Codecs

0.1 compression is the key to effective information delivery

Media	uncompressed	compressed
voice 8k samples/sec, 8 bits/sample	64 kbps	2-4 kbps
slow motion video 10fps 176x120 8 bits	5.07 Mbps	8-16 kbps
audio conference 8k samples/sec 8bits	64 kbps	16-64 kbps
video conference 15 fps 352x240 8bits	30.4 Mbps	64-768 kbps
audio (stereo) 44.1 k samples/s 16 bits	1.5 Mbps	128k-1.5Mbps
video 15 fps 352x240 15 fps 8 bits	30.4 Mbps	384 kbps
video (CDROM) 30 fps 352x240 8 bits	60.8 Mbps	1.5-4 Mbps
video (broadcast) 30 fps 720x480 8 bits	248.8 Mbps	3-8 Mbps
HDTV 59.9 fps 1280x720 8 bits	1.3 Gbps	20 Mbps

Codec = (en)coder + decoder

images, video, audio are amenable to compression:

- statistical redundancy in signal
  - spatial correlation – neighbour samples in single frame
  - spectral correlation – between multiple sensors
  - temporal correlation – between segments (frames)
- information that is irrelevant from perceptual point of view
- redundant features (accross space and time)

B. Vasudev & W. Li, Memory management: Codecs Handbook of Multimedia Management, p 237-278

encoding & decoding

signal -¿ source coder -¿ channel coder (encoding)

signal ¡- source decoder ¡- channel decoder (decoding)

codec design problem

From a systems design viewpoint, one can restate the codec design problem as a bit rate minimization problem, meeting (among others) constraints concerning:

- specified levels of signal quality
- implementation complexity
- communication delay (start coding – end decoding)

classification of compression methods

- model-based – LPC, polynomial fitting, object-based
- waveform-based

  lossless:

  - statistical – gilbert, hufmann
  - universal – arithmetic, pattern matching

  lossy:

  - spatial & time domain – delta modulation
  - frequency domain
    - filter-based – subband, wavelet
    - transform-based – fourier, DCT

tradeoffs

- coding efficiency – compression ratio
- coder complexity – memory, power requirements, ops/sec
- signal quality – bit error probability, signal/noise, ...

issues in compression selection

- resilience to transmission errors
- degradations in decoder output (lossy)
- data representation – (browsing & inspection)
- interplay of data modalities – audio & video (conferencing)
- transcoding to other formats – (interoperability)

standard-based codecs

- JPEG – ISO/IEC 10918-1, ITU-T (T.81)
- MPEG
  - ISO 11172 (up to 1,5 Mbps) – MPEG-1
  - ISO 13818 ITU-T H.262 – MPEG-2
- H3.20 – for ISDN-like environments
- ITU-T H.261 – P x 64 standard (rate in kbs, p=1..30)

- H.324 – video conferencing for GSTN, 26kbps/sec

pixels versus objects

pixel-based standards

- MPEG-1, MPEG-2, H3.20, H3.24

object-based codec(s)

- MPEG-4 – segmentation-based DFD (Displaced Frame Difference)