CSc 461/561
Multimedia Systems
Video Representation

Jianping Pan

Spring 2015

Video is a sequence of images

- Recorded/displayed at a certain rate
- Types of video signals
  - component video
    - separate RGB signals; e.g., VGA CRT/LCD
  - composite video
    - luminance and chrominance in one signal carrier
  - S-video
    - 1 luminance and 1 composite chrominance signal






* more digital interfaces: DVI, HDMI

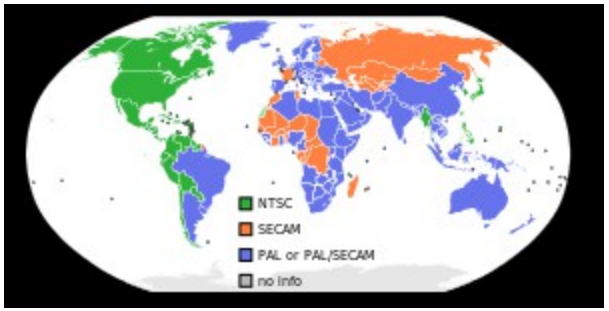
Video

- Image
  - picture resolution: e.g., 640x480
  - pixel depth: e.g., 8-bit
- Video
  - frame rate > flicker-free rate
    - movie: 24 frames/second
    - TV: 25 or 30 frames/second
    - VGA CRT/LCD: e.g., 50Hz

* higher resolutions: HDTV? 4KTV? higher refresh rates: 60Hz? 120Hz?

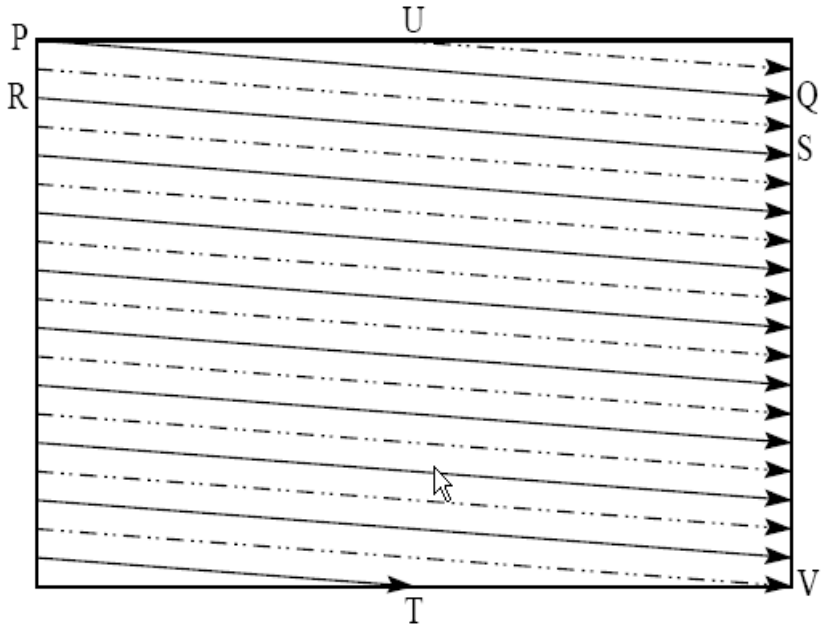
We see most video on

- Television and now more computer screens
  - PAL (Phase Alternating Line)
    - 625 lines interlaced (576 visible)
    - 25 frames/second
    - aspect ratio 4:3
    - YUV
  - NTSC (National TV Standards Committee)
    - 525 lines interlaced (480 visible)
    - 30 frames/second (29.97 to be exact), 4:3, YIQ



Interlaced vs progressive

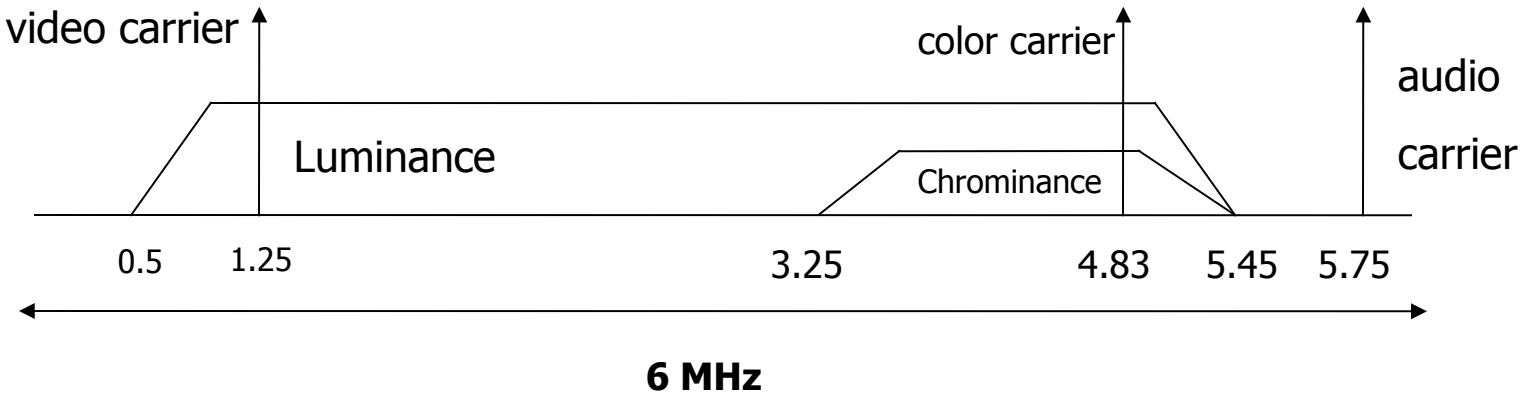
- Interlaced
  - odd line: P => Q
  - Q => R (H retrace)
  - R => S
  - …
  - T => U (V retrace)
  - even line: dash-dot
- Progressive



* 720i vs 720p?

TV broadcasting

- NTSC (6MHz channel)
  - lower band: guard; upper band: audio (FM)
  - Y: 4.2MHz
  - I: 1.6MHz; Q: 0.6MHz



* digital TV broadcasting?

Digital video

Standards for Video

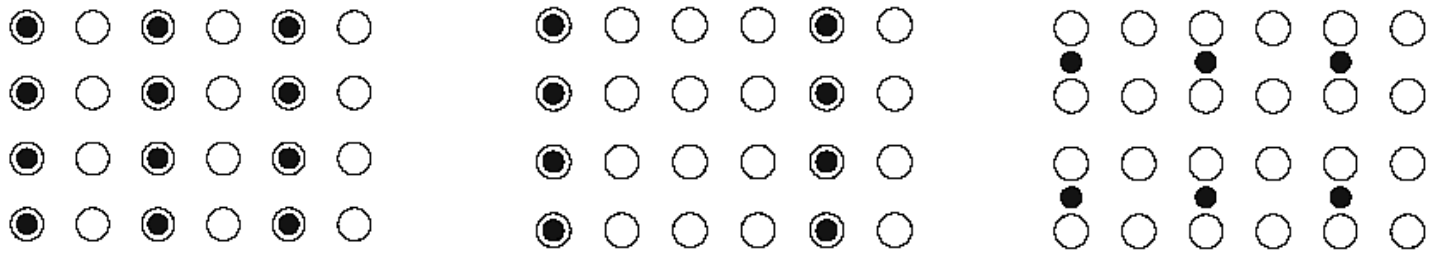
	HDTV	CCIR 601 NTSC	CCIR 601 PAL	CIF	QCIF
Luminance Resolution	1920 x 1080	720 x 486	720 x 576	352 x 288	176 x 144
Chrominance Resolution	960 x 540	360 x 486	360 x 576	176 x 144	88 x 72
Color Subsampling	4:2:2	4:2:2	4:2:2	4:2:0	4:2:0
Fields/sec	60	60	50	30	30
Aspect Ratio	16:9	4:3	4:3	4:3	4:3
Interlacing	Yes	Yes	Yes	No	No

CCIR – Consultative Committee for International Radio
CIF – Common Intermediate Format (approximately VHS quality)

* now most HDTV does progressive too!

Chroma subsampling

- 4:4:4: no subsampling
- 4:2:2, 4:1:1: chroma as 1/2 or 1/4 luma
- 4:2:0: vertical subsampling as well



4:2:2 4:1:1 4:2:0

* human beings are less sensitive to color information than black&white

Chroma subsampling examples

- Common Intermediate Format (CIF)
  - 4:2:0
  - Y: 352 x 288; U and V: 176 x 144
- Quarter CIF (QCIF): 176x144; 4:2:0

Y: 176 x 144

U: 88 x 72

V: 88 x 72

HDTV

- High Definition TV: better video/audio

# of Active Pixels per line	# of Active Lines	Aspect Ratio	Picture Rate
1,920	1,080	16:9	60I 30P 24P
1,280	720	16:9	60P 30P 24P
704	480	16:9 & 4:3	60I 60P 30P 24P
640	480	4:3	60I 60P 30P 24P

* 4KTV!

TV resolution evolution

- LDTV: low definition
  - 240i60, 288i50
- SDTV: standard definition
  - 480i60, 480p30, 576i50, 576p25
- EDTV: enhanced definition
  - 480p60, 576p50, 720i50/60, 720p24/25/30
- HDTV: high definition
  - 720p50/60, 1080p24/25/30, 1080i50, 1080i60

- 3DTV
  - glasses?
  - glasses-less?

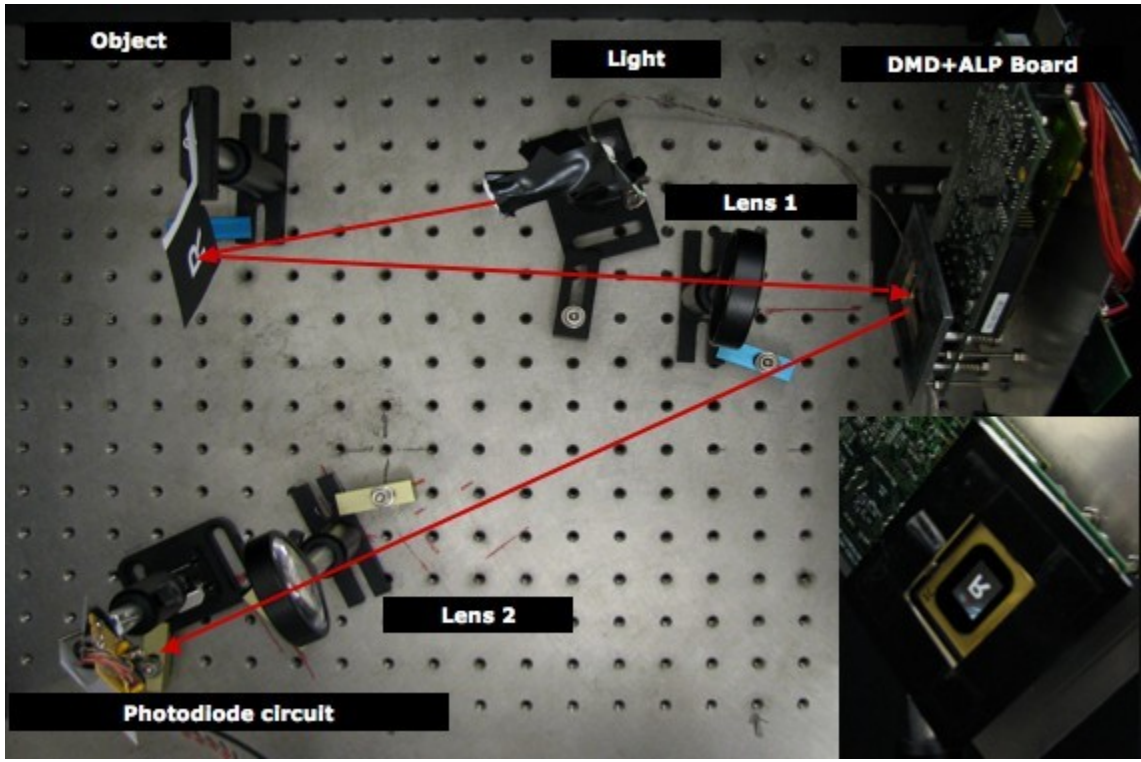
What's new?

Larger, thinner, brighter!

- So bigger, it has to be bended
  - more than 100 inches (diagonal)!
  - more pixels: 8KTV
- Thinner than your cell phone
  - some: 0.2 inch deep
- Sharper than you envisioned
  - OLED: organic LED
  - HDR: high dynamic range

What's next?

- Single-pixel camera?!
  - current cameras
    - more&more pixels
    - sense once/pixel
  - a possible future
    - one light-detection element (CCD)
    - a few measurements
  - compressed sensing



* http://dsp.rice.edu/cscamera

This lecture

- Video representation
  - type of video signals
  - picture resolution and frame rate
  - analog & digital & HD video
  - interlaced vs progressive
  - chroma subsampling

Next lecture

- Multimedia manipulation
  - lossless compression [Ref: Li&Drew Chap 7]
    - compressibility [7.2]
    - Hoffman coding [7.4.2]
    - LZW compression [7.5]