Chapter 4

Media Representations:
Visual Media (Continuous)

Motion Video

- **Persistence of vision**
  - An image transmitted to the brain persists for a short time before fading out, or being replaced by another image.
  - Duration of persistence varies from person to person.
  - Usually longer than 30 msec.
- Discrete image perceived as continuous motion sequence when presented at a rate > 30 fps.
  - Jerkiness often resulted when video is played at 24 fps.
  - Low-cost video phones give 2 fps. Motion becomes discrete sequence.
  - Much smoother motion can be achieved with 60 fps technologies.
  - TV broadcasting standards: NTSC is 30 fps and PAL is 25 fps.

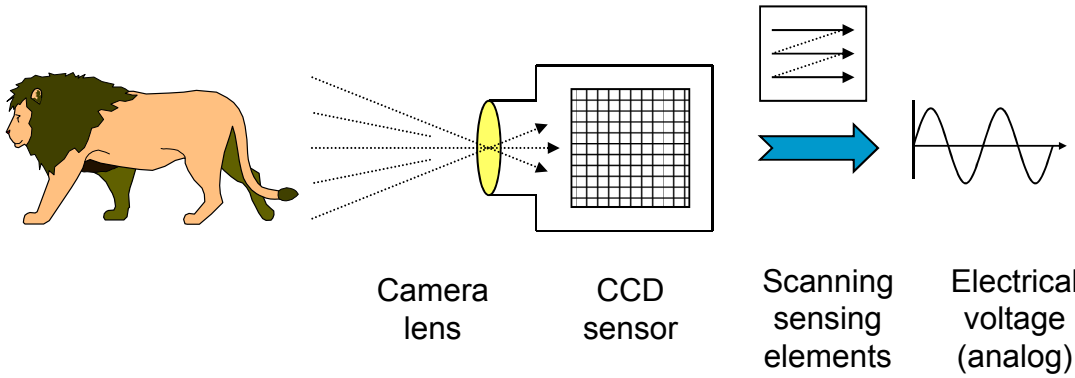
Image Capture

- Image formation process:

  Light irradiated on the camera due to objects in the scene

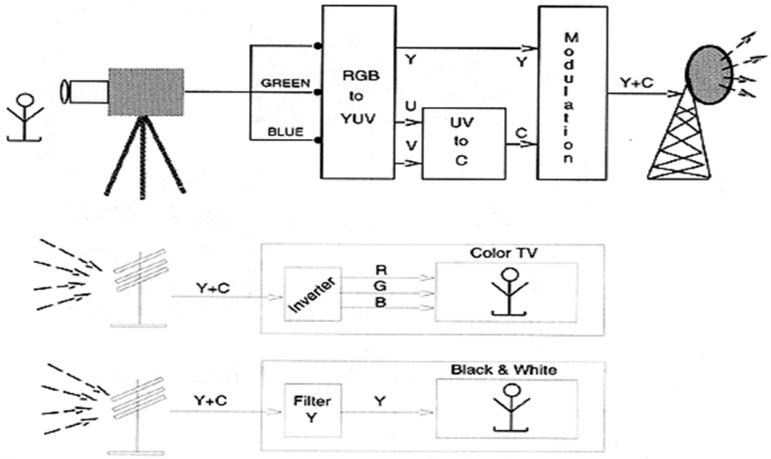
  ⇒ electrical voltage on the CCD sensor array

  ⇒ 2D image



Analog TV

- Last generationTV signal is not represented as digital bits, but analog signal.
- Instead of transmitting bits through the channels, the analog signal is transmitted. (Because the technology is very old, more than 50 years)
- RGB signals output from the video camera and usually converted to YUV or YIQ for transmission. Why?

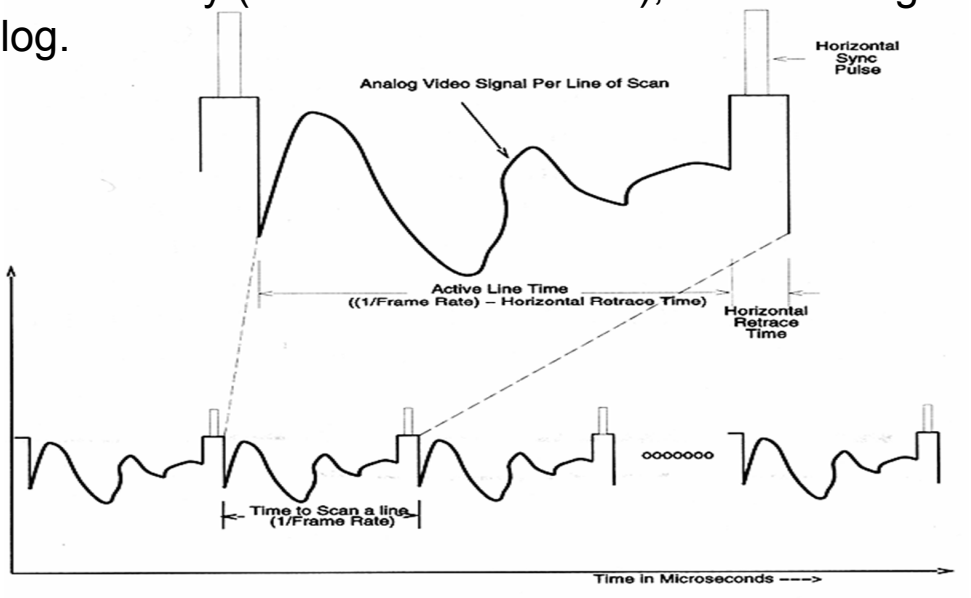


Analog TV (2)

- Human are more sensitive to intensity level than color signal.
- YUV or YIQ effectively separates luminance (intensity) from chrominances (color) components
- Compatible with old B/W TV
- By reducing the bandwidth of the two chrominances components, we can reduce the bandwidth needed.
- Transmitted signal is analog!!
- How to compress analog signal? Not very effective

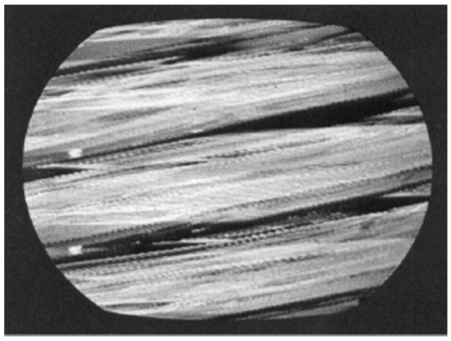
Analog Video Signal

- To represent the information on the 2D screen, the video signal is sampled vertically.
- That is, a 2D continuous function (2D view) is composed of discrete number of scanlines.
- But horizontally (within each scanline), the video signal is analog.

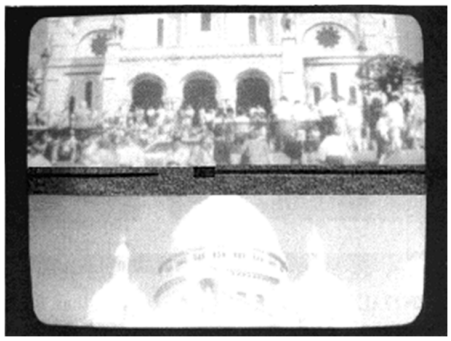


Analog Video Signal (2)

- Spatial-temporal information is ordered as function of time according to a predefined scanning convention.
- A synchronization signal is introduced to synchronize horizontal and vertical retreats. Actual video signal occupies lesser time.



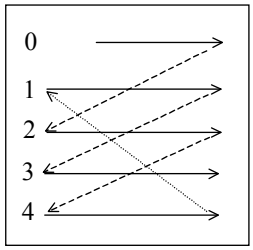
Out of sync (horizontal)

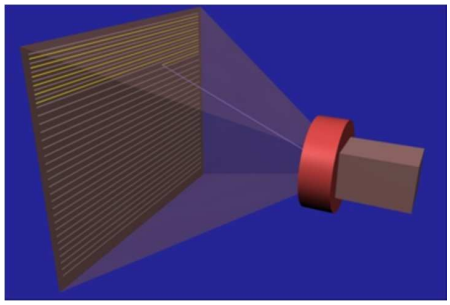


Out of sync (vertical)

Interlacing

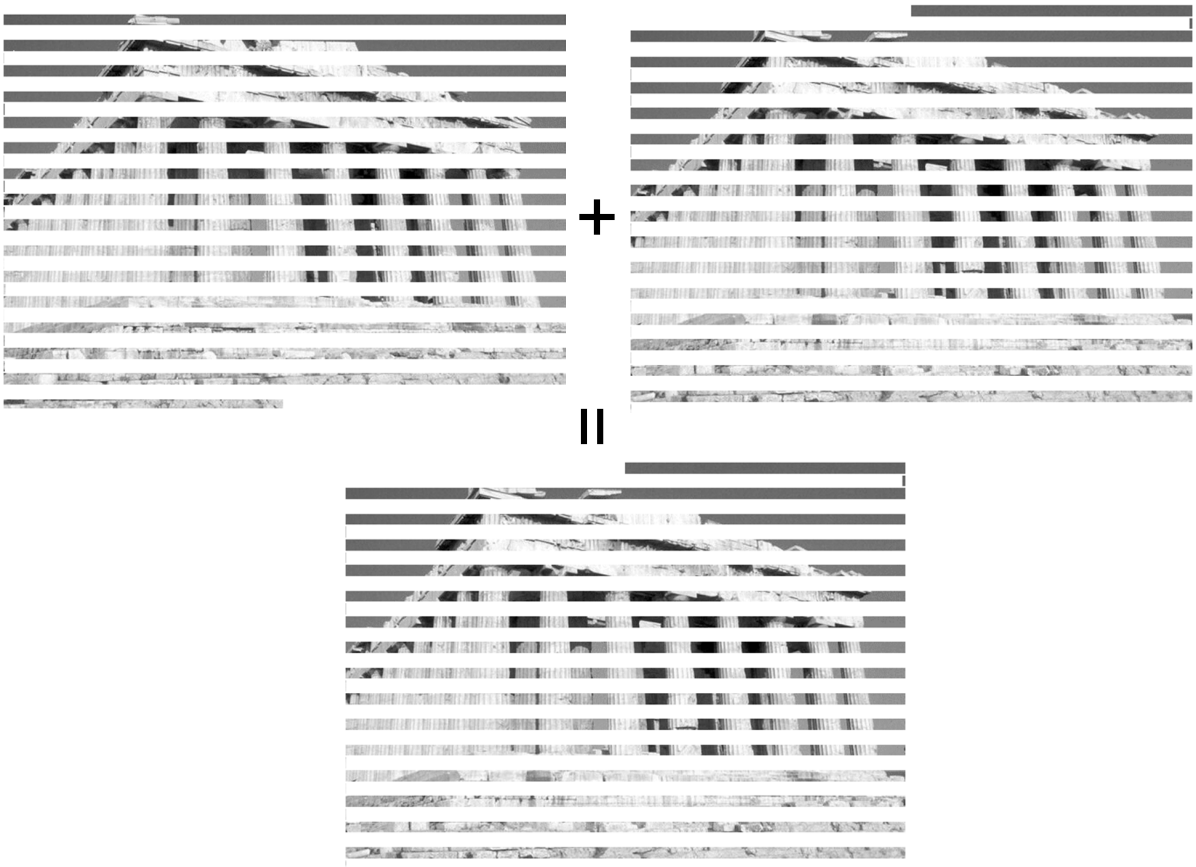
- Progressive scanning traces a complete picture (frame) from top to bottom and left to right.
- Interlaced scanning is used in TV industry. It traces odd and even numbered lines separately.





- Allow us to see the whole screen in half of the time
- Design for CRT with slow refresh rate (cheaper), so that 30Hz looks like 60Hz.
- May look flicking for some users with sensitive vision
- Similar techniques used in image format e.g GIF89, progressive JPEG

Interlacing



Interlacing During Capture

- High-speed video capture is more expensive
- Interlacing is also used in DV

Original frame from DV

Postprocessed digitally

Common TV Standards

NTSC (National Television Systems Committee)

- 525 scan lines, 30 frames per second, interlaced
- Aspect ratio 4:3
- First 20 lines are reserved for control information
- Color model for transmission: YIQ
- Bandwidth allocated, Y:4.2MHz, I: 1.0MHz, Q:0.6MHz.
- Used in USA, Japan & Latin America.

PAL (Phase Alternating Line)

- 625 scan lines, 25 fps, aspect ratio 4:3, interlaced
- Color model used YUV
- Y: 5.5MHz, U: 1.8MHz, V: 1.8MHz
- U and V are lowpass filtered to half bandwidth of Y.
- Used in Western Europe & Hong Kong.

Common TV Standards (2)

SECAM (SEquential Couleur Avec Memoire)

- 625 scan lines, 25 fps, interlaced
- Aspect ratio 4:3
- Color model for transmission: YIQ
- Bandwidth allocated, Y: 6.0MHz, I: 2.0MHz, Q: 2.0MHz.
- Used in Eastern Europe & France.

Digital Video

- Analog video are difficult to manipulate.
- Instead of representing each frame as a discrete number of scan line of analog signal, each frame can be digitized to a 2D digital image.
- Movie industry and TV broadcast are already using digital video due to power of non-linear video editing
- Non-linear video editing includes image processing techniques, fade-in and fade-out, insertion of synthetic objects, ….

Digital Video (2)

- Difficulties of analog video:
  - nonlinear editing is not possible e.g live action+synthetic monster
  - hard to compress, all you can do is to manipulate the waveforms, no semantic information you can make use
  - may degrade if repeated record
  - interference between luminance and chrominance.
  - Noisy, ghosting, ...
- Advantages of digital video:
  - nonlinear video editing, all studio use digital video for special effect
  - most universal digital compression techniques can apply
  - no degradation if repeated record
  - allow separate coding of luminance & chrominance.
  - Either sharp or receive nothing.
  - Moreover, error detection and error recovery are possible

High Definition TV (HDTV)

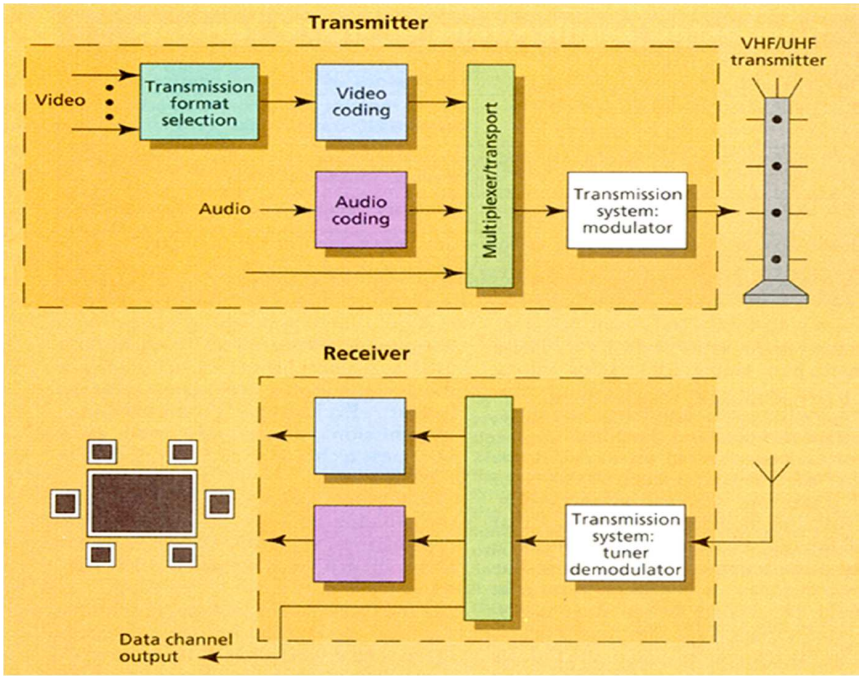
- A fully digital video technology for TV broadcast.
- Two line structures: 720-line and 1080-line
- Several frame rates. Aspect ratio 16:9
- e.g. 720 scan lines for TV, 60 fps, progressive scanning.
- Coding format is decoupled from transmission format
- Highly dependent on digital compression techniques

  Video compression:
  - motion compensation
  - discrete cosine transform
  - i.e. MPEG-2

  Audio compression
  - digtial audio compression technique AC-3
  - significant audio features are encoded with more bits
  - spectral components that are less audible are not encoded.

HDTV (2)

- HDTV encoding, transmission and decoding:



- It can be transferred through various networks, such as terrestrial simulcast, cable satellite, fiber.

HDTV (3)

- The physical channel does not matter as the bit-stream can still be modulated, transmitted and demodulated.
- Currently, there are 3 major HDTV standards
- Previously mentioned HDTV is USA standard.
- European HDTV is similar to American HDTV
- Japanese HDTV is the first HDTV standards proposed by NHK in 1968. It is pretty old and not fully digital. Also known as MUSE
- In 2008, Hong Kong launched HDTV. Two standards are adopted: MPEG2 (for simulcast such as TVB Pearl) and H.264 (for pure digital TV)

Motion Video

- Most critical issue is size of data.
  - An appreciable display contains 640x480 pixels in a frame ≈ 300 KB.
  - A video of 30 fps requires transmission of 10 MB per sec!
  - 24-bit full color display demands 30 MB per sec.
- Transmission and storage of uncompressed video is impractical.
  - Compression ratio of 100:1 reduces it to 0.3 MB per sec.
  - Video compression techniques: H.261, MPEG.

Computer Animation

- Video and computer animation is analogous to image and graphics.
- Computer animation generates the motion sequence of a still figure.
- Key frame approach involves
  - Input step
  - Interpolation step
- Input step
  - Specifying ***key frames*** in which the figures are at characteristic positions.

Computer Animation(2)

- Interpolation step
  - Generate intermediate positions of figures in between the key frames.
  - Easiest approach is linear interpolation, but has lots of shortcomings.
  - Cubic spline is better approach to yield smooth trajectory of motion.
- Motion capture
  - Instead of entering keyframes by mouse and keyboard
  - They are entered by natural postures.
  - Tracking the markers (magnetic or optical)
  - Latest advancement: vision based tracking, e.g. Kinect

http://www.youtube.com/watch?v=1NZa1oafiZU&feature=related

Computer Animation(3)

- The final movie sequence is synthesized by rendering the objects with the predetermined position and orientation.
- e.g. flash