

6T1: Harmonic Model

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Harmonic model

$$y_h[n] = \sum_{r=1}^R A_r[n] \cos(2\pi r f_0[n] n)$$

R : number of harmonic components

$A_r[n]$: instantaneous amplitude

$f_0[n]$: fundamental frequency (Hz)

Spectral view

$$Yh_l[k] = \sum_{r=1}^{R_l} A_{(r,l)} W[k - r \hat{f}_{(0,l)}]$$

W : spectrum of analysis window

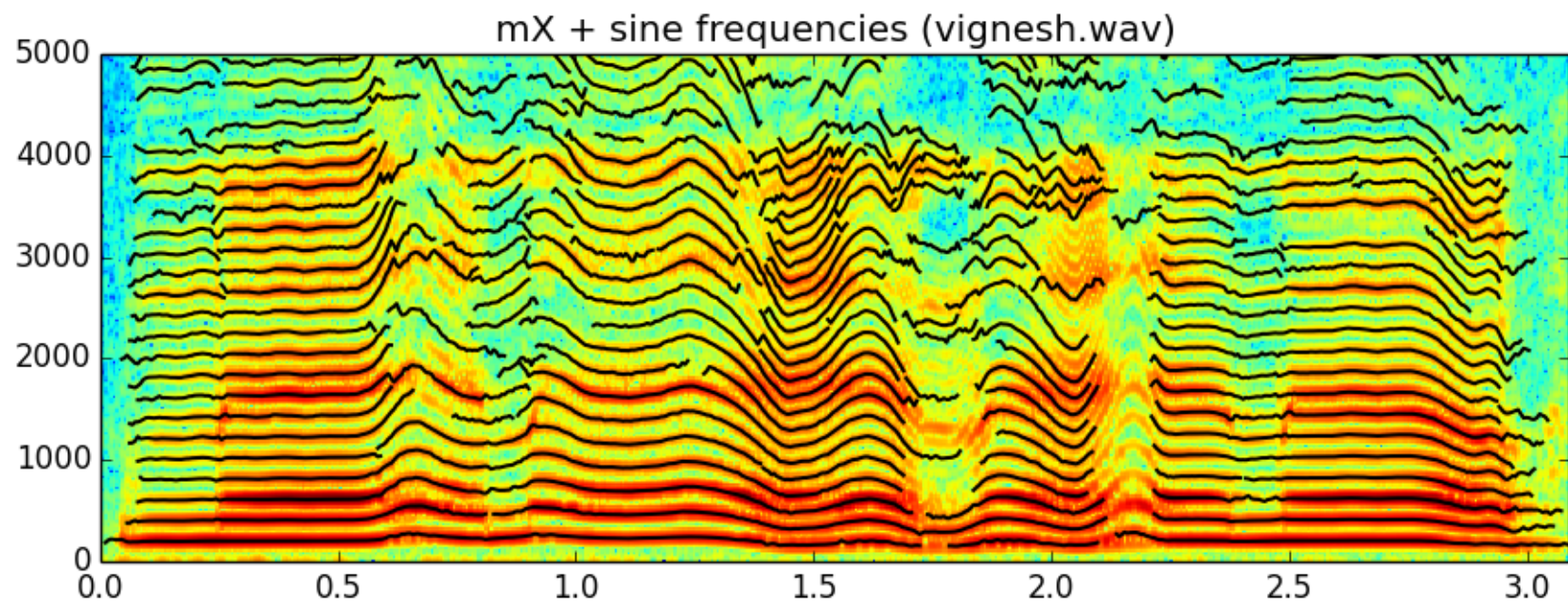
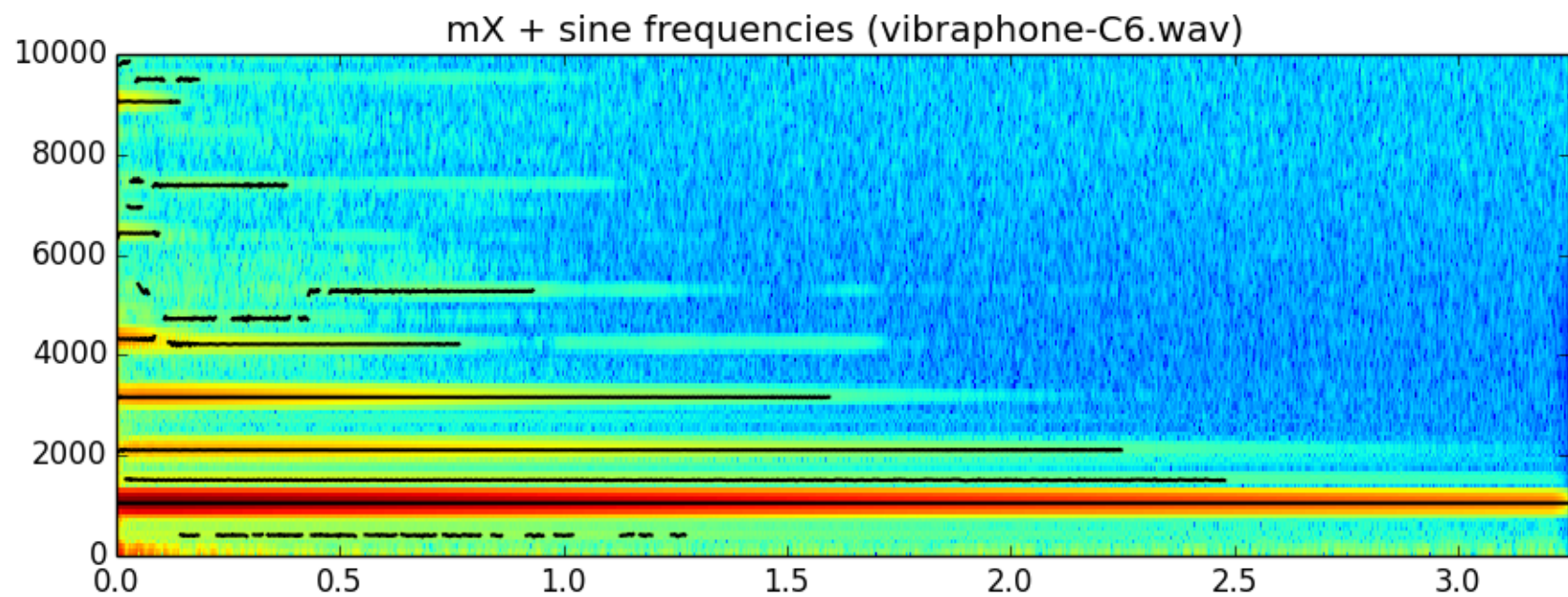
R : number of harmonics

A : amplitude of harmonic

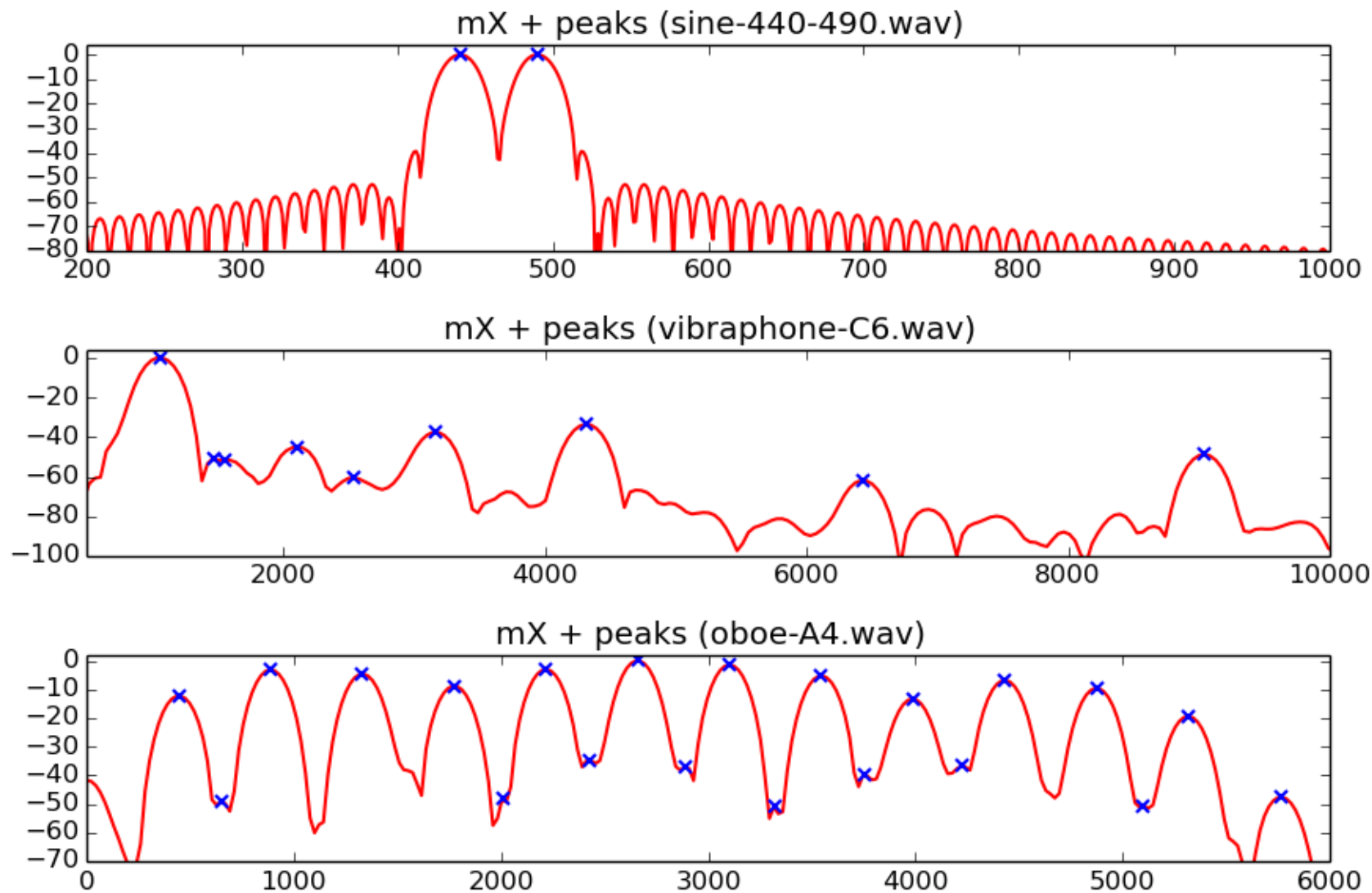
\hat{f}_0 : normalized fundamental frequency

l : frame number

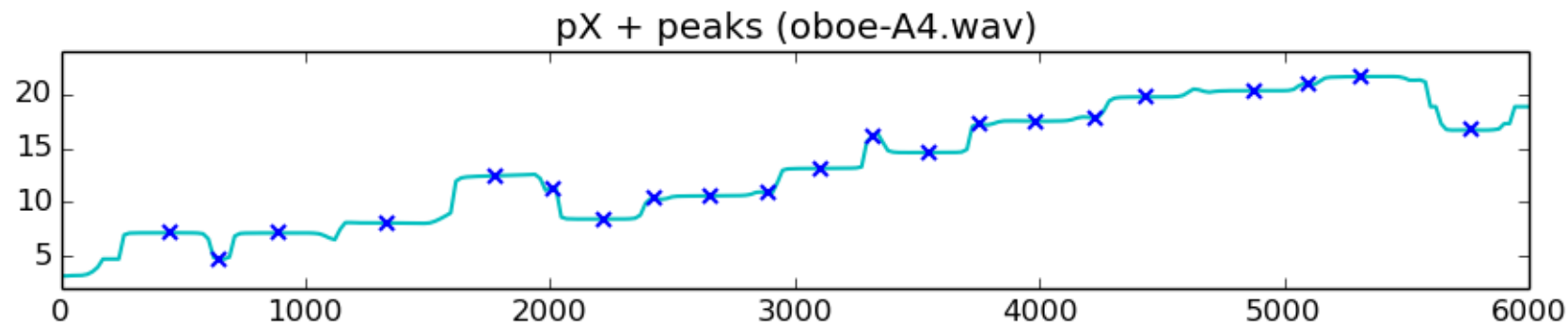
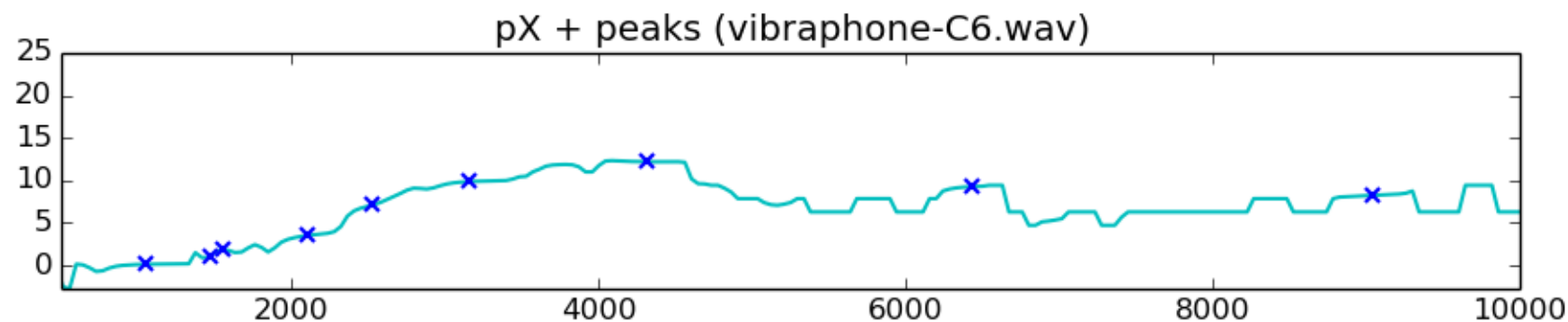
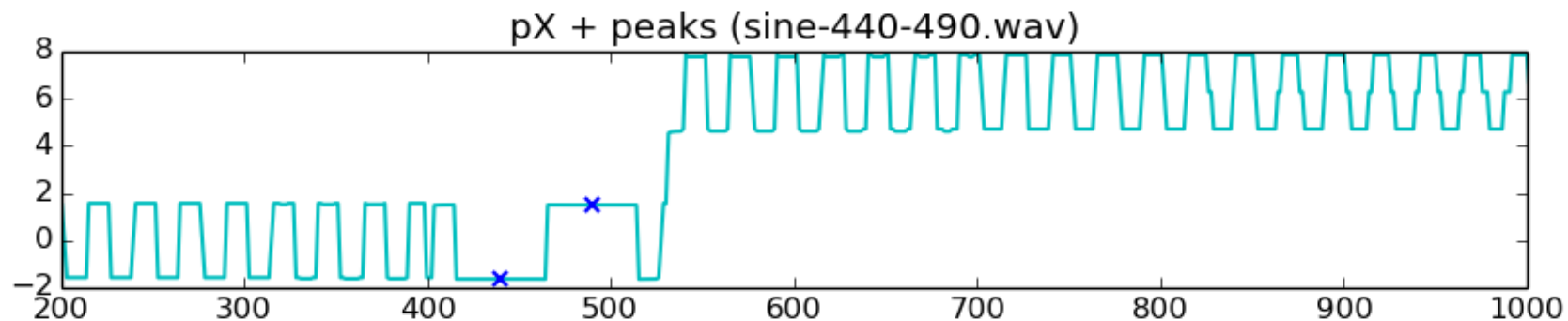
r : harmonic number



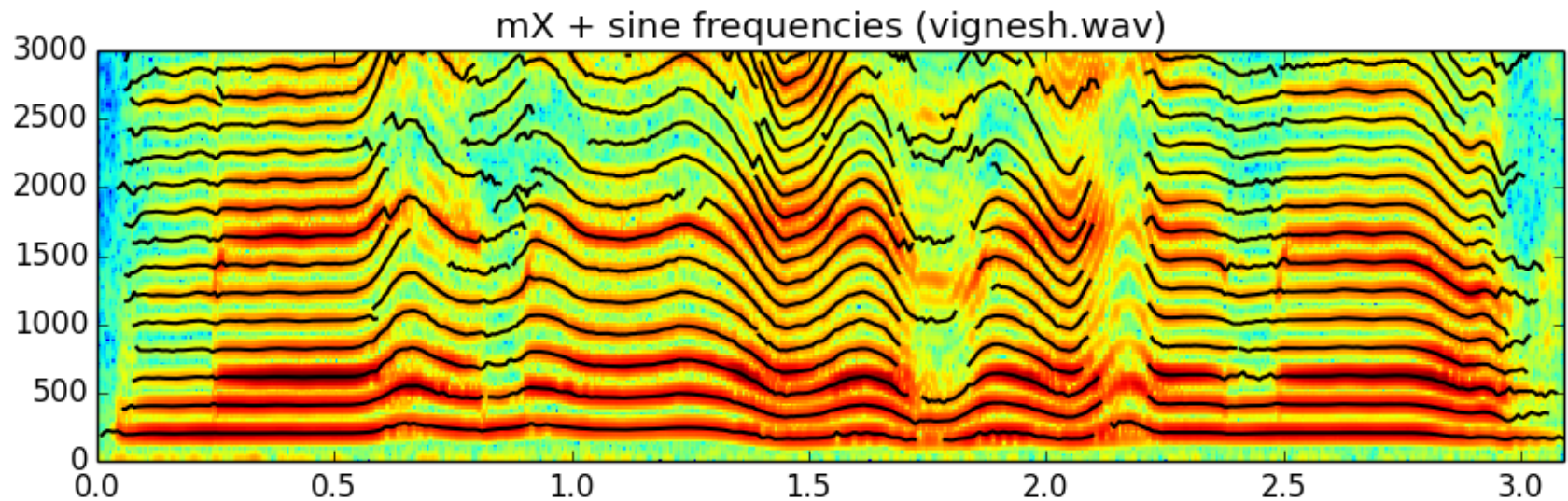
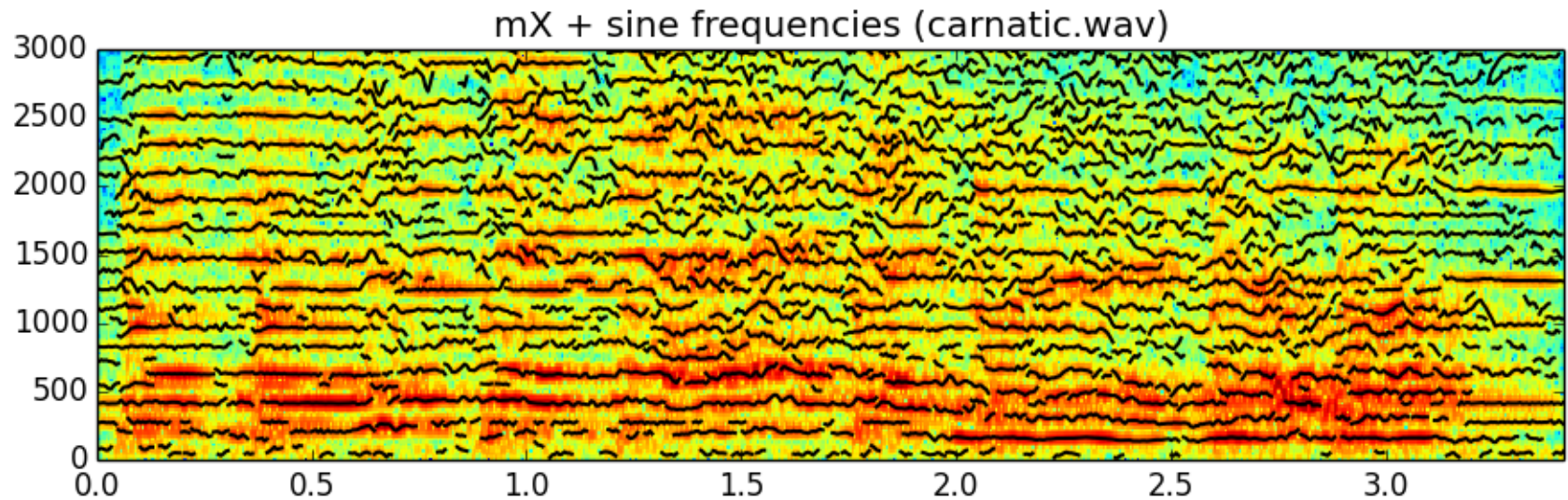
Sinusoids-partials-harmonics



Sinusoids-partials-harmonics



Polyphonic-monophonic signals



Harmonic detection

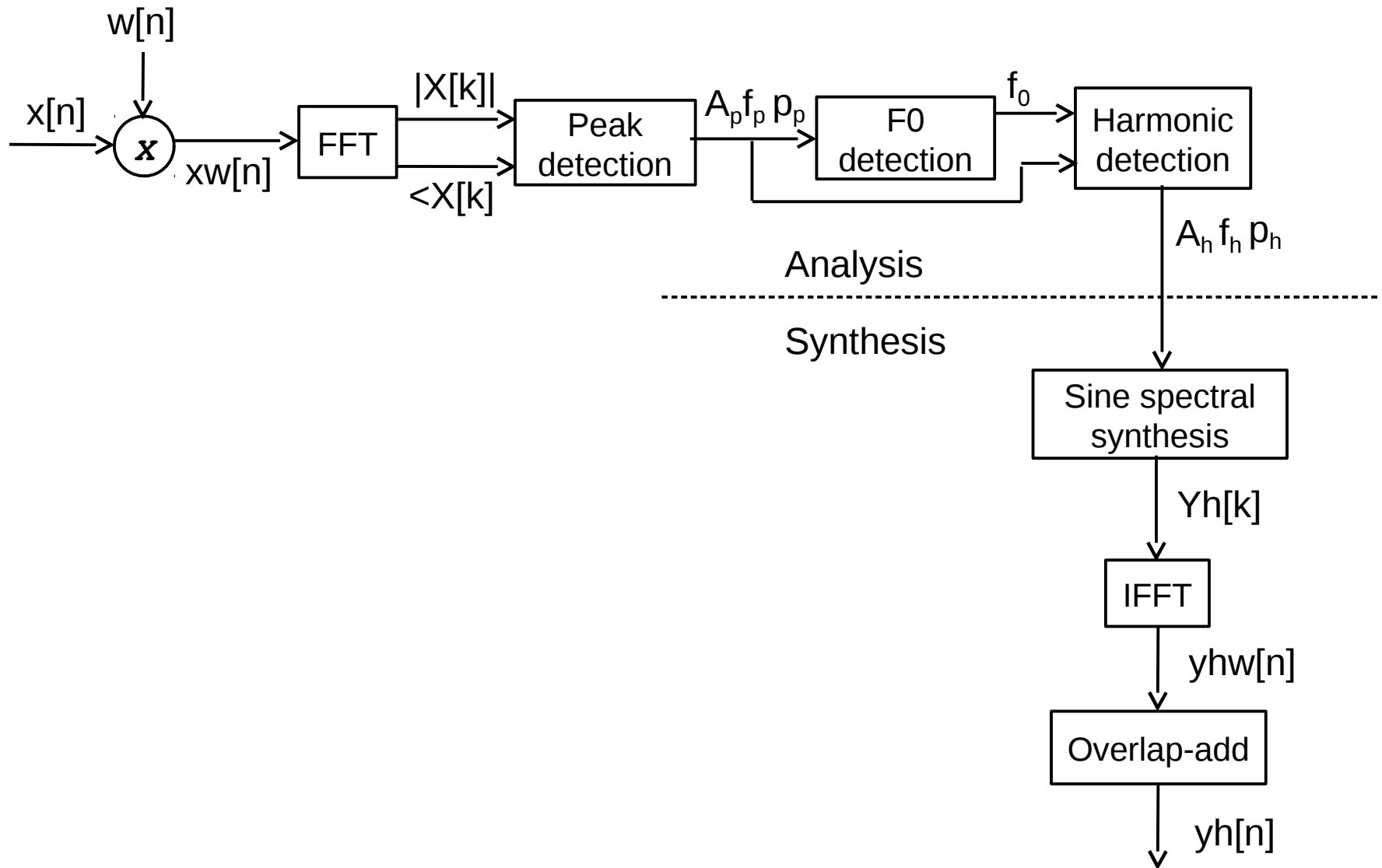
Harmonic \rightarrow stable spectral peak whose frequency is close to a **multiple** of the fundamental frequency.

Condition for a peak f_p to be a harmonic f_h :

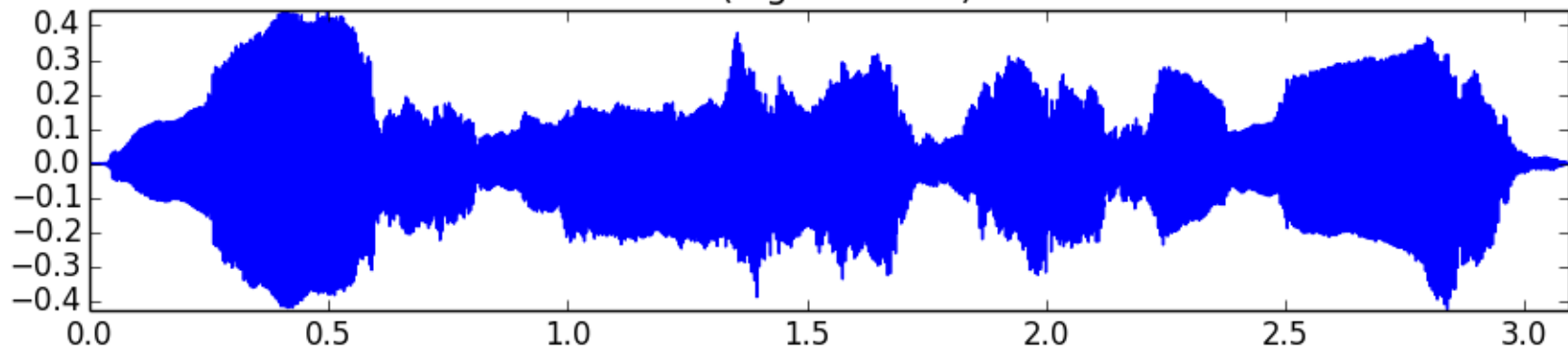
$$f_p[l] = f_h[l] \text{ if } (|f_p[l] - (h * f_0[l])| < \textit{threshold})$$

and exists $f_h[l-2], f_h[l-3], \dots, f_h[l-L]$

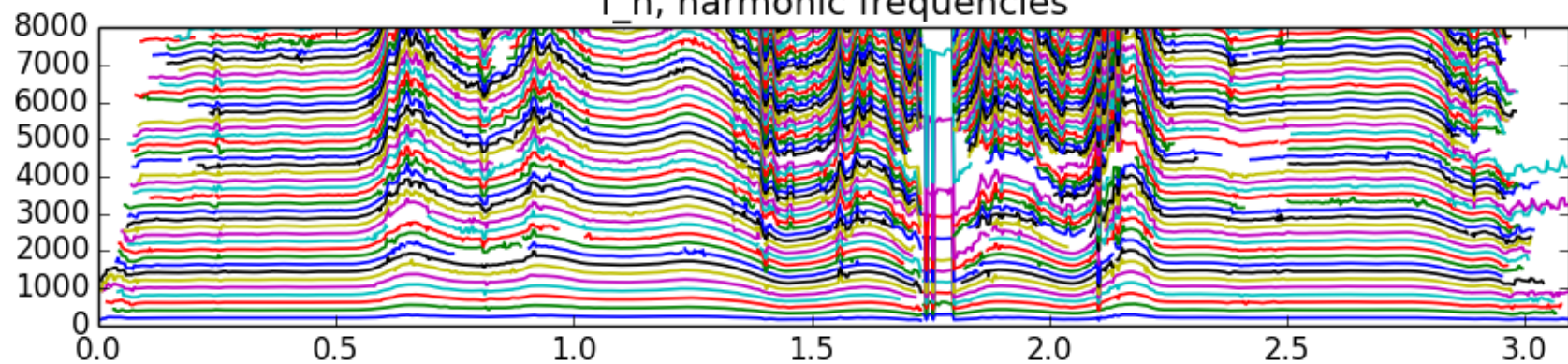
Harmonic model system



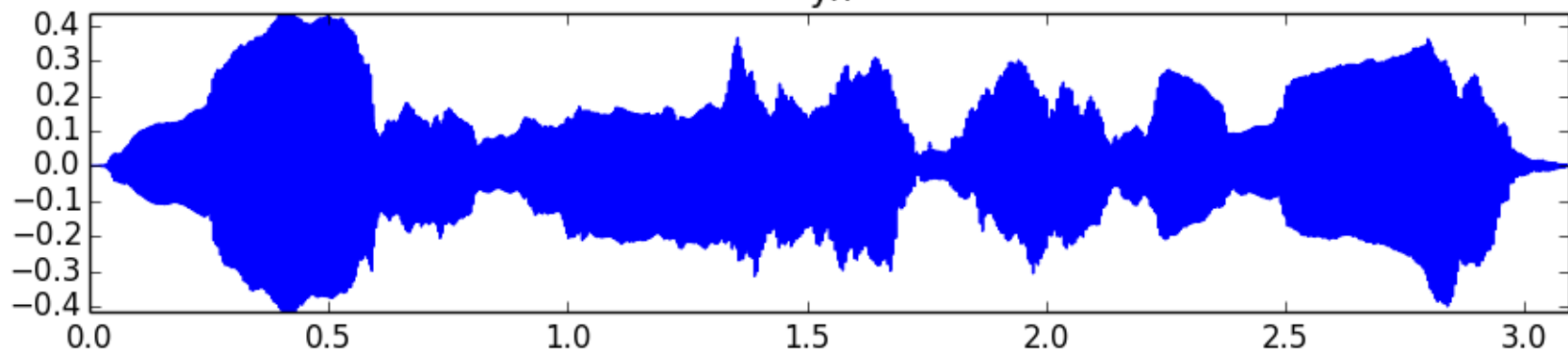
x (vignesh.wav)



f_h, harmonic frequencies



yh



References and credits

- More information in:
[https://en.wikipedia.org/wiki/Harmonic_series_\(music\)](https://en.wikipedia.org/wiki/Harmonic_series_(music))
<https://en.wikipedia.org/wiki/Harmonic>
- 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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