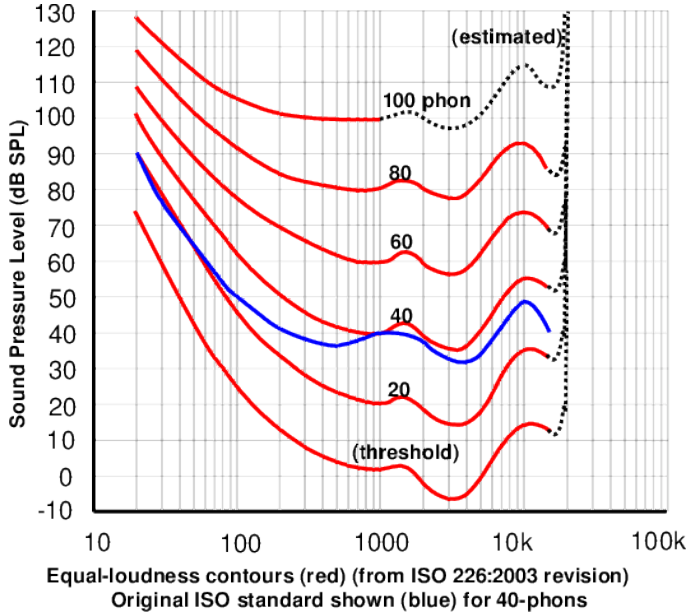
Compression of signals

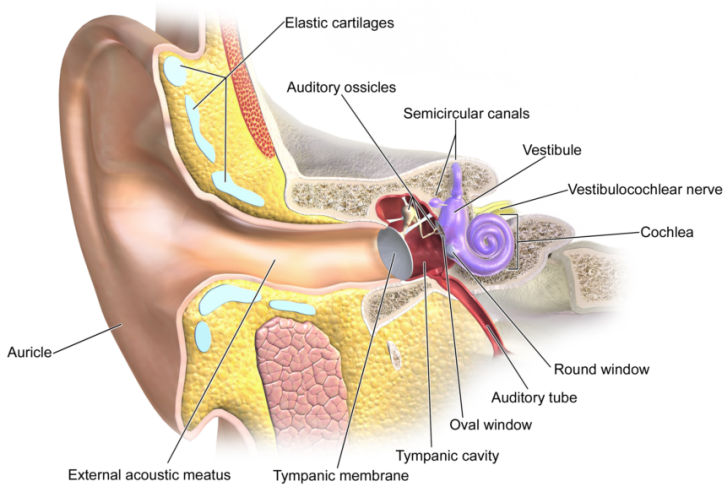
- Split into blocks (frames, segments) with almost constant properties
- Use suitable transform to condense information
  - Signal model
  - Perception model
- Remove some information (for lossy compression)
  - Match channel capacity
  - Apply human perception model (to make less harm)
- Serialize (for 2-D)
- Encode efficiently (entropy coding, e.g. Huffmann)

Human ear – perception: loudness curve



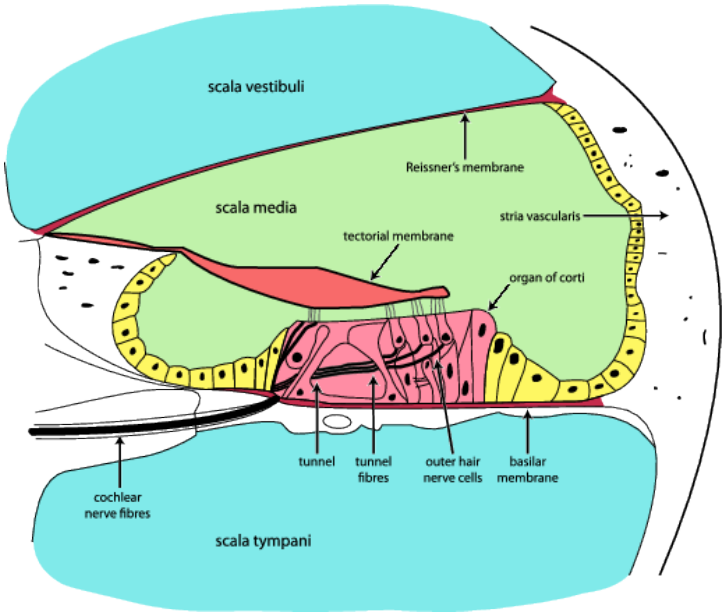
”Lindos1” by Lindosland - http://en.wikipedia.org/wiki/Image:Lindos1.svg.

Human ear – perception: selectivity

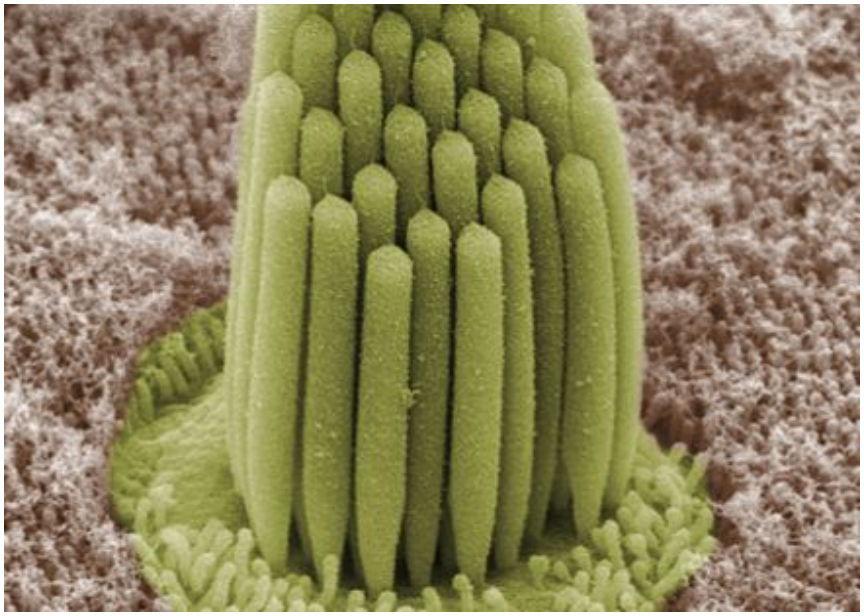


The Anatomy of the Ear

Human ear – perception: selectivity

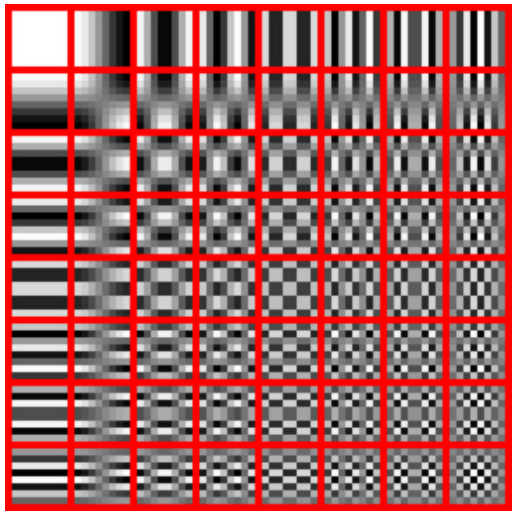


(Frog) ear – sensing element



”Stereocilia of frog inner ear.01” by Bechara Kachar - http://irp.nih.gov/our-research/research-in-action/high-fidelity-stereocilia/slideshow.

DCT transform



$$X(k) = \sum_{n=0}^{N-1} x(n) \cos\left[\frac{\pi}{N}\left(n+\frac{1}{2}\right)k\right]$$

(equivalent to 1/4 of a DFT of 2N length real, symmetric sequence, upsampled to 4N)

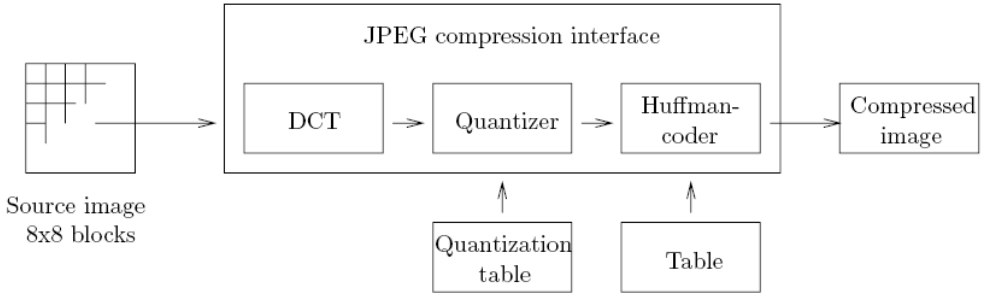
$$X(k,l) = \sum_{m=0}^{M-1}\sum_{n=0}^{N-1} x(m,n) \cos\left[\frac{\pi}{M}\left(m+\frac{1}{2}\right)k\right] \cos\left[\frac{\pi}{N}\left(n+\frac{1}{2}\right)l\right]$$

JPEG compression

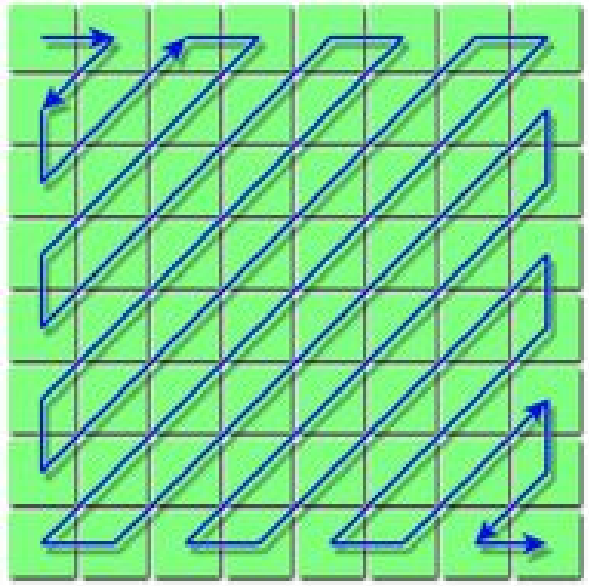
- 8x8 block
- Discrete Cosine Transform
  - suitable for natural images (with soft transitions)
  - non-sensitive to edge problems (opp. to DFT)
  - fast implementations (e.g. similar to FFT)
- Lossy opertion: quantization (less important values more roughly)
- Serialization along diagonal (“zig-zag”:low-low frequencies first, then high-low to low-high, high-high last: concentrate similar values)
- RLE + Huffmann coding (variable number of bits per coefficient)
- Transmit Huffmann table or use predefined one

Efficiency: `identify lena.jpg:  512x512 PseudoClass 256c 20kb`

Quantization and serialization



(u, v)	0	1	2	3	4	5	6	7
0	16	11	10	16	24	40	51	61
1	12	12	14	19	26	58	60	55
2	14	13	16	24	40	57	69	56
3	14	17	22	29	51	87	80	62
4	18	22	37	56	68	109	103	77
5	24	35	55	64	81	104	113	92
6	49	64	78	87	103	121	120	101
7	72	92	95	98	112	100	103	99



Lena

Picture size: 512x512=262000 pixels

151 kB

20 kB