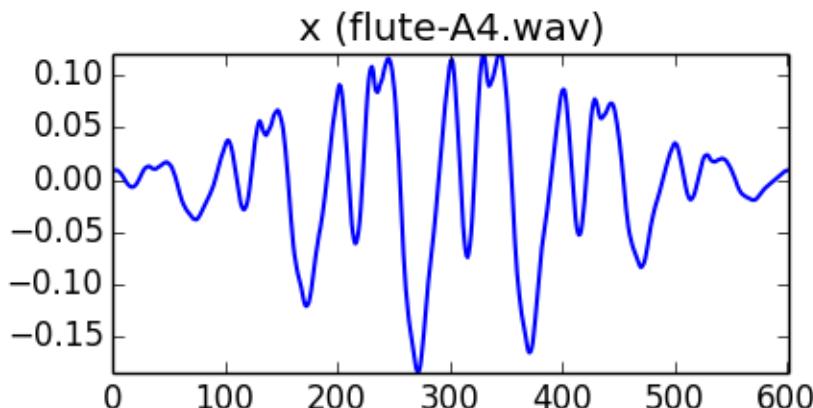
$A_{(r,l)}$: amplitude of sinusoid

$\hat{f}_{(r,l)}$: normalized frequency of sinusoid

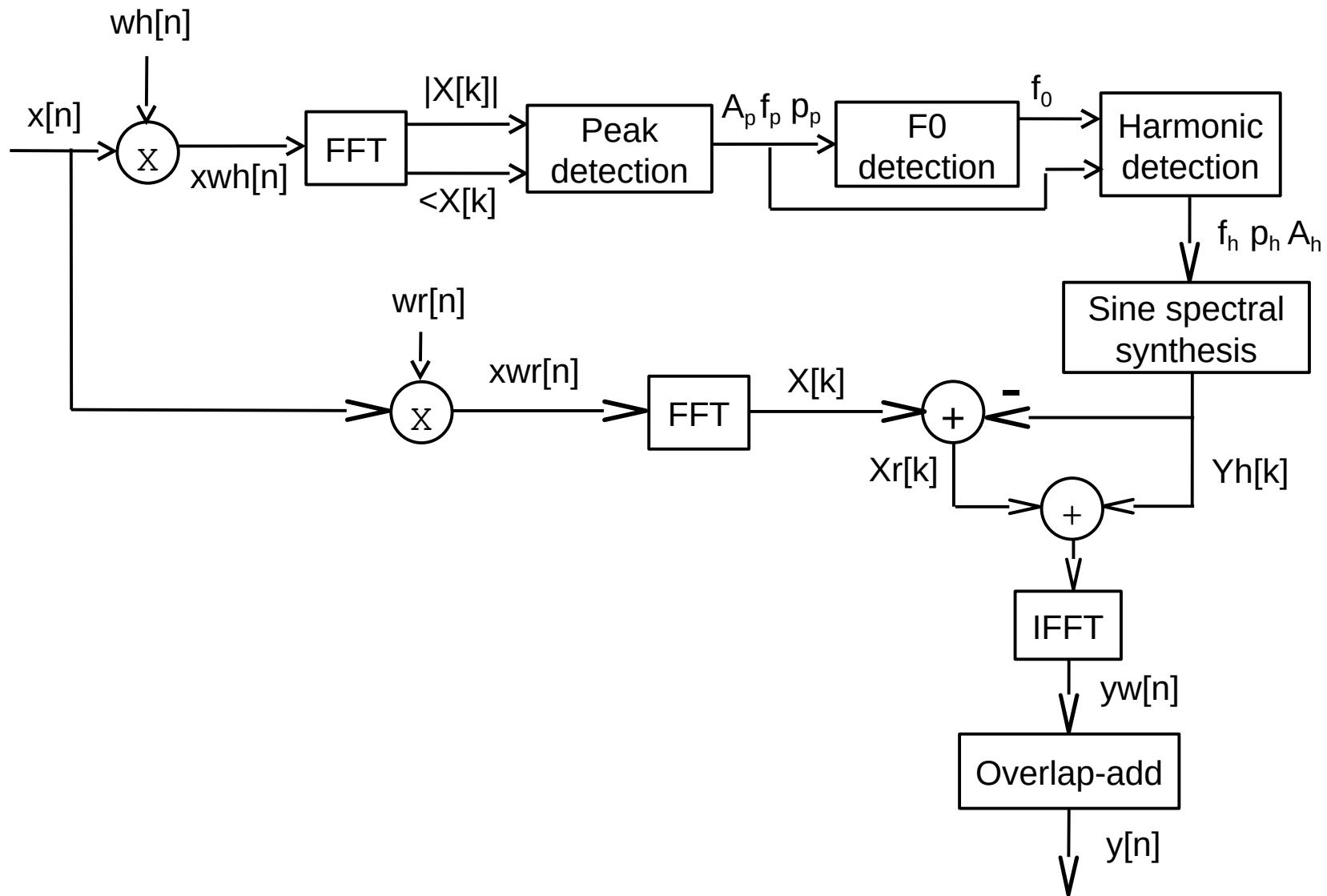
$Ys_l[k]$: sinusoidal component spectrum

$Xr_l[k] = X_l[k] - Ys_l[k]$: residual component spectrum

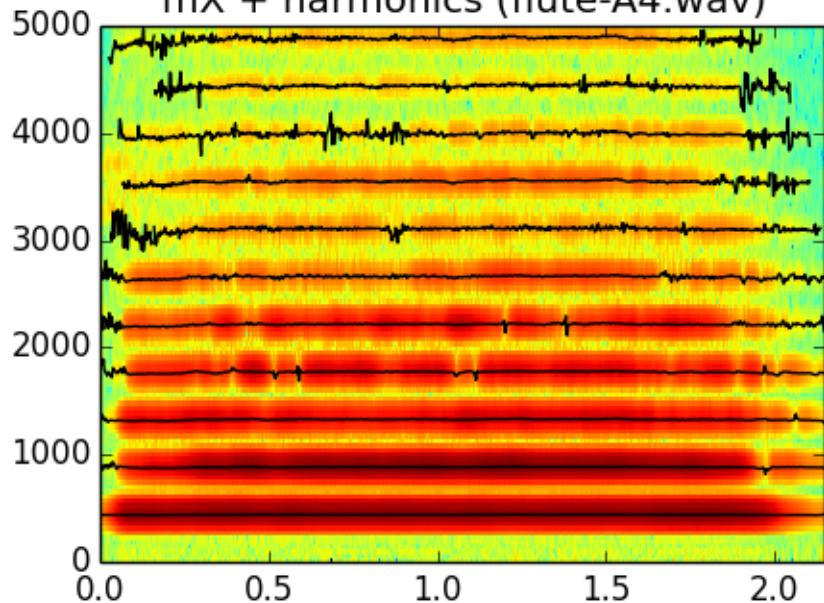
l : frame number



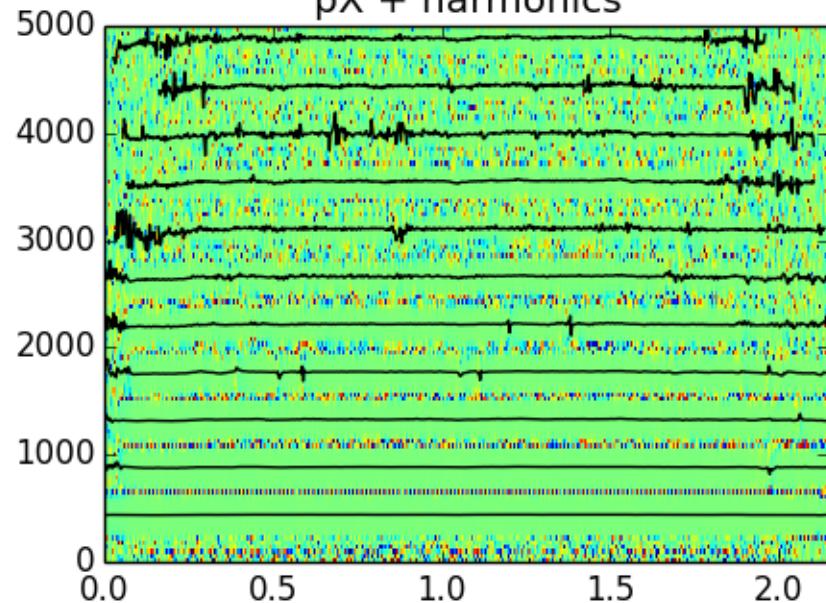
HpR model system



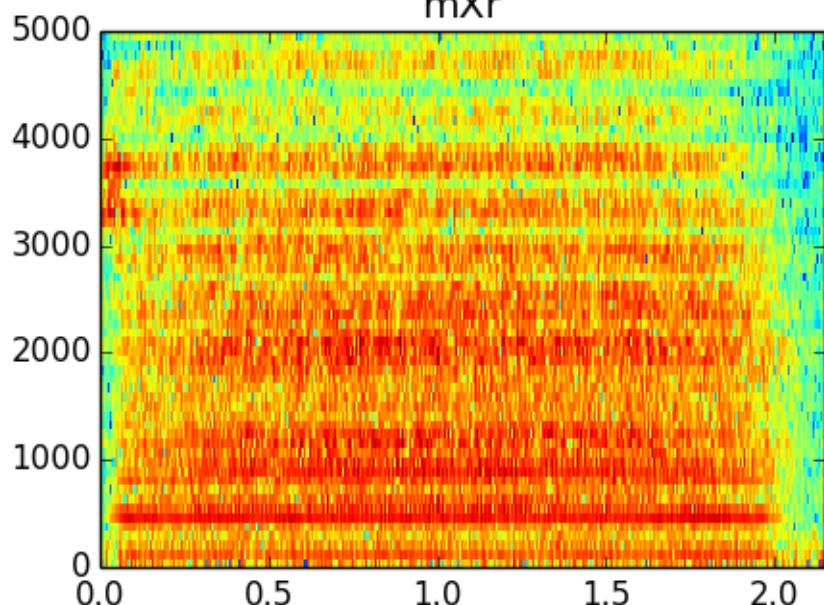
mX + harmonics (flute-A4.wav)



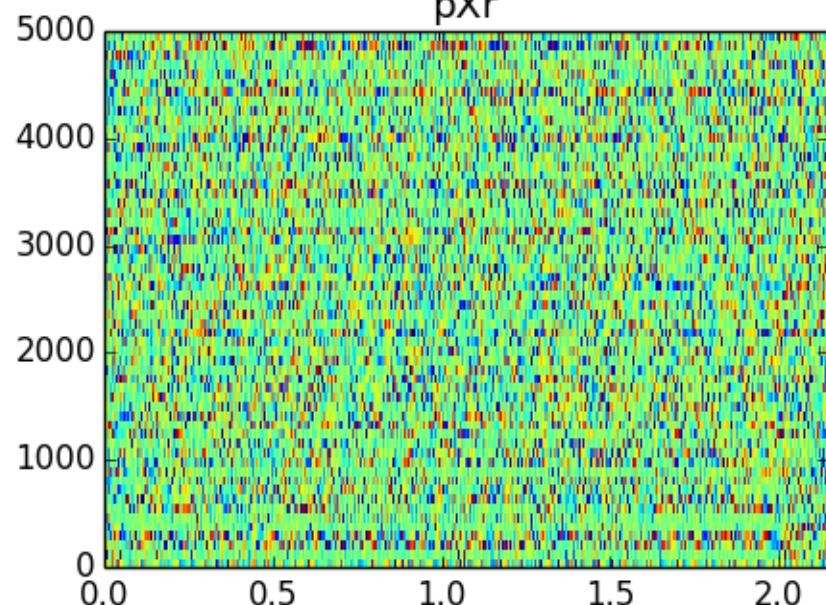
pX + harmonics



mXr



pXr



Sinusoidal plus stochastic model

$$y[n] = \sum_{r=1}^R A_r[n] \cos(2\pi f_r[n]n) + yst[n] = ys[n] + yst[n]$$

R : number of sinusoidal components

$A_r[n]$: instantaneous amplitude

$f_r[n]$: instantaneous frequency (Hz)

$yst[n]$: stochastic component

$ys[n]$: sinusoidal component

where:

$$yst_l[n] = \sum_{k=0}^{N-1} u[k] h_l[n-k]$$

$u[n]$: white noise

$h[n]$: impulse response of residual approximation

l : frame number

Spectral view

$$Y_l[k] = \sum_{r=1}^{R_l} A_{(r,l)} W[k - \hat{f}_{(r,l)}] + Yst_l[k]$$

$W[k]$: spectrum of analysis window

R_l : number of sinusoidal components

$A_{(r,l)}$: amplitude of sinusoid

$\hat{f}_{(r,l)}$: normalized frequency of sinusoid

l : frame number

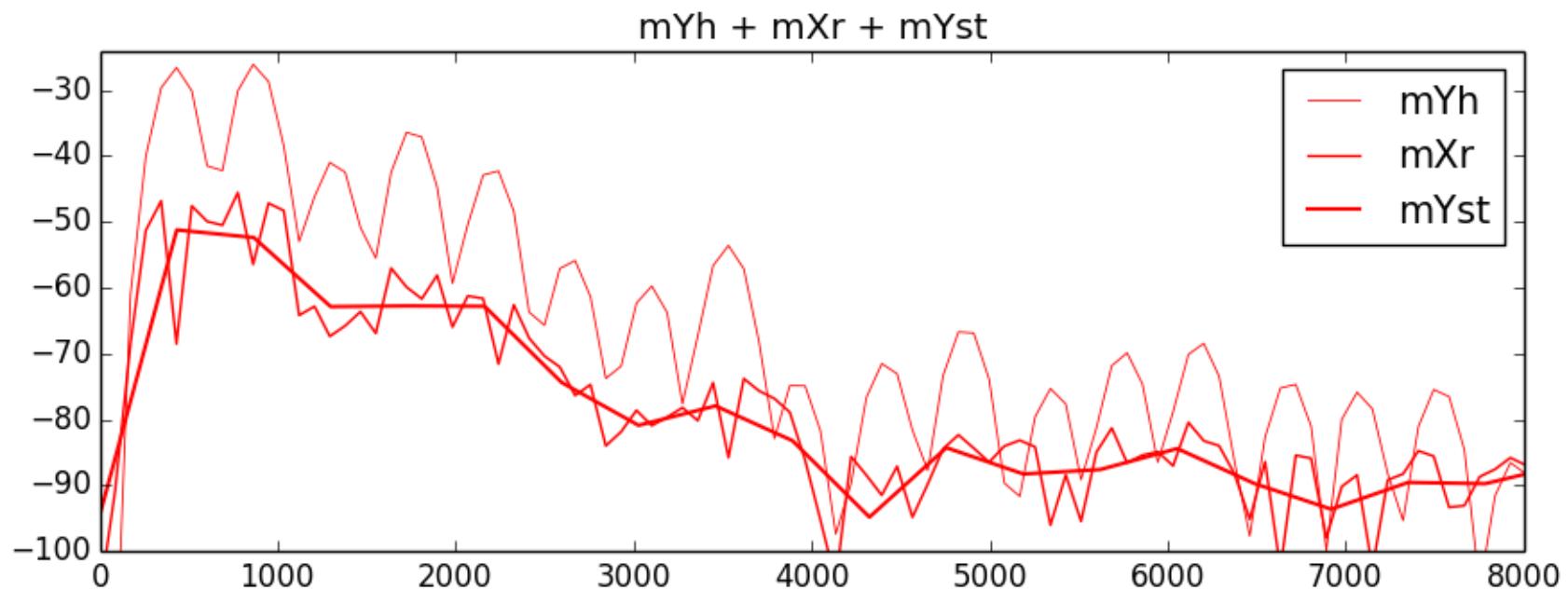
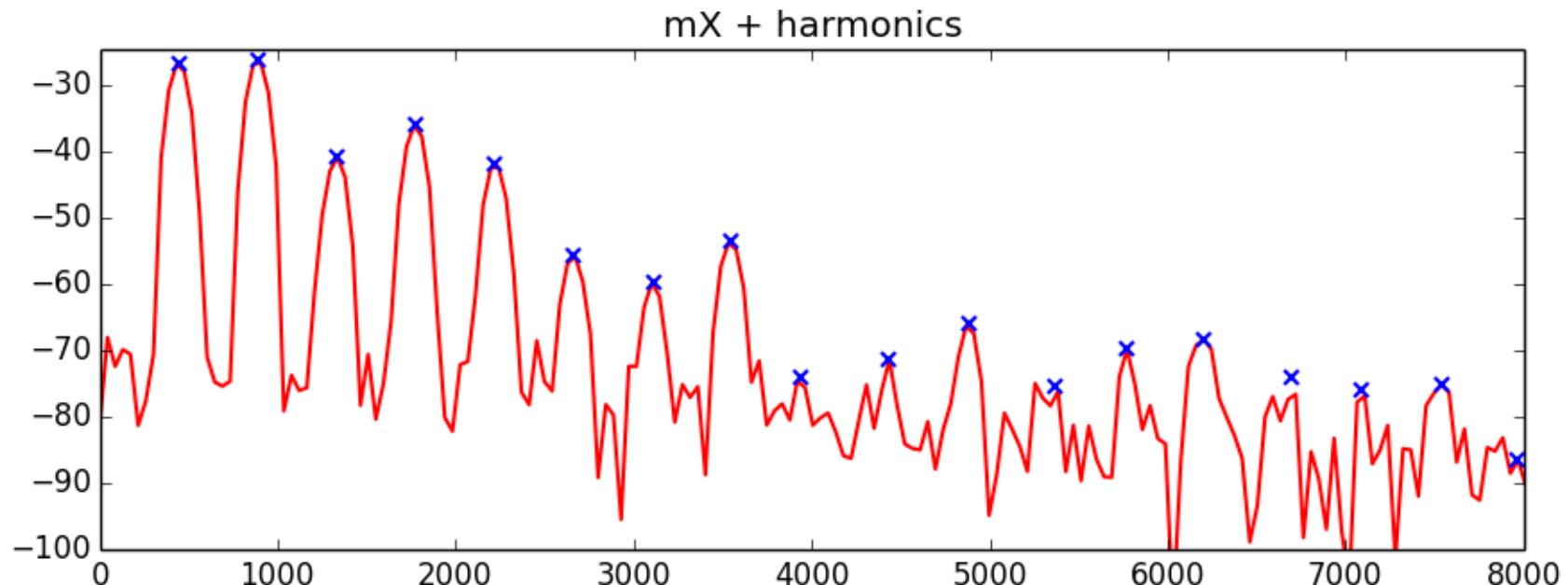
where:

$$Yst_l[k] = |\tilde{X}r_l[k]| e^{j \star U[k]}$$

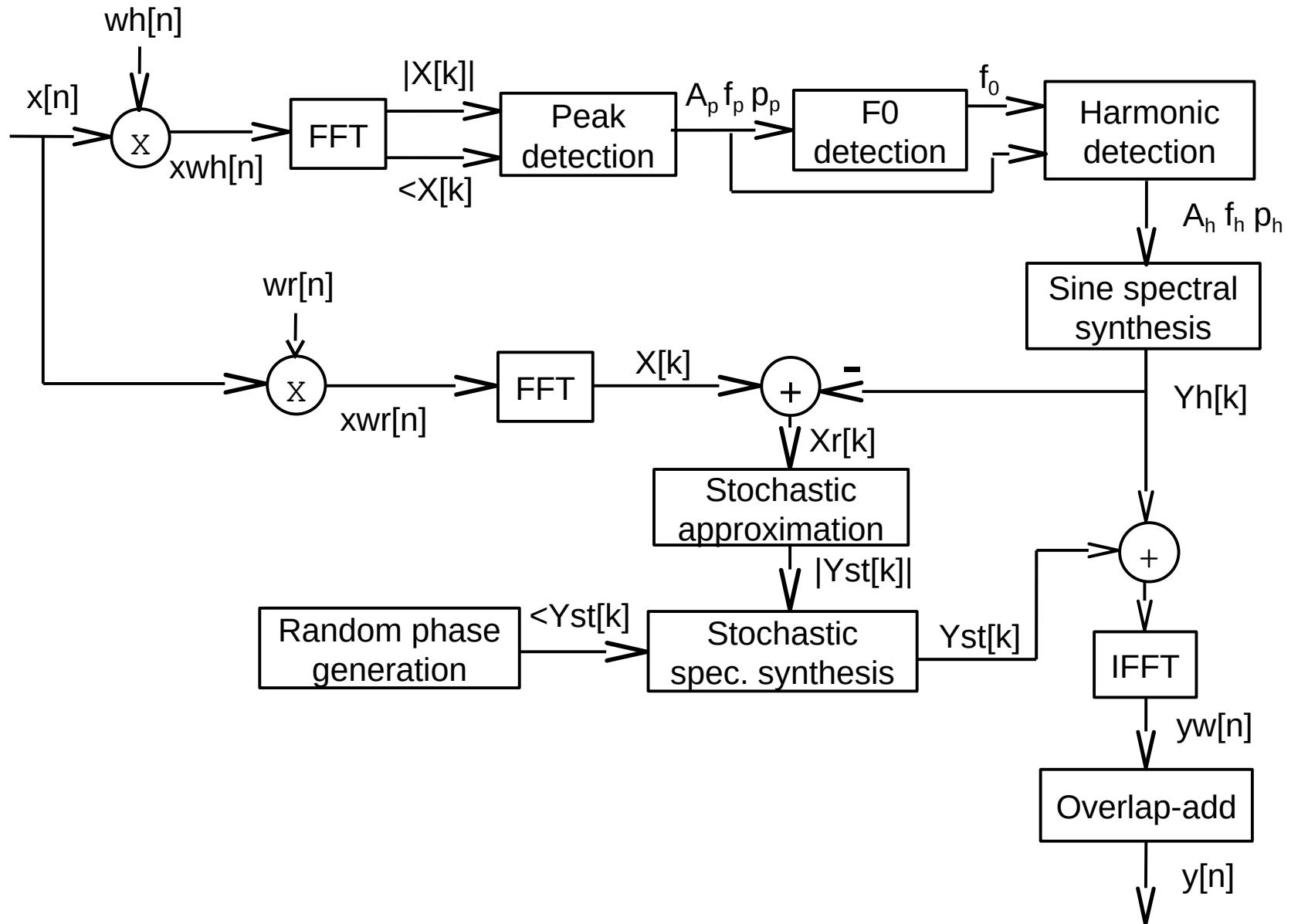
$|\tilde{X}r_l[k]|$: magnitude spectrum approximation of residual

$\star U[k]$: spectral phases of noise

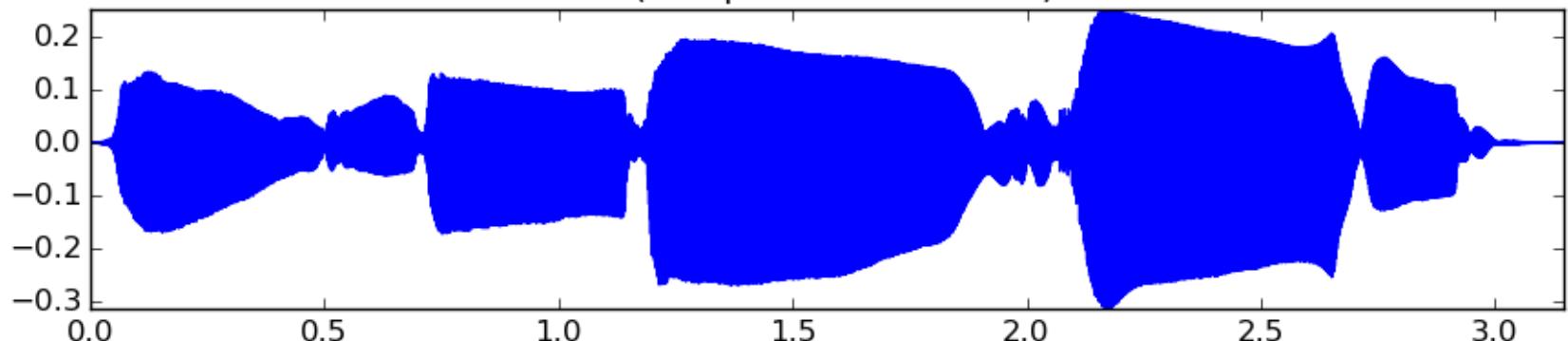
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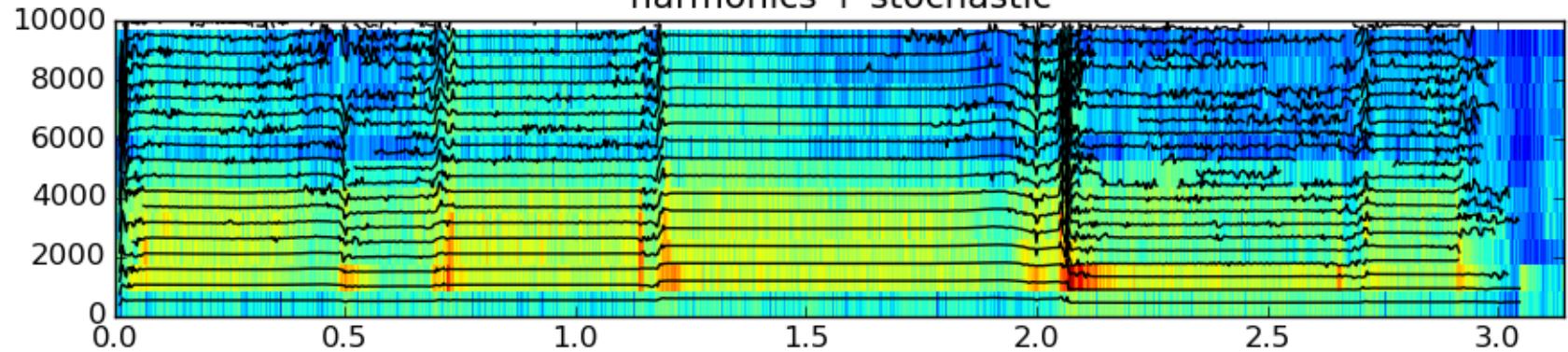
HpS model system



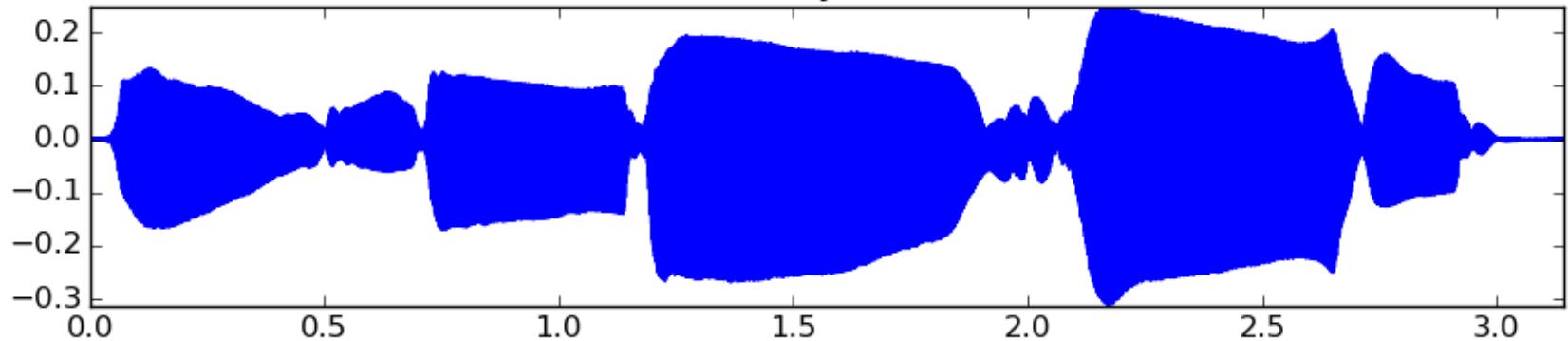
x (sax-phrase-short.wav)



harmonics + stochastic



y



References and credits

- Further references: <http://mtg.upf.edu/technologies/sms>
- Sounds from: <http://www.freesound.org/people/xserra/packs/13038/>
- Slides released under CC Attribution-Noncommercial-Share Alike license and code under Affero GPL license; available from <https://github.com/MTG/sms-tools>

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