CSc 461/561
Multimedia Systems
Overview

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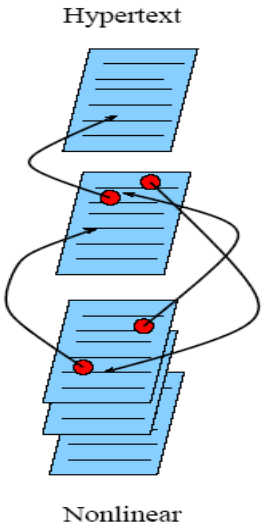
*Multi*media

- Information presented in multiple formats
  - text (structured/unstructured, hypertext, etc)
  - *images*
  - graphics (drawings)
  - animation
  - *audio*
  - *video*



- Discrete/continuous media, interactivity

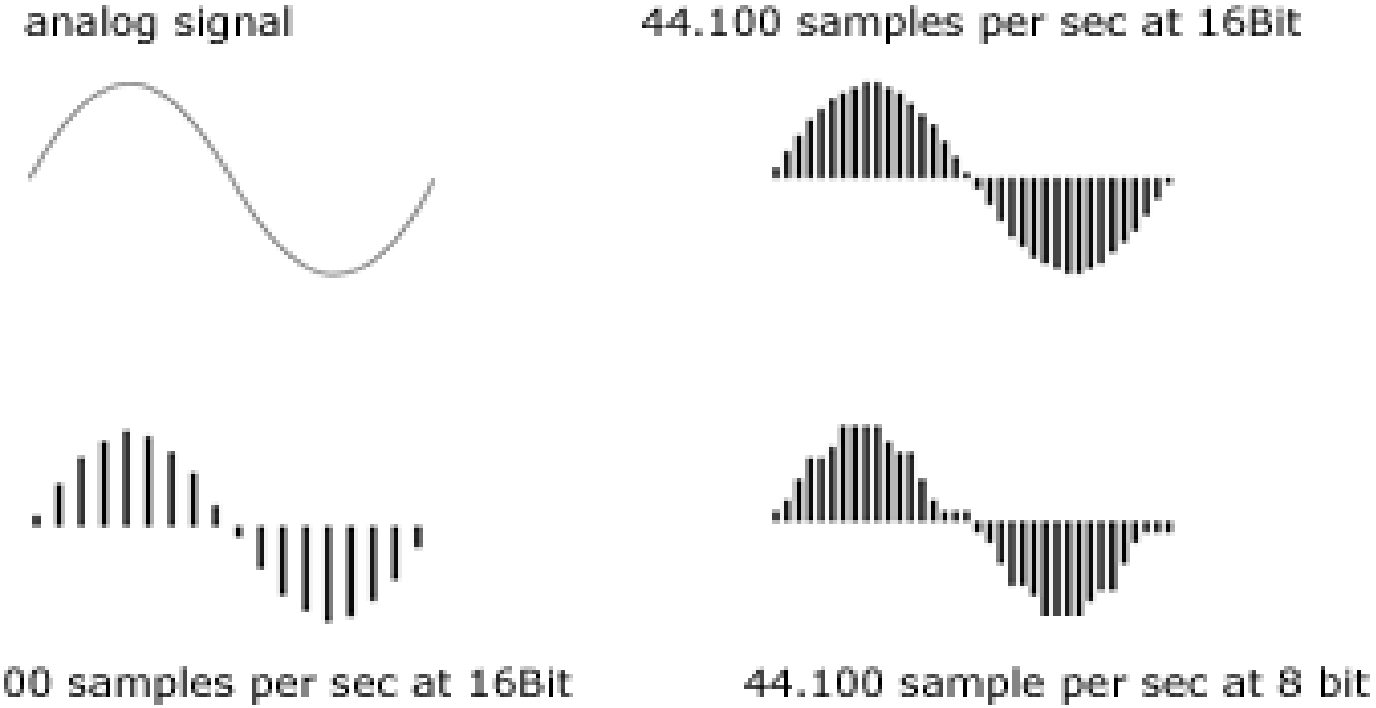
Multimedia systems

- Systems that represent, manipulate, deliver multimedia information
- Producer-consumer process
  - capture, represent, transform, compress, store, transmit, …, reproduce, etc
- Examples
  - WWW, online videos, video conferencing, interactive TV, online games, virtual reality, ...

* youtube, netflix, hulu, pplive, uusee, joost, etc

Audio representation

- How to digitize analog audio (sound wave)?

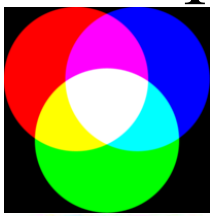


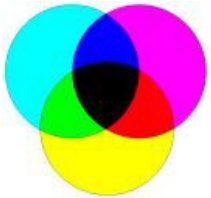
* frequency and amplitude

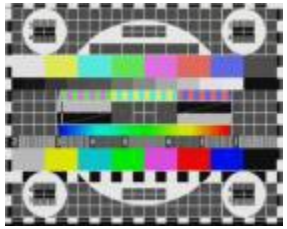
* sampling and quantization

Image representation

- Digital image is a 2-d array of pixels
- Pixel is represented by bits in "color" space
  - RGB in CRT/LCD
    - additive color
  - CMY(K) in printing
    - subtractive color
  - YUV for black-white/color TV
    - luminance/chrominance





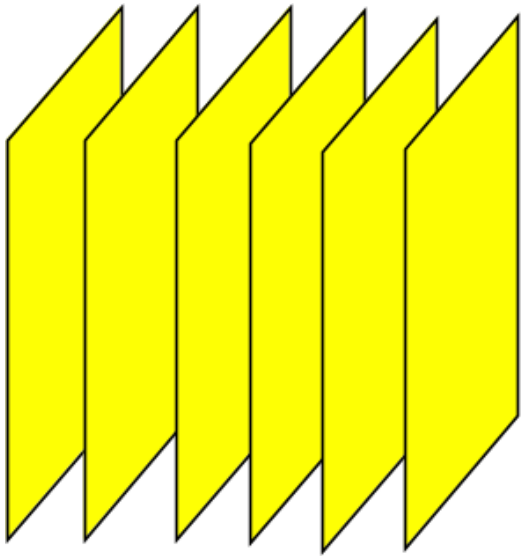


* resolution and bits/pixel

* HDTV? 4:3 vs 16:9? 3DTV? 4KTV?

Video representation

- Video is a sequence of images
  - Displayed at a certain rate



* human perception on motion pictures: still -> slow -> full motion

Why multimedia compression

- "A picture is worth a thousand of words!"
  - so is the amount of data
- One-minute audio CD clip
  - sampling rate: 44.1 KHz
  - sample size: 16-bit
  - channels: 2
  - bit-rate: 1.4 Mbps
  - data size: 10.6 MB

* HDTV (compressed): > 20Mbps; (uncompressed): > 1Gbps

Generic data compression

- Lossless compression
  - no information loss
  - example: executable file compression
  - relatively low compression ratio
- Lossy compression
  - may lose some information
  - example: multimedia data compression
  - usually higher compression ratio

* human perception and sensitivity considerations

Multimedia compression

- There is (a lot of) redundancy in multimedia
  - data redundancy
    - how information is represented
    - some formats are better than others
    - e.g., vector vs bitmap images
  - information redundancy
    - how human receives the information
    - some information is more important than the other
- To do: remove redundancy *adequately*

* one-pixel camera?

Audio encoding

- Surprisingly, audio is *hard* to compress!
- Sampling
  - Frequency band and sub-bands
- Quantization
  - uniform or non-uniform quantizer, differential
- Encoding
- Standards: ITU-T G.7xx, MP-3, AAC, etc

* audio: generic, voice, music, etc

* silence suppression vs skype

Image compression

- Transformation
  - exploit spatial redundancy
- Quantization
  - remove information redundancy
- Encoding
  - remove data redundancy
- Standards: JPEG (1993), JPEG2000, etc

* image: vector vs bitmap

* FFT, DCT, DWT, etc

Video compression

- Video is a sequence of images
  - there is temporal redundancy between frames
- Image compression
  - transformation, quantization, encoding
- Further, for video compression
  - motion estimation
- Standards: MPEG-1/2/4, H.26x, etc

* layered/scalable/adaptive video, multi-description/view video, etc

Generic data networking

- Move data from one location to another
  - reliably, in-sequence
- TCP/IP-based Internet
  - TCP: flow, error and congestion control
  - IP: addressing and routing
  - Best-effort paradigm
- Applications
  - Telnet, FTP, email, Web, etc

* CSc361 or equivalent

Why multimedia is different?

- The amount of multimedia data is huge
  - many need certain (minimum) bandwidth
  - some can tolerate packet loss to a certain extent
- Multimedia applications often interactive
  - many have upper bound on end-to-end delay
  - some are sensitive to delay variance (jitter)
- Multimedia may involve multiple endpoints
  - some need multicast support, session mgmt

Multimedia networking

- Better than “best-effort” paradigms
  - IntServ/RSVP and DiffServ
- Multicast support
  - in network or in application layer
- “Realtime” protocols
  - RTP/RTCP, RTSP
- Session management
  - SIP/SDP, media synchronization

This lecture

- An overview on multimedia systems
  - audio/image/video representation
  - lossless/lossy compression and examples
  - multimedia communication technologies
- After class
  - start to think about your project topics
  - send "[csc461/561] A0" to pan@uvic.ca by Fri
    - see details in 0-intro.pdf

Next lecture

- Multimedia representation
  - audio [Li&Drew Chap 6]
    - what is sound wave?
    - sampling [6.1.3]
    - quantization [6.1.6]
    - encoding
    - examples
      - PCM [6.3.2], DPCM [6.3.5], ADPCM [6.3.7]