LPC

A Speech Analysis/Synthesis Method

LPC

• LPC = Linear Prediction Coding
• Model: predict next sample as a weighted sum of past samples.

\[ s_n = \sum_{i=1}^{p} a_i s_{n-i} \]

• This formulation gives rise to an \textit{allpole} filter: the response consists of resonant peaks.
• LPC analysis finds the filter with that best approximates the signal spectrum.
LPC Analysis

- The physical analogy is a tube with varying cross-section:
- Conducted in frames (analogous to short-time windows in SFFT)
- Frames give rise to changing coefficients, which model changes in tube geometry (or vocal tract shape)

Acoustic Tube Producing “AH”

LPC Analysis, continued

- LPC creates an inverse filter.
- Applying inverse filter gives a \textit{residual}.
- Residual may either be an estimate of glottal pulses \( \rightarrow \) do pitch analysis to estimate source
- Or noise \( \rightarrow \) use noise model for source

LPC

\begin{itemize}
  \item Input signal
  \item Formant analysis
  \item Residual
  \item Error
  \item Pitch detector
  \item Pitch (per frame)
  \item Voiced/unvoiced analysis
  \item Voiced/unvoiced decision (per frame)
  \item Amplitude detector
  \item RMS amplitude (per frame)
  \item Allpole filter coefficients (per frame)
\end{itemize}
Musical Applications

- Replace source with some other sound
- “Warp” the filter frequencies
- Modify the source and LPC coefficients (glottal pulses or noise) to perform time stretching
- See demos/lpcdemo.lsp