MUS420 Lecture
Commuted Synthesis of Strings

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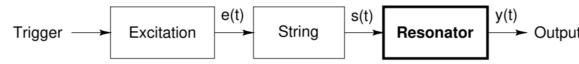
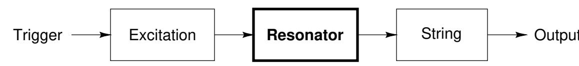
Outline

- Basic Idea
- Commuted Piano Synthesis
  - String Interface
  - Excitation Factoring
- Linear Commuted Violin Synthesis

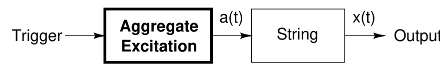
Commuted Synthesis of Strings



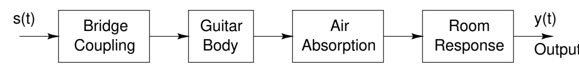
Schematic diagram of a stringed musical instrument.



Equivalent diagram in the linear, time-invariant case.



Use of an aggregate excitation given by the convolution of original excitation with the resonator impulse response.



Possible components of a guitar resonator.

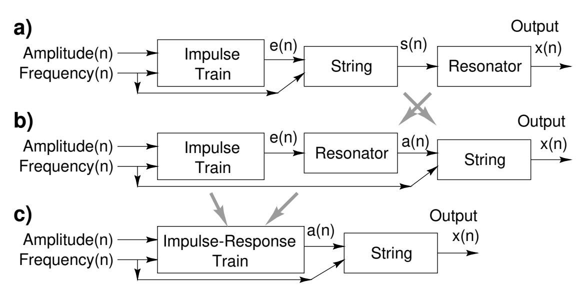
Features of Commuted Synthesis

- Enormous resonators can be implemented inexpensively (three orders of magnitude less computation for typical stringed instruments)
- Good qualitative excitation signals are easy to measure (just tap on the bridge)
- Apparent "resonator size" can be modulated by changing the *playback rate* of the excitation table

Drawbacks:

- Requires *linearity* and *time invariance*

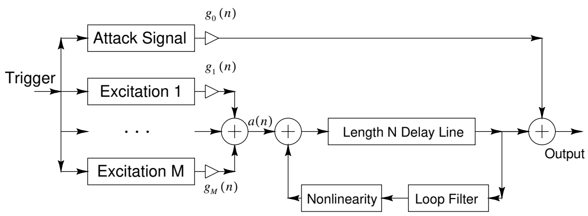
Linear Commuted Violin Synthesis



- Assumes *ideal Helmholtz motion*
- Sound examples:

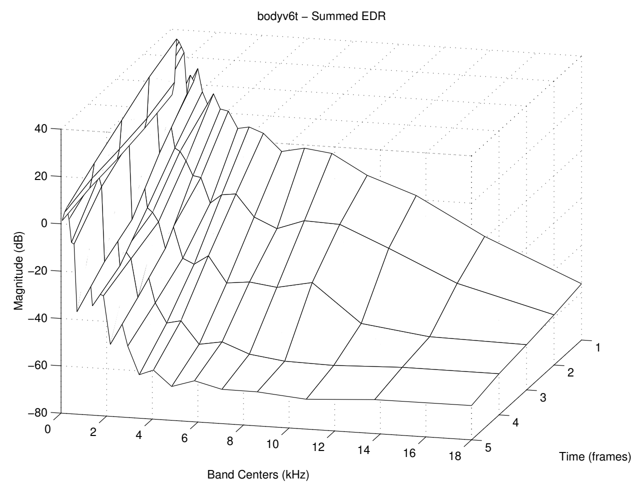
http://ccrma.stanford.edu/~jos/wav/vln-lin-cs.wav

Multiple-Excitation Commuted Synthesis



- For pianos, harpsichords, etc.,
  - Excitation point moves with key number
  - Wavetable interpolation can be used as in *sampling synthesis*
- For guitars, violins, cellos, etc.
  - Each string has a slightly different excitation point
  - Vertical and horizontal excitations different
- "Attack Signal" = sound going "around" the strings (or only once through the string)

Energy Decay Relief (EDR) of a Violin Body Impulse Response



- Energy summed over frequency within each "critical band of hearing" (Bark band)
- Low-frequency modes "resolved"
- High-frequency modes merge together perceptually into a

Filtered-Noise Excitation Synthesis