Commuted Synthesis of Strings

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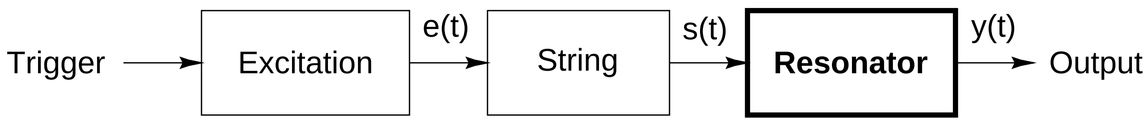
Outline

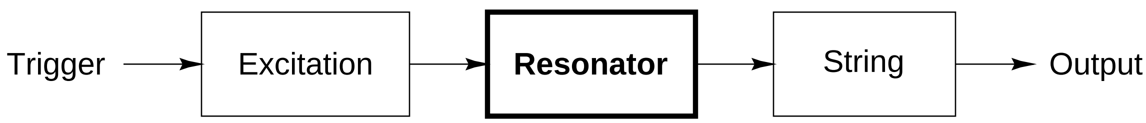
- Basic Idea
- Body Resonator Factoring
  - Shortened Body Impulse Response
  - Corresponding Amplitude Response
  - Localized Second-Order Mode Elimination Filter
- Commuted Piano Synthesis
  - String Interface
  - Excitation Factoring
- Linear Commuted Violin Synthesis

*Work supported by the Wallenberg Global Learning Network

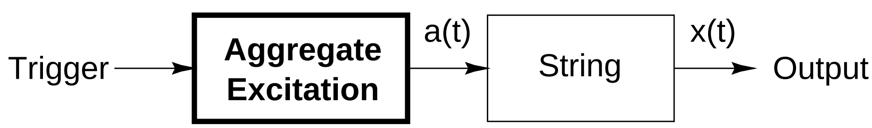
Commuted Synthesis of Strings



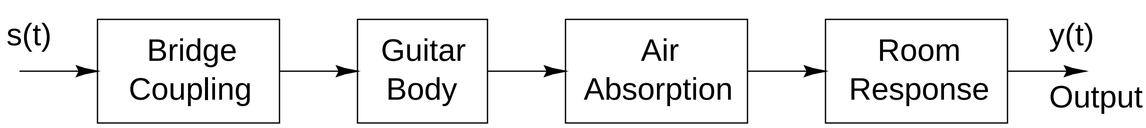
Schematic diagram of a stringed musical instrument.



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.

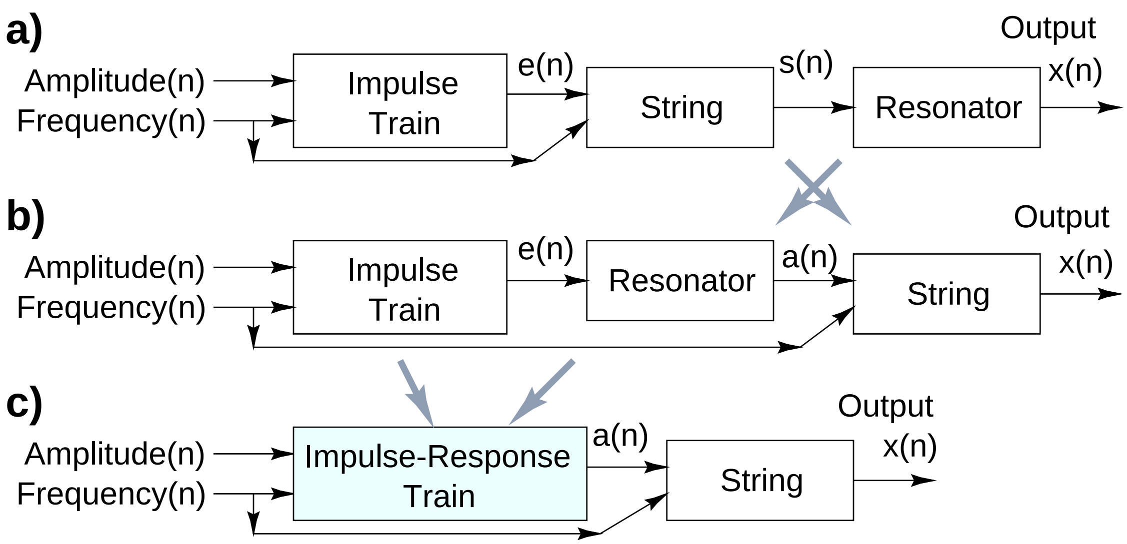
Features of Commuted Synthesis

- 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*

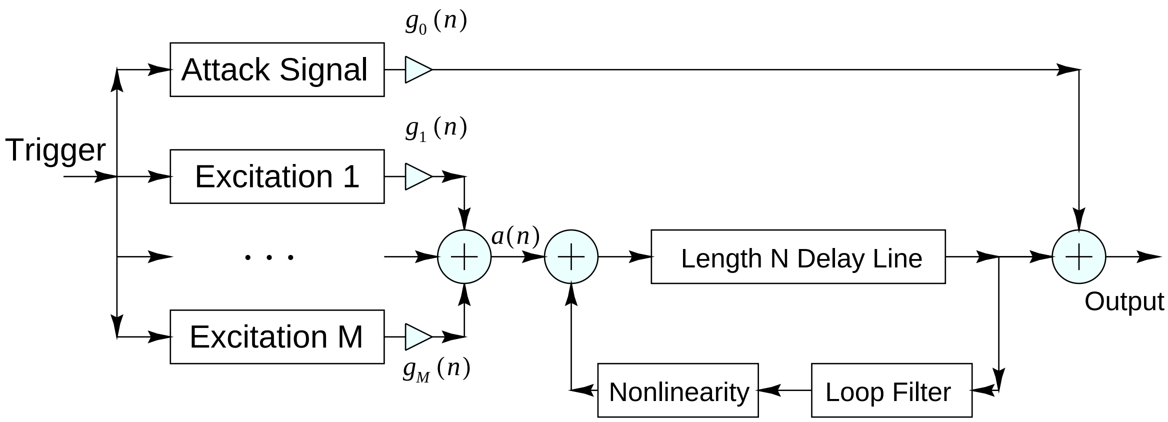
Linear Commuted Violin Synthesis



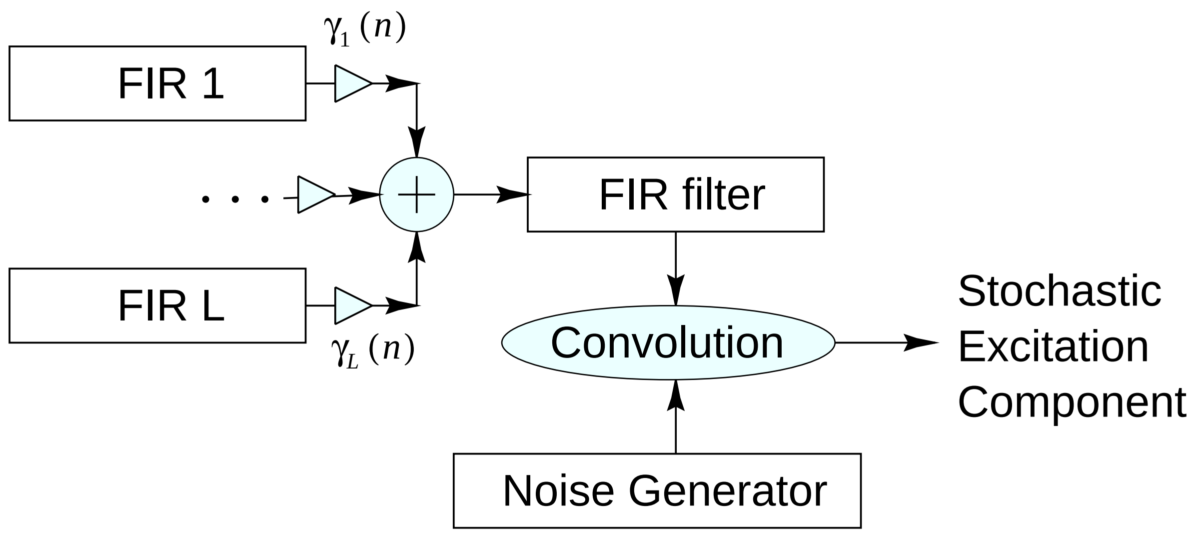
- Assumes *ideal Helmholtz motion*
- Sound examples:

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

Multiple-Excitation Commuted Synthesis



Filtered-Noise Excitation Synthesis



Commuted Synthesis of the Linearized Violin