What You’ll Learn Today

– Why do they call it a “motion picture”?
– What is digital video?
– How does digital video use compression?
– How does YouTube send video over the internet?
Who invented moving pictures?

"I am experimenting upon an instrument which does for the eye what the phonograph does for the ear, which is the recording and reproduction of things in motion ...."

Thomas A. Edison
1888

Moving Pictures

How do you make moving pictures out of still images?

– Play enough images quickly enough to fool the mind into perceiving the images as continuous.
– Analogous to sampling by taking many successive pictures.
Frame Rate

The frame rate describes how many distinct images per second.

Below which frame rate do humans see discrete picture versus animation?

Show: frame rate examples

- Television plays out at 30 frames/sec.
- 35 mm movie cameras use a standard of 24 frames/second.
TV Data Requirements

Consider:
- 480 * 360 pixels (standard TV resolution)
- 3 bytes per pixel (TrueColor)
  = 518,400 bytes per frame
- 30 frames/second
  = 15,552,000 bytes per second

How much data per minute?
What about the audio?

Data Requirements

CD Audio Requirements:
- 16 bits per channel
- 44,100 samples/sec
  = 1,411,200 bits/sec = 176,400 bytes/sec

“TV + CD Audio” data requirements:
15,728,400 bytes per second
- This works out to about 14 megabytes per second of data
- A standard CD ROM holds about 700 MB, almost enough for 50 seconds of video + audio
But That’s Ridiculous!

Of course, the data requirements on the previous slides are ridiculous!

Why?

Compressing Video

Video compression is key to getting enough video onto a physical medium (e.g. DVD).

Video codec -- COmpressor/DECompressor
Algorithms used to shrink the size of a movie to allow it to be played on a computer or over a network.

Most codecs use **lossy** compression -- why?
Video Compression

Video is effectively a 3-dimensional array of pixels:
- Two spatial dimensions (width & height)
- One time dimension (across frames)

Video data contains spatial and temporal redundancy.

Spatial Compression

Based on removing redundant information within a frame.
- effectively what the JPEG format does.
- JPEG can typically achieve 90% or 95% reduction in file image size without a visible loss in quality.
Temporal Compression

Based on differences between consecutive frames.

Example:

Digital Video Formats

- MPEG-2 (standard definition DVD)
  - compresses video 15-30 times
- Quicktime
  - Incorporates Apple and open standard protocols for audio, images, video codecs
- MPEG-4
  - Enables streaming over networks, iPhone
- Flash Video Player
  - Installed in about 99% of web browsers
Flash Video

Flash applications can run in enabled browsers

- Flash Video Player runs as an application (.SWF file)

- .FLV files are embedded or linked to from SWF.
- Content can be delivered as progressive download.

Flash Video

Streaming Video
- Uses Flash Media Server
- Example: CNN Live

Progressive Download
- Uses standard web server
- Example: YouTube videos
Aspect Ratio

Aspect ratio describes the width:height:
(left)     SD TV     4:3
(n/s)     European Flat  5:3

How does YouTube do it?

– Video player built on Macromedia’s Flash v.7
– Standard video playback in 320 by 240 pixels at 25 frames per second
  • Average bitrate is about 200kbps for video
– Audio: an embedded MP3 audio stream, one channel
  • Average bitrate is 64kbps (or 22050 Hz).
Many Flavors of YouTube

Comparison of YouTube media types

<table>
<thead>
<tr>
<th>Container</th>
<th>Standard</th>
<th>High (default)</th>
<th>High (non-default)</th>
<th>HD</th>
<th>Mobile</th>
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<td>H.264/MPEG-4 AVC</td>
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YouTube: YMMV
Video Chat/Conferencing

Apple’s iChat video chat provides up to:
– 640 by 480 resolution (320 by 240)
– 20 frames/second

Data requirements are 900 kbps
– on a LAN segment it will use up to 2000 kbps.

*Why such high bitrates?*
(YouTube video + audio is 25 fps in ~264kbps)

What You Learned Today
– Moving pictures
– Codec
– Temporal and spatial compression
– Flash video
– YouTube, Video Chat
Announcements and To Do List

– HW 7: Digital Audio due WED 3/9
– Readings:
  • Wong ch 6 pp 158-188 (today)
  • General about Flash (Wednesday):
    http://www.mediacollege.com/adobe/flash/
  • Flash tutorial:
    http://www.w3schools.com/flash/default.asp
– You might want to download the 30-day trial version of Flash CS5:
  http://www.adobe.com/go/tryflash