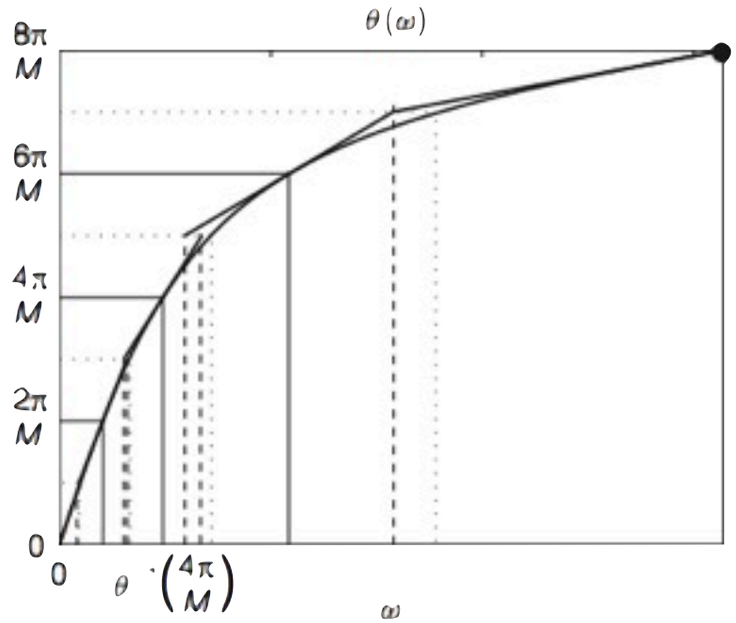
Vocoder-based approximation of frequency warping

- Short-Time Laguerre method relies on the linear approximation of the phase of the allpass, valid for the low-frequency range.
- Warping map is constrained to the Laguerre curves

Vocoder-based approximation of frequency warping



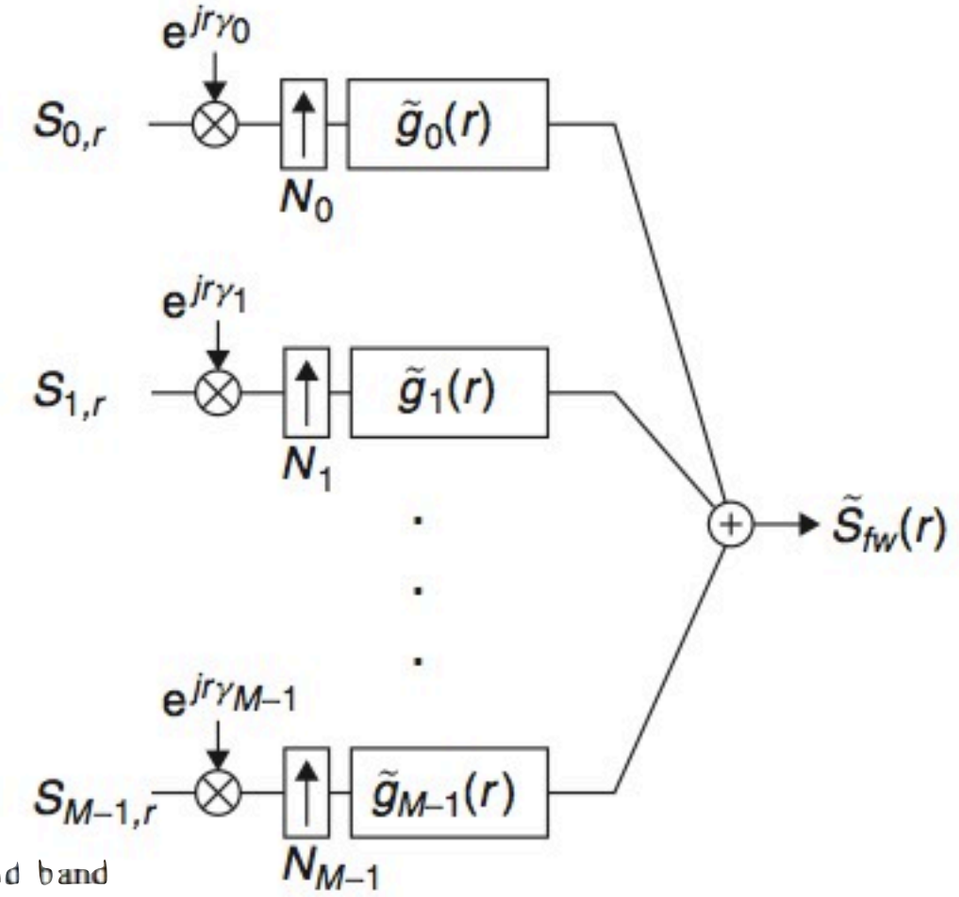
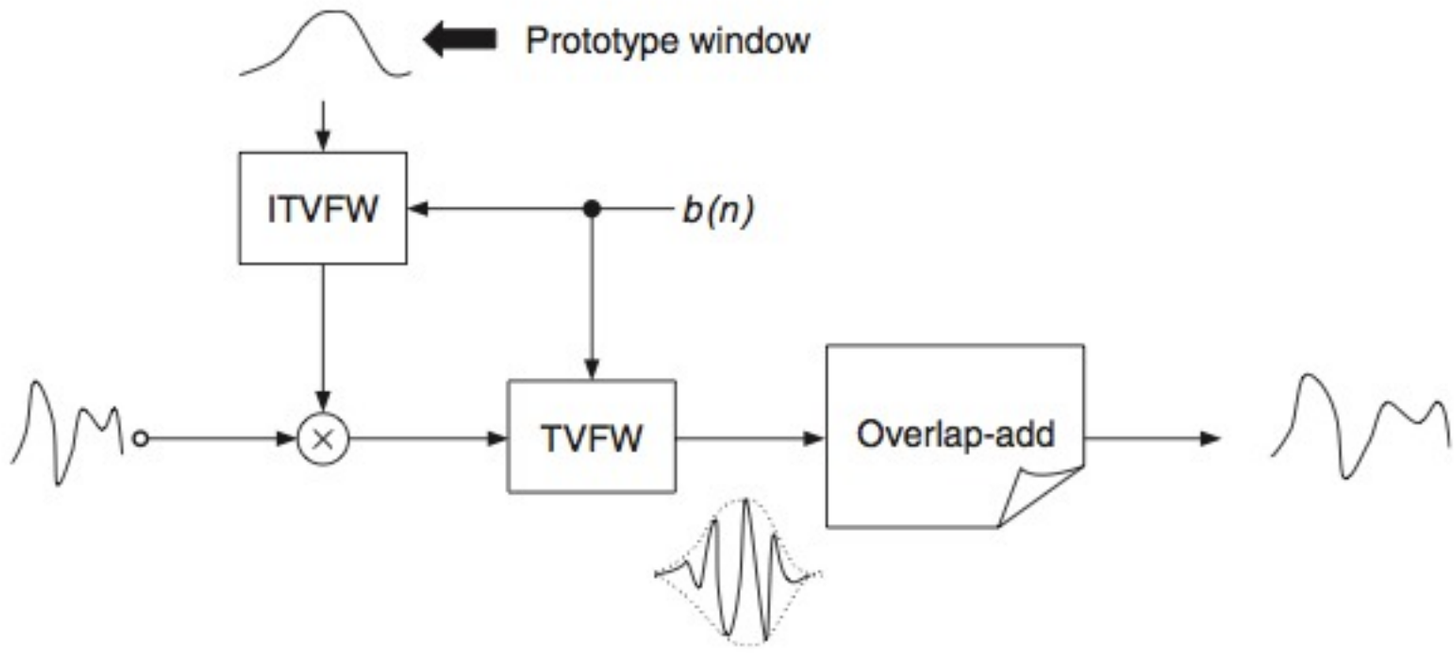


Figure 11.10 Locally linear approximation of warping map: center bands (solid lines) and band edges (dotted lines)

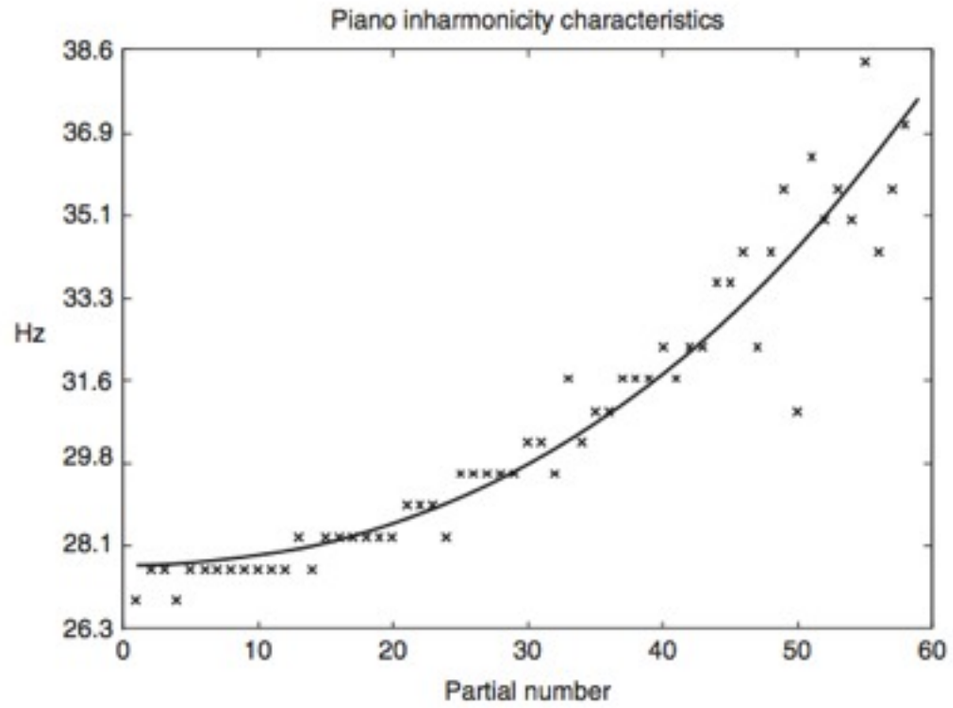
Time-Varying Frequency Warping



Musical Uses of Warping

- Pitch-Shifting inharmonic sounds
- Inharmonizer
- Comb filtering + warping and extraction of excitation signals in inharmonic sounds
- Vibrato, glissando, trill and flatterzunge
- Morphing

Pitch-Shifting inharmonic sounds



$$b = \frac{\tan\frac{\pi f_0}{f_S} - \tan\frac{\pi \widehat{f}_0}{f_S}}{\tan\frac{\pi f_0}{f_S} + \tan\frac{\pi \widehat{f}_0}{f_S}}.$$

Figure 11.14 Inharmonicity characteristics of a 27 Hz piano tone: data are marked by x and the solid curve represents the optimum Laguerre difference curve fitting the data.

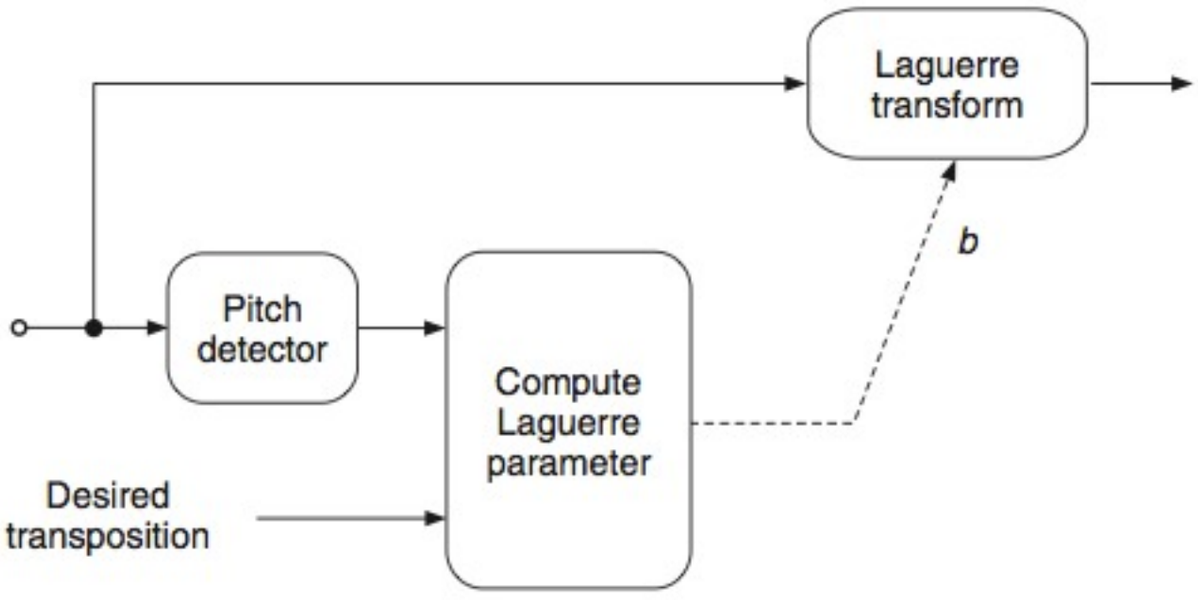


Figure 11.15 Block diagram of inharmonic sounds pitch shifter.

Inharmonizer

- Map harmonic partials to inharmonic partials
- Can make sounds more rich
- Can be used in conjunction with physical modeling

Comb Filtering + Warping and extraction of excitation signals in inharmonic sounds

- By frequency warping the original piano tone with the inverse of the fitted Laguerre map, one transforms the originally inharmonic partials into a set of harmonic partials.

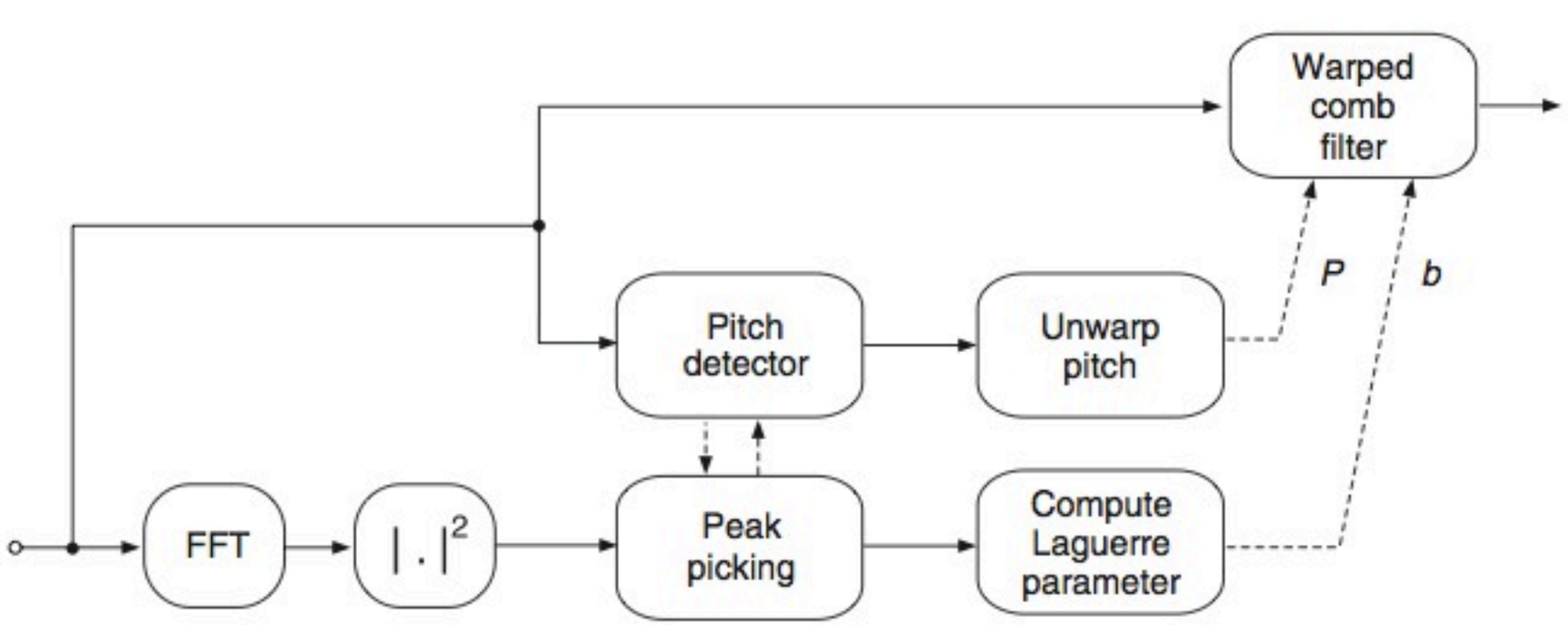


Figure 11.16 Block diagram of tuned warped comb structure for extracting partials or excitation noise from inharmonic sounds.

Vibrato, Glissando, Trill and Flatterzunge

- oscillate b slightly
- only perceived change is pitch

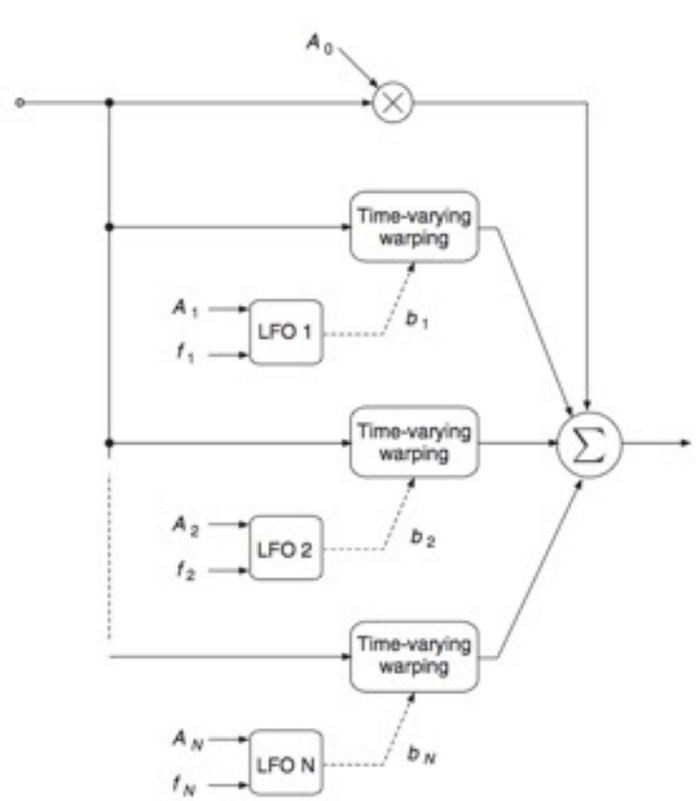


Figure 11.17 Block diagram for computing vibrato, trill, chorus-like, phasing-like or flange-like effects. For Flatterzunge we add random noise to the LFOs. For glissando the LFOs are replaced by envelope generators.

Morphing

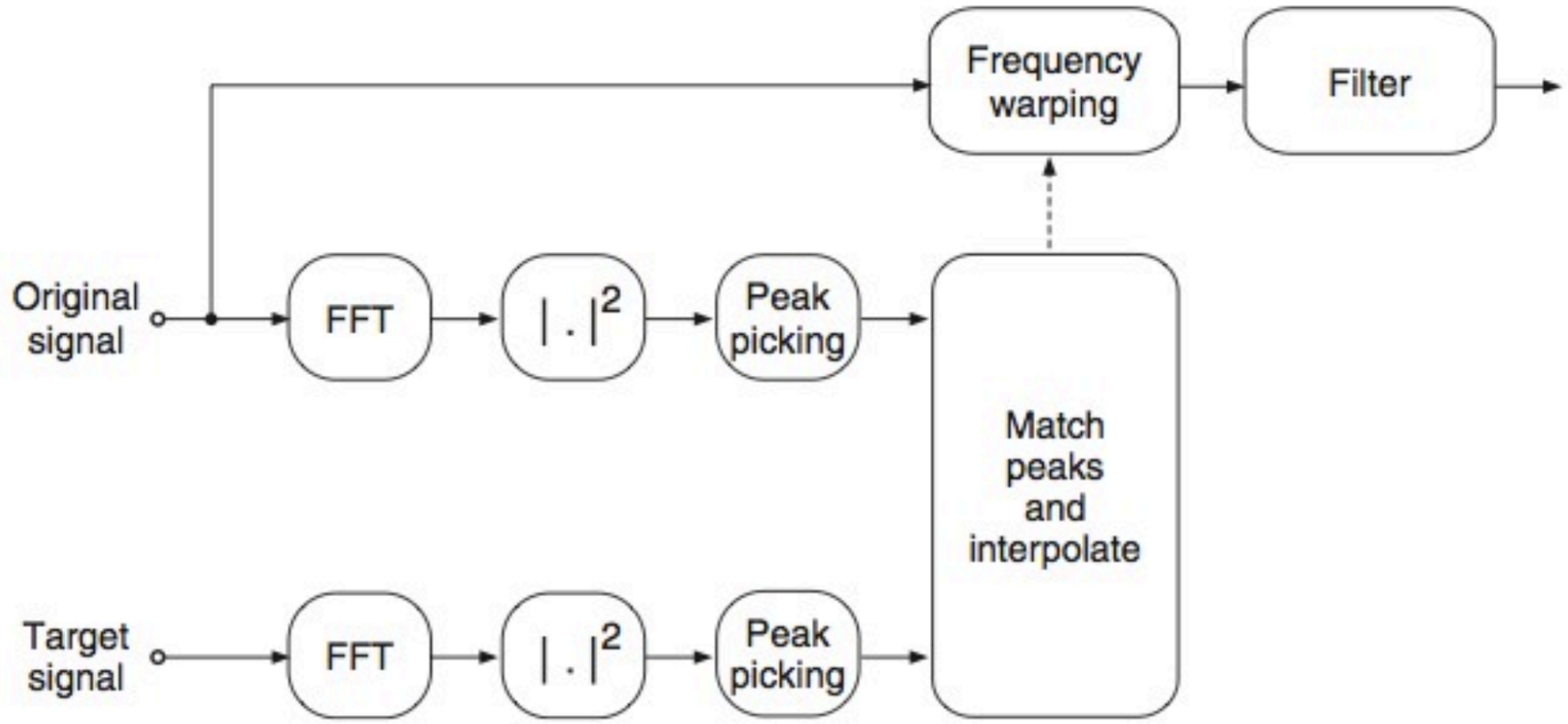


Figure 11.18 Simple diagram for computing morphing via frequency warping.

Questions?

Link

- http://staffwww.itn.liu.se/%7egiaev/ISCCSP08_examples_nojs.html