

Technion - Israel Institute of Technology Electrical Engineering Department Image and Signal Processing Laboratory

Coding of High-Quality Audio Signals at Low Bit-Rates

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General Information

Input Signal:

- Sampled at 44.1kHz
- 16 bits per sample (uniform PCM)
- One channel (monophonic)
- Input rate is 705.6 kbit/sec

Output Rates :

- 128 kbit/sec
- 64 kbit/sec

Block Diagram of a General Subband Coding System



Block Diagram of the Proposed Subband Coding System



Analysis/Synthesis Filterbanks

- MPEG-Audio layers I,II divide the signal into 32 equal bands.
- Wavelet based filterbanks divide the signal into equal Q bands (bandwidth increases with center frequency).
- Wavelet packets based filterbanks allow the selection of a desired filterbank structure among many available.





Wavepacket Based Filterbank

- The wavepacket based filterbank used in the proposed system consists of 5 levels of QMF stages - splitting the input signal into 32 frequency bands.
- The transmitted coefficients can come from the output of any stage - generating a variaty of available divisions of the frequency scale.

Two Examples of Wavelet Packets Filterbanks





Best Basis Selection

- Select the tree structure that minimizes a cost function.
- An apropriate selection of the cost function will cause better reconstruction quality when using Best Basis based filterbank structure.
- Cost function depends on the coding algorithm.

Adaptive Filterbank

- Signal properties change with time.
- The Best Basis decomposition of the signal changes with time.
- Desired filterbank structure varies with time.
- Switching between different filterbank structures causes undesired transients in output signal.
- Transients may be eliminated using post filtering.



Input Signal

Before Post-Filtering

After Post-Filtering

Zero-Tree Coding

- The Zero-Tree algorithm was originally used in image compression systems that use subbands/wavelets.
- The coding performance of the algorithm depends strongly on the input signal's spectrum.
- The basic assumption is that most of the signal's energy is concentrated in the lower frequency bands and the energy level lowers at higher frequency bands.

Zero-Tree Coding (cont'd)

- Under the above assumption there is a high propability that if the energy in some band is lower than a threshold - then the energies of the higher bands will remain below that threshold too.
- In that case a 'zero-tree' code is sent for the entire set of bands thus saving bits of information.

Preliminary Results

 A subband coder consisting of a fixed filterbank structure (uniform bands or wavelet like bands) and the Zero-Tree alg. achieves lower mean square reconstruction error than the MPEG-Audio layer I standard coder for various types of music signals.

• Perception quality of both coders is the same.

Preliminary Results (cont'd)

• The coder using adaptive filterbank is currently under study.