Sub-band Coding for Digital Audio Compression

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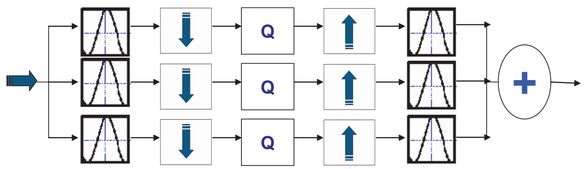
CADSP
Cooperative Analog and Digital Signal Processing

Introduction

Digital Audio Compression:
- Reduces memory and bandwidth requirements for audio information
- Used in various applications: cell phones, popular music media (mp3), etc.

Sub-band Coding:
- Decomposes a signal into critical sub-bands
- Quantizes each sub-band depending on its significance in the overall signal
  - Significant sub-bands are processed with higher bit-rates



Audio Input>>Analysis Filter>>Down-sampler>>Quantizer>>
Up-sampler>>Synthesis Filter>>Audio Output

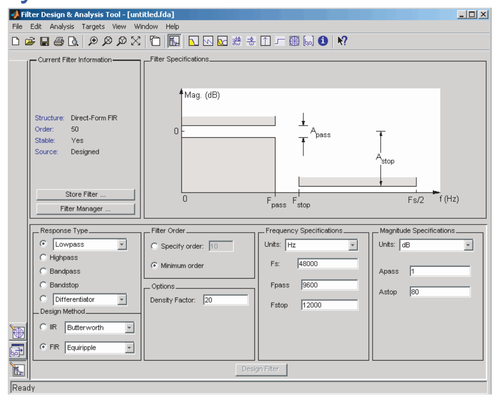
Background

Advances in digital audio compression led to the development of MPEG Standards:
- MPEG is an international group that created standards for compression of digital media
- MPEG layers 2 and 3 achieve a reduction factor of 12 without any noticeable loss in quality

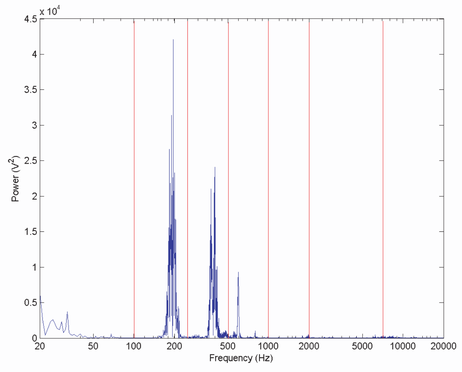
Methods

For each critical sub-band:

- Synthesize filters



- Find significance



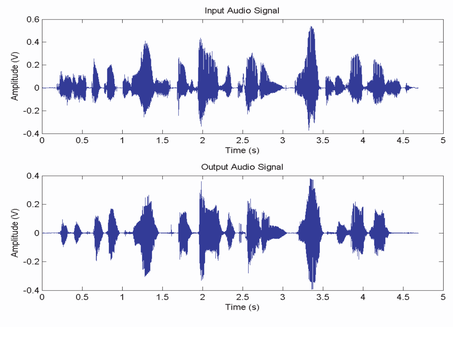
- Design quantizers

$$S_i = \frac{1}{f_i - f_{i-1}} \int P(f)\,df$$

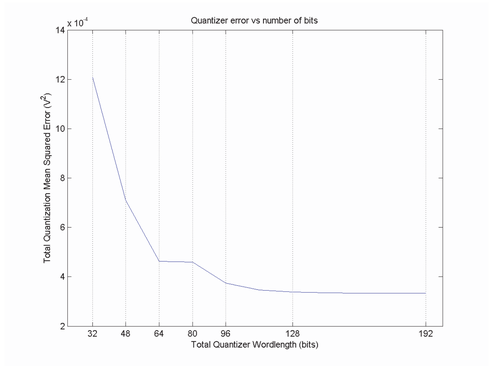
$$\text{Quantizer wordlength} = \frac{S_i}{\sum S_i} \Big| \text{Total wordlength}$$

Results

- We applied this system to a 48000 Hz speech signal:



- As we increase total wordlength of quantizers, total error drops:



- We observe different quantization wordlengths in each sub-band:

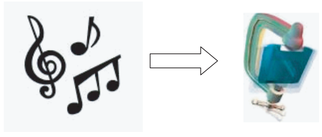
quantizer:	1	2	3	4	5	6	7
bits:	5	31	24	4	0	0	0
freq:	20 100	250	500	1000	2000	8000	16000

Conclusion

- Sub-band decomposition is one of the steps of digital audio compression.
- Each critical sub-band has different significance
- Processing each sub-band separately allows to reduce bit-rate w/o considerable quality loss

Future Work

- Reduce bit-rate further by integrating down-samplers and up-samplers
- Integrate post-synthesis filters
- Develop an MP3 encoder-decoder in software
- Explore hardware implementation possibilities



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