So far....

- Chapter 4 Color spaces
- Chapter 3 image representations
 - Bitmap
 - grayscale



8-bit color image

- Can show up to 256 colors
- Use color lookup table to map 256 of the 24-bit color (rather than choosing 256 colors equally spaced)
 - Back in the days, displays could only show 256 colors. If you use a LUT for all applications, then display looked uniformly bad. You can choose a table per application in which case application switch involved CLUT switch and so you can't see windows from other applications at all





24-bit Color Images

- In a color 24-bit image, each pixel is represented by three bytes, usually representing RGB.
 - This format supports 256 x 256 x 256 possible combined colors, or a total of 16,777,216 possible colors.
 - However such flexibility does result in a storage penalty: A 640 x 480 24-bit color image would require 921.6 kB of storage without any compression.
- An important point: many 24-bit color images are actually stored as 32-bit images, with the extra byte of data for each pixel used to store an alpha value representing special effect information (e.g., transparency)

Popular Image Formats

► GIF

- Lossless compression
- 8 bit images
- Can use standard LUT or custom LUT
- LZW compression





JPEG

Lossy compression of TrueColor Image (24 bit)

Human eye cannot see high frequency

- Transform from spatial to frequency domain using discrete cosine transformation (DCT) (fast fourier approximation)
- In frequency domain, use quantization table to drop high frequency components. The Q-table is scaled and divided image blocks. Choice of Q-table is an art. Based on lots of user studies. (lossy)
- Use entropy encoding Huffman encoding on Quantized bits (lossless)
- Reverse DCT to get original object
- Human eye cannot discern chroma information
 - Aggresively drop chroma components. Convert image from RGB to YCbCr. Drop Chroma using 4:2:0 subsampling



JPEG artifacts (from Wikipedia)

Original



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⊕

JPEG artifacts (Q=50)

 Differences

 (darker means more changes)



CSE 40373/60373: Multimedia Systems

Other formats

- PNG
- ► TIFF
 - Container for JPEG or other compression
- JPEG is a compression technique, JFIF is the file format. A JPEG file is really JFIF file. TIFF is a file format.
- Postscript is a vector graphics language
 - Encapsulated PS adds some header info such as bounding box
- PDF is a container for PS, compression and other goodies

Summary

- Multimedia technologies use the limitations of human vision and devices in order to achieve good compression
- What does this mean for surveillance applications? Are the assumptions made by JPEG still true for applications that are analyzing images for other purposes

What about printing, medical images?

Chapter 5: Video

- Types of video signals
 - Component video
 - Three separate cables carry the RGB or YCbCr signals (Analog)
 - Best form of analog video





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S-Video

- One wire for luminance
- One wire for both chroma component



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Composite video

- Single RCA cable carries luminance and chroma component
- Signals interfere
- For even cheaper connections, VCRs have a connector that broadcasts signals in Channel 3/4. Signals are modulated and demodulated, losing fidelity

Digital connections

DVI

- Example display modes (single link):
 - <u>HDTV</u> (1920 × 1080) @ 60 Hz
 - <u>UXGA</u> (1600 × 1200) @ 60 Hz
 - <u>WUXGA</u> (1920 × 1200) @ 60 Hz
 - <u>SXGA</u> (1280 × 1024) @ 85 Hz
- Example display modes (dual link):
 - <u>QXGA</u> (2048 × 1536) @ 75 Hz
 - HDTV (1920 × 1080) @ 85 Hz
 - WQXGA (2560 × 1600) pixels (30" LCD)
 - <u>WQUXGA</u> (3840 × 2400) @ 41 Hz



HDMI

- High definition Multimedia Interface
 - uncompressed, all-digital audio/video interface
 - High-Bandwidth Digital Content Protection (HDCP) DRM
 - Without HDCP HD-DVD & Bluray can restrict quality to DVD
 - Supports 30-bit, 36-bit, and 48-bit (RGB or YCbCr)
 - Supports output of <u>Dolby TrueHD</u> and <u>DTS</u>-HD Master Audio streams for external decoding by AV receivers



Analog video

Interlaced Raster Scan

- Way to increase refresh frequencies by alternating odd and even scan lines in separate refresh
- NTSC has a notion of blacker than black signal that triggers a beginning of line
- 525 scan lines at 29.97 frames per second
- VHS: 240 samples per line, S-VHS: 400-425, Hi-8: 425, miniDV: 480x720)
- PAL and SECAM: 625 scan lines, 25 frames per second
 - NTSC: 6 MHz, PAL&SECAM: 8 MHz



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Digital video - Chroma subsampling

- 4:4:4, 4 pixels of Y, Cb and Cr each
- 4:2:2 : Cb and Cr are half
 - NTSC uses this subsampling
- 4:1:1 : Cb and Cr are factor of four
 - DV uses this subsampling
- 4:2:0 : Cb and Cr are subsampled, effectively 4:1:1
 - Used in JPEG, MPEG and HDV

Chroma sub-sampling



#

Digital video standards

CCIR Standards for Digital Video

- CIF stands for Common Intermediate Format specified by the CCITT.
 - (a) The idea of CIF is to specify a format for lower bitrate.
 - (b) CIF is about the same as VHS quality. It uses a progressive (non-interlaced) scan.
 - (c) QCIF stands for "Quarter-CIF". All the CIF/QCIF resolutions are evenly divisible by 8, and all except 88 are divisible by 16; this provides convenience for blockbased video coding in H.261 and H.263

Digital video specifications

	CCIR 601 525/60 NTSC	CCIR 601 625/50 PAL/ SECAM	CIF	QCIF
Luminance resolution	720 x 480	720 x 576	352 x 288	176 x 144
Chrominance resolution	360 x 480	360 x 576	176 x 144	88 x 72
Colour Subsampling	4:2:2	4:2:2	4:2:0	4:2:0
Fields/sec	60	50	30	30
Interlaced	Yes	Yes	No	No



High Definition TV

US style:

- MPEG 2 video, Dolby AC-3 audio
- 1920x1080i NBC, CBS ..
- 1280x720p ABC, ESPN
- 1920x1080p Xbox 360, PSP3
 - 1920x1080p24 cinematic
- HDV uses rectangular pixels: 1440x1080
- For video, MPEG-2 is chosen as the compression standard. For audio, AC-3 is the standard. It supports the so-called 5.1 channel Dolby surround sound, i.e., five surround channels plus a subwoofer channel.