Multimedia Course

Multimedia Course

By

Dr. Mai Kamal El Den

Lecturer, Computer Science Department,

Faculty of Computers and Artificial Intelligence,
Benha University

Multimedia Course
CSx58

Teams Link

https://teams.microsoft.com/l/team/19%3aY1IWWnAYjMbfpfphN770t_sAvrDZz01ElBVMa-oy2Dw1%40thread.tacv2/conversations?groupId=3677812 3-7bfe-4c77-86a1-fb733e69007c&tenantId=ff4a48d6-4b5e-4fd3-8266-7eafc3e6e23e

Multimedia Course

Lecture 6

Multimedia Data Representations

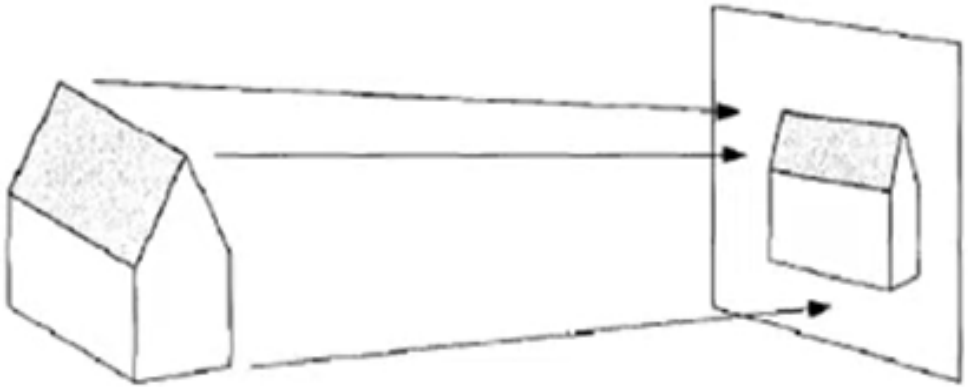
Video Data Representations

Purpose of Using Video

- **Video** is an excellent tool for delivering multimedia.
- **Video** is the technology of electronically capturing, recording, processing, storing, transmitting, and reconstructing a sequence of still images representing scenes in motion.
- **Digital video device** produces excellent finished products at a fraction of the cost of analog.
- The video places the highest performance demand on the computer and its memory and storage.

Video Image or Frame

- The video image is a projection of a 3-D scene onto a 2-D plane.



- 3-D scene consisting of several objects each **with** depth, texture, and illumination projected onto a plane to form a 2-D representation of the scene.
- The 2-D representation contains varying texture and illumination **but no** depth information.

Graphics and Video: Movies

- **Video** is an effective way to present information that cannot be delivered by any other media because it can convey meaning and information in a relatively shot period of time.
- **Video** or movie, is a series of images (frames) that slightly differ one from another, passing them one after the other at a certain speed (**frame rate**) will give the illusion of movement.
- Digital video has replaced analog video as the method of choice for making and delivering video for multimedia.
- Video can created from a variety of sources, one of them is signals themselves.

Graphics and Video: Movies

- **Frame rate** is the speed of flipping the frames one after another.
- **Films** are usually shot and displayed at 24 frames per seconds (**fps**).
- TV pictures are presented at between 25 and 30 fps, depending on what country you live in.
- High definition TV, uses 60 fps.

Sources of Video

Video Cassette Recorder (VCR)

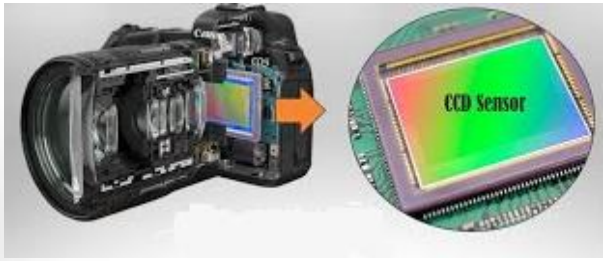
Betacam

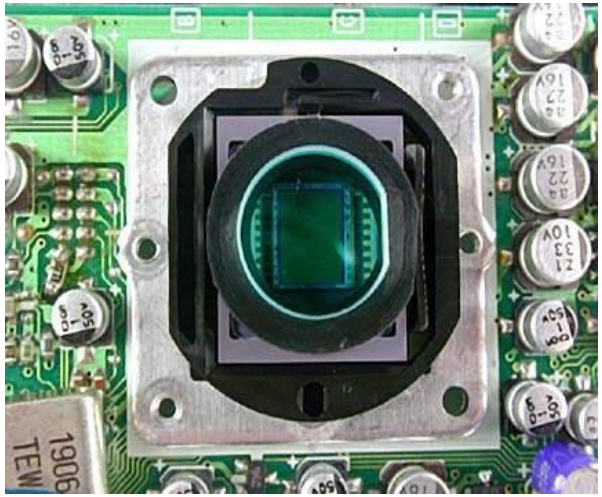
Laser Disc

Camcorder

How Video Works?

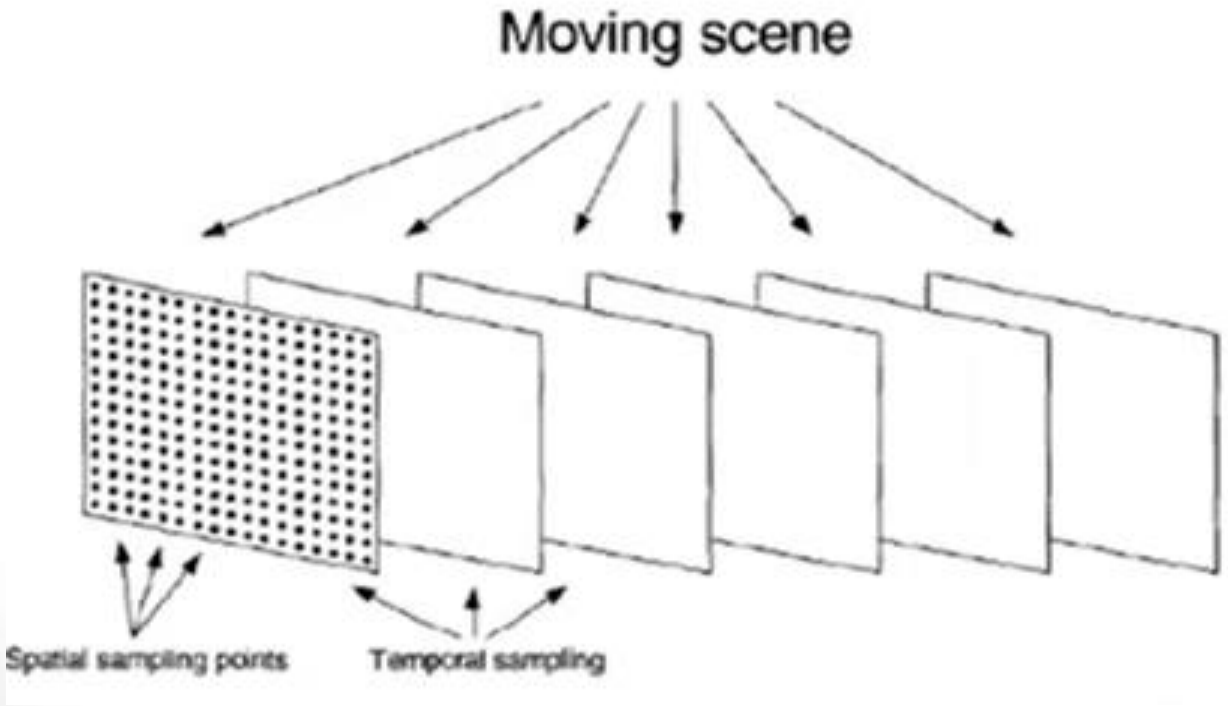
- When light reflected from an object passes through a video camera lens, that light is converted into an electronic signal by a special sensor called a **charge-coupled device (CCD).**





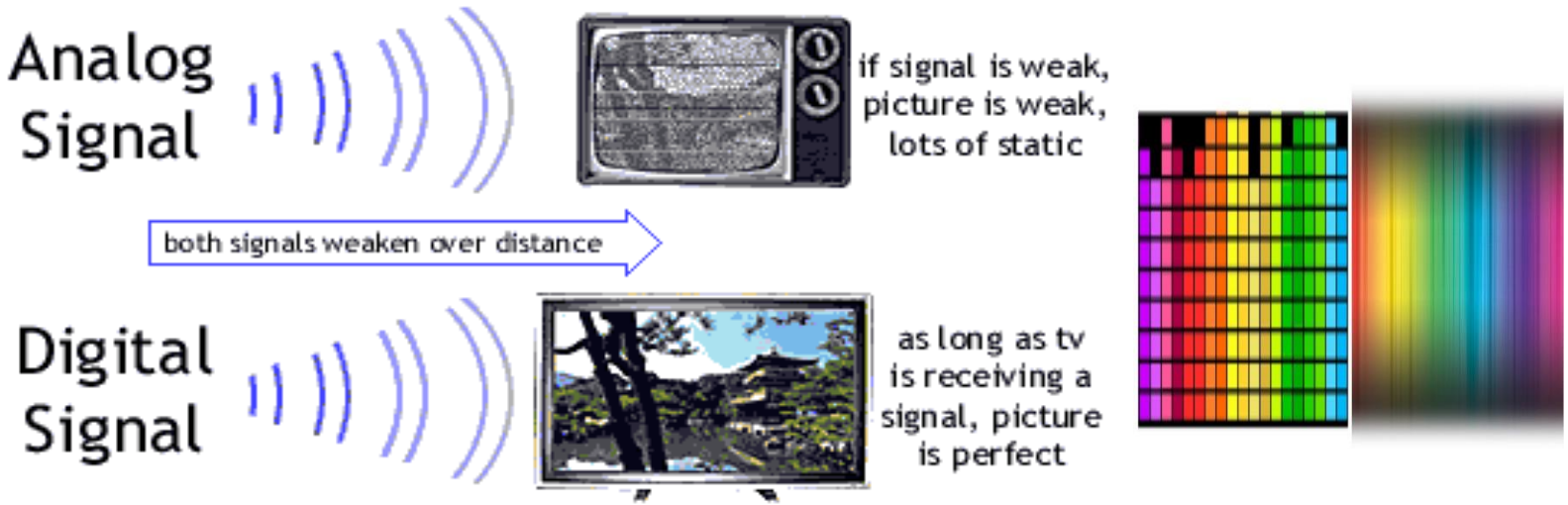
Video Image or Frame

- In order to represent and process a visual scene digitally it is necessary to sample the real scene spatially and temporally.



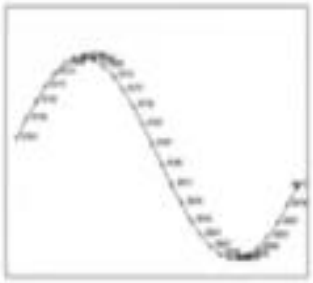
Video Types

- Video classified into **two categories**:
  - **Analog video** is represented as a continuous (time-varying) signal.
  - **Digital video** is represented as a sequence of digital images.



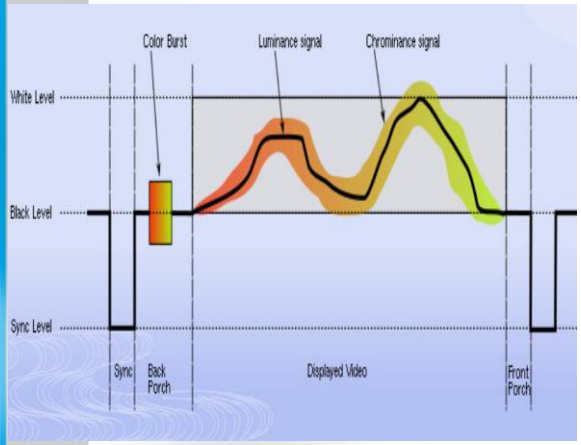
Analog Video

- **Video Information** is stored using television video signals, film, videotape or other non-computer media.
- **Each frame** is represented by a fluctuating voltage signal **know as** an analogue wave form.



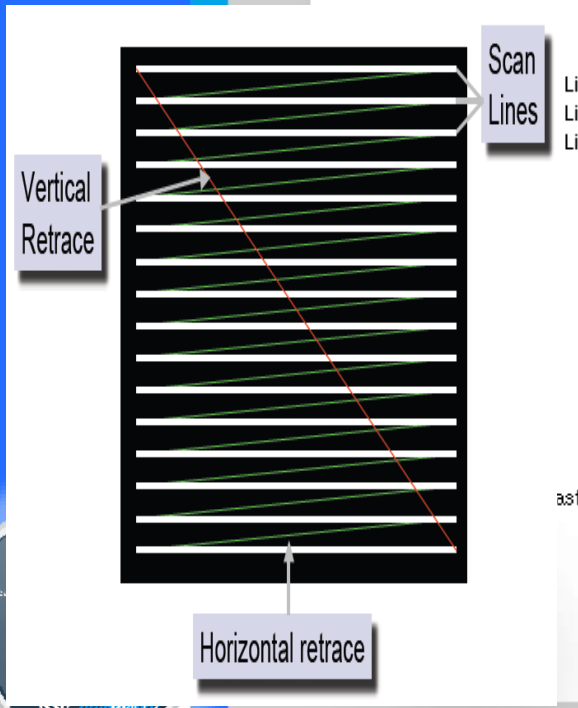
Analog Video

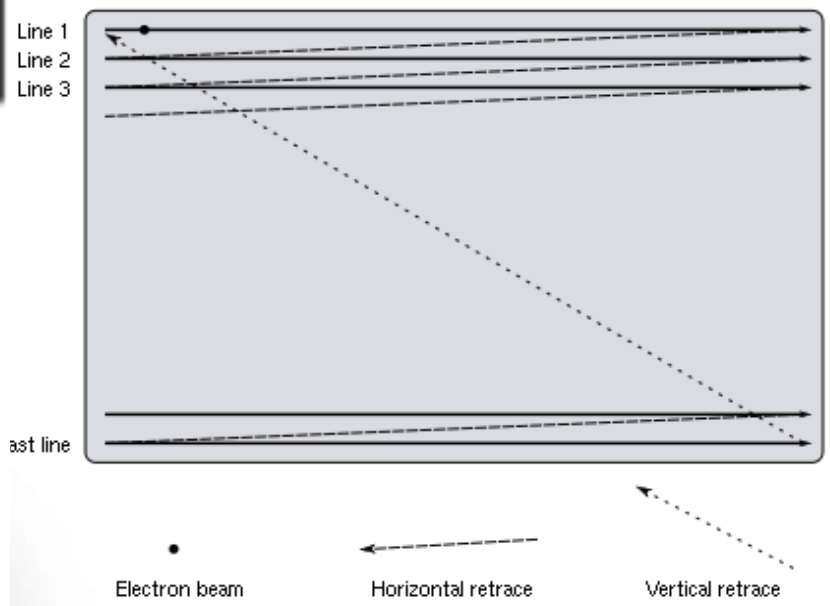
- is represented as a continuous time signal.
- Each line in the video image represents continuous measurements of the color and brightness along the horizontal axis.



Analog Video

- Analog video has a resolution measured in the number of horizontal scan lines (due to the nature of early cathode-tube cameras).





Analog Video

- **Two different types of scanning systems used to "paint" the image on the screen.**
  - **Television signals** and compatible displays are typically **interlaced**.
  - **Computer signals** and compatible displays are typically **progressive.**
- These two formats are incompatible with each other; one would need to be converted to the other before any common processing could be done.

Digital Video

- **Digital video** combines features of graphics and audio to create dynamic content for multimedia products.
- **Video** is simply moving pictures.
- **Video** is represented as a sequence of discrete images (frames) shown in quick succession.
- **Digital video** can be edited more easily.
- **Digital video file** can be extremely large.

Why Digital Video?

- ***The advantages of digital representation for video:***
  - Storing video on digital devices or in memory, ready to be processed (noise removal, cut and paste, and so on) and integrated into various multimedia applications.
  - Direct access, which makes nonlinear video editing simple.
  - Repeated recording without degradation of image quality.
  - Ease of encryption and better tolerance to channel noise.

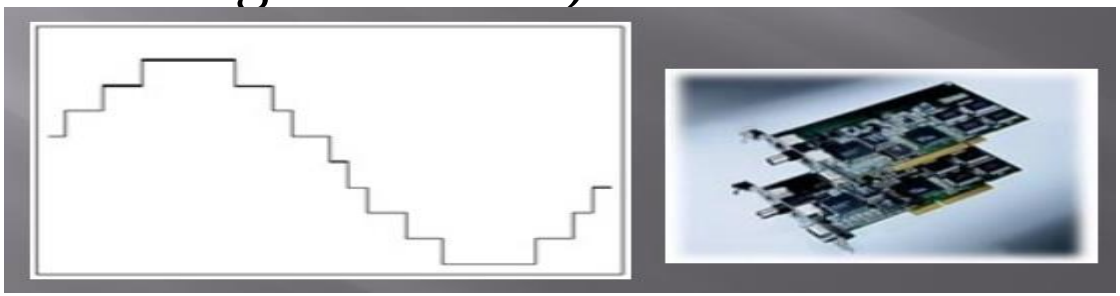
Exercises

- Consider a 2 hours film to be displayed on a computer at 24 fps. Each frame is 640x380 pixels and a 24-bit RGB color encoding is being used. How many bytes will be required to represent the whole file?
- **Answer:**
  - The number of pixels in one frame = 640 * 380 = 243200 pixels.
  - The number of bytes needed to represent one frame = 243200 * 3 = 729600 bytes.
  - The number of seconds in 2 hours = 2 * 60 * 60 = 7200 seconds.
  - The number of frames in 2 hours = 7200 * 24 = 172800 frames.
  - The number of bytes needed to represent the whole film = 172800 * 729600 = 126074880000 bytes.

    = 126074880000 / 2^{30} = 117.416 GB.

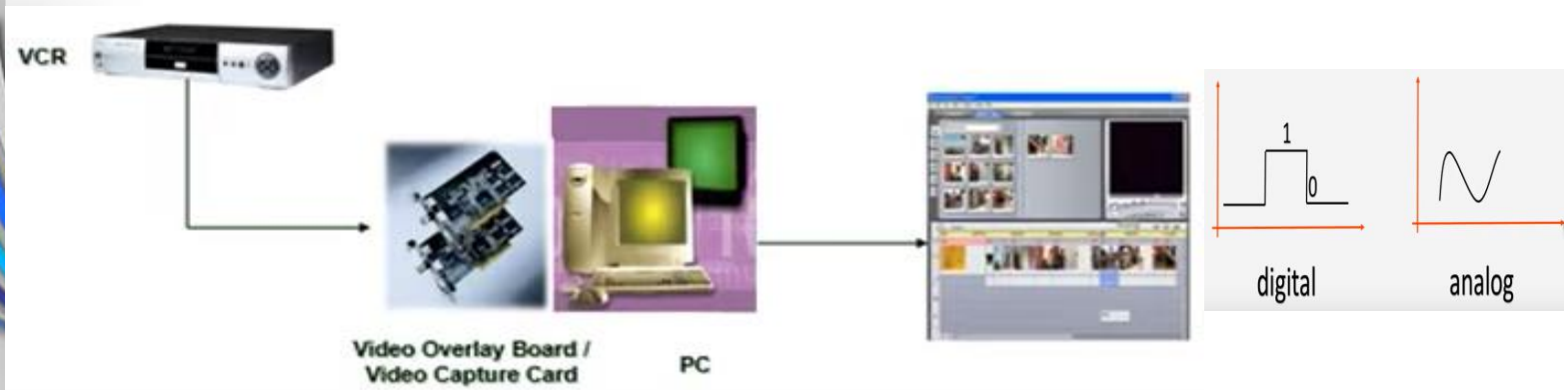
Convert from Analog to Digital Video

- Digital video is the digitizing of analog video signals into numerical format.
- It creates the illusion of full motion by displaying a rapid sequence of charging images on a display device.
- Conversion from analog to digital requires the use of an ADC(Analog to Digital Converter).
- DCA (Digital to Analog Converter) can be used to output digital video on analog equipment.



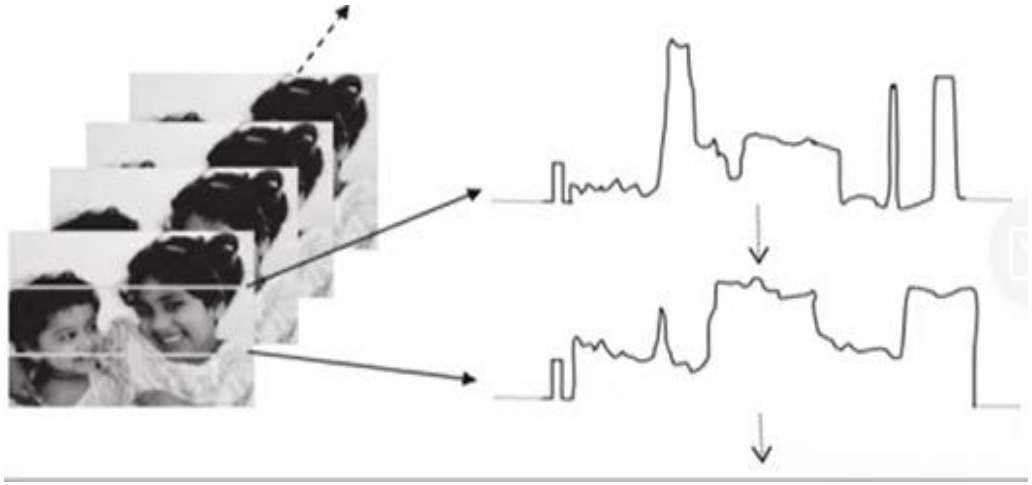
Convert from Analog to Digital Video

- **Video source** (video camera, VCR, or videodisk) is connected to a Video Capture Card (VCC) into a computer.
- As the video source is played, the analog signal is sent to the video card and **convert** into digital file (include sound from video).

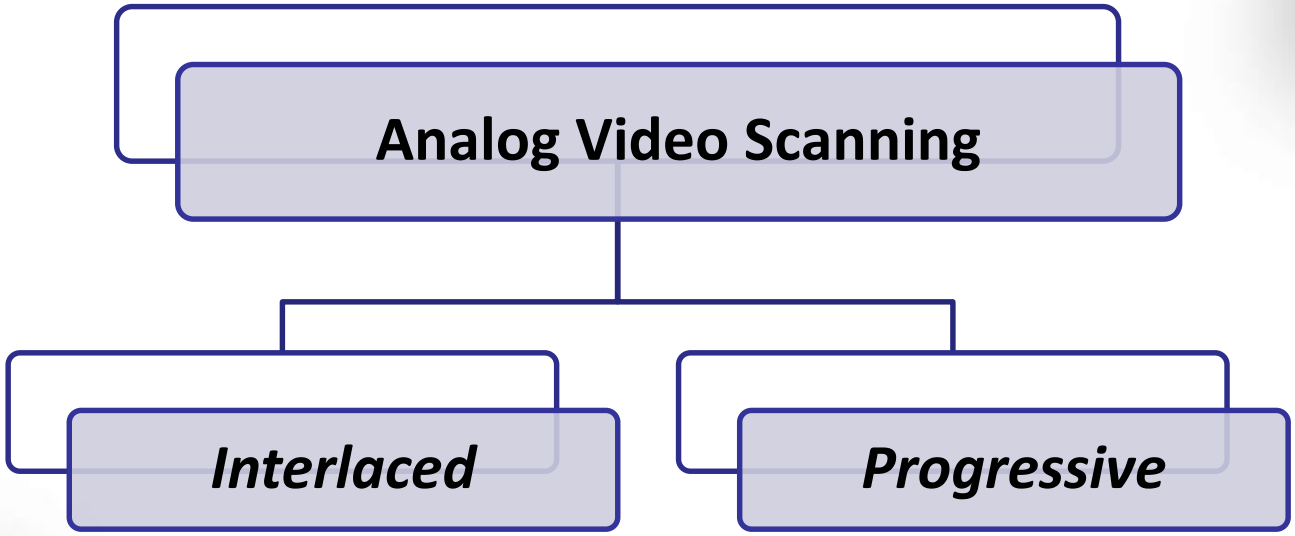


Representation of Digital Video

- **Two Important Properties for Video Representation**
  - **Frame rate:** the number of frame per second.
  - **Scanning format:** converting the video to 1D signal.

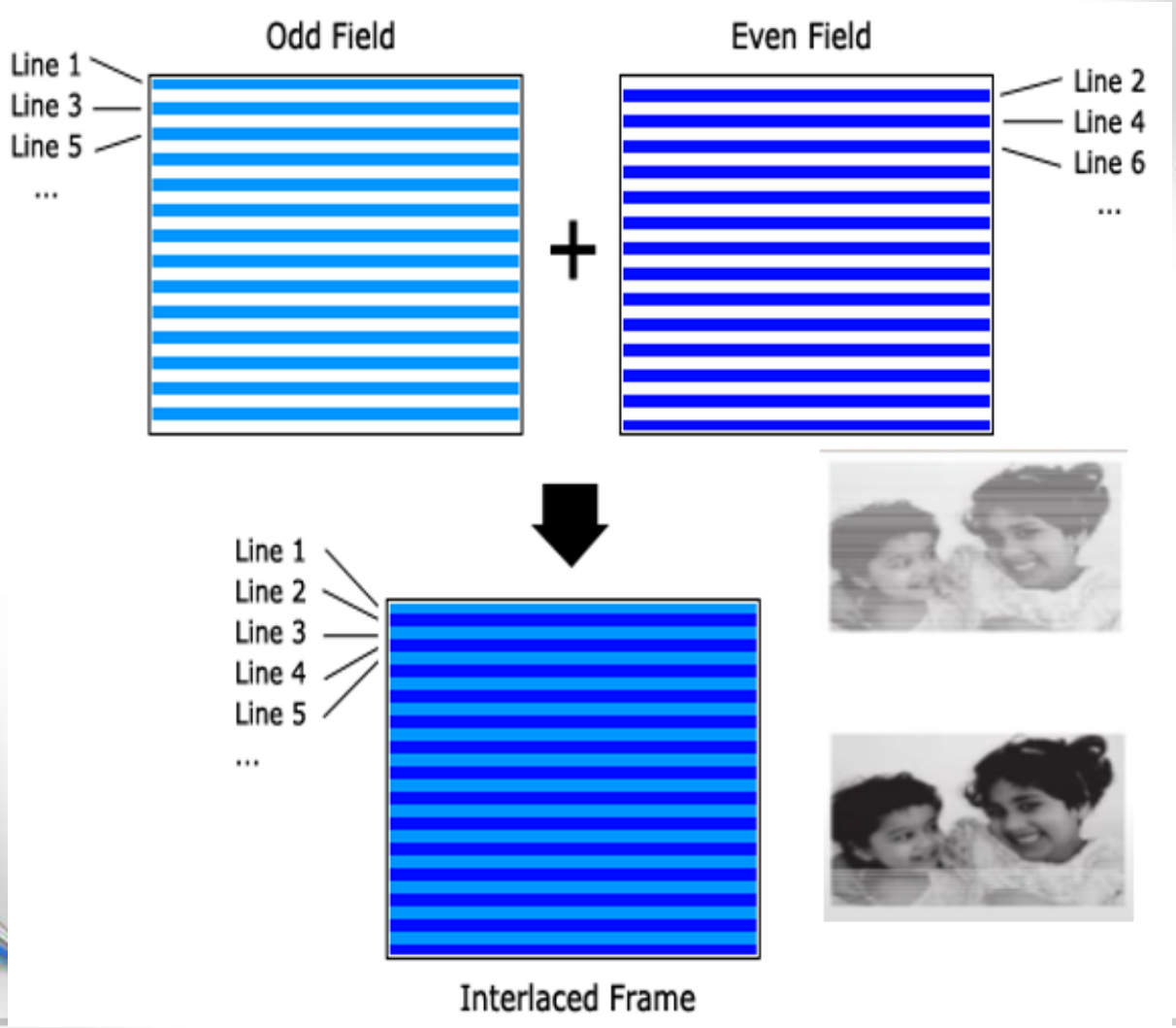


Analog Video Scanning



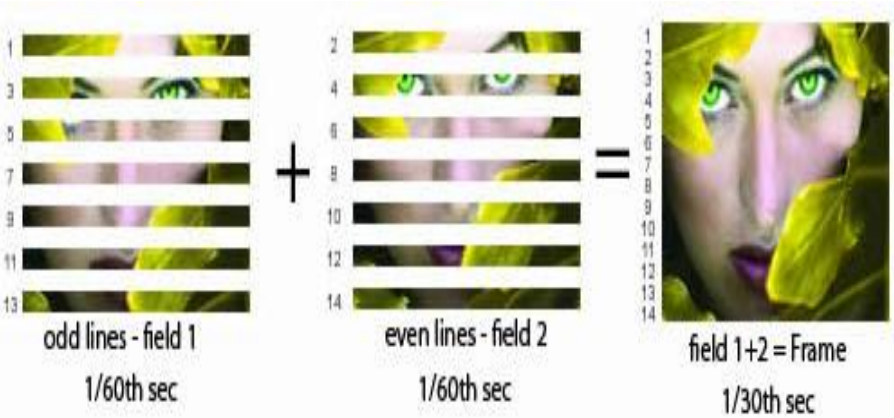
Analog Video Scanning

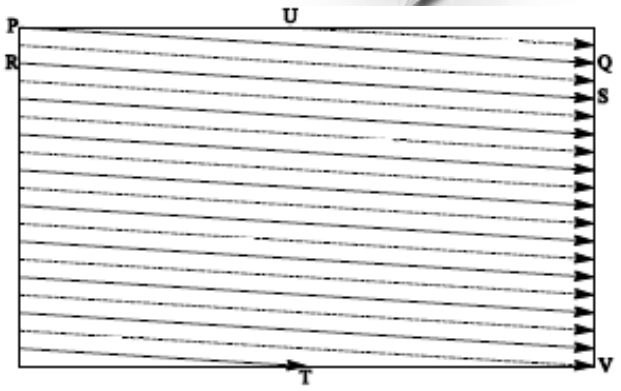
(1) Interlacing Scanning



Analog Video Scanning
(1) Interlacing Scanning

- In fact, the odd lines (starting from 1) end up at the middle of a line at the end of the odd field, and the even scan starts at a half-way point.





- First the solid (**odd**) lines are traced—*P* to *Q*, **then** *R* to *S*, and so on, ending at *T*.
- **Then** the even field starts at *U* and ends at *V*.
- The scan lines are not horizontal because a small voltage is applied, moving the electron beam down over time.

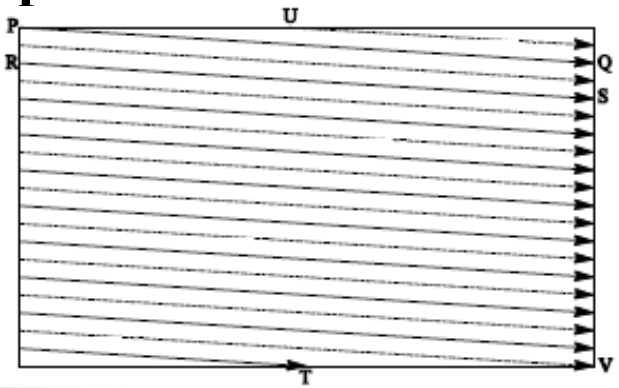
Analog Video Scanning

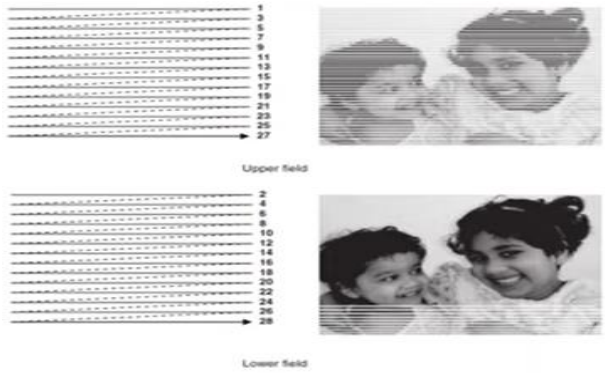
(1) Interlacing Scanning

- Interlacing was invented because, when standards were being defined, it was difficult to transmit the amount of information in a full frame quickly enough to avoid flicker,

  the double number of fields presented to the eye reduces the eye perceived flicker.

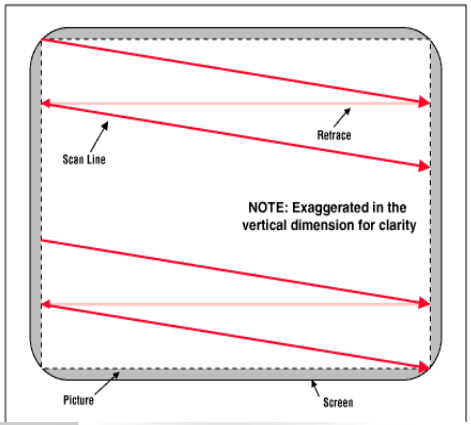
- The **jump** from *Q* to *R* and so on is called the *horizontal retrace*, during which the electronic beam in the CRT is blanked.
- The **jump** from *T* to *U* or *V* to *P* is called the *vertical retrace*.

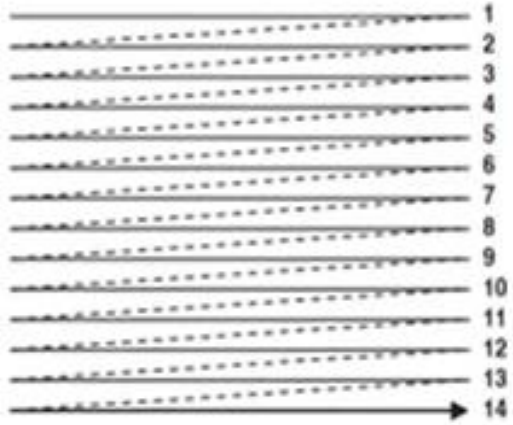




Analog Video Scanning
(2)Progressive Scanning

- A progressive (non-interlaced) image is painted on the screen by scanning all of the horizontal lines of the image in one pass from the top to the bottom.
- Require more bandwidth, however it not produce flicker and artifacts.





Analog Video Scanning

❖ *Comparison*

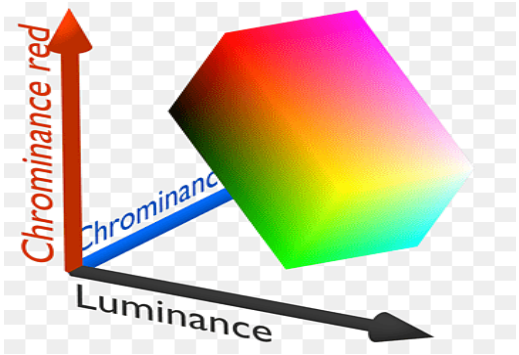
Interlaced Camera	Progressive Camera
Application: Analog camera	**Application:** Digital cameras
Scanning: Alternate order	**Scanning:** Sequential order
Require **time** to produce a frame	Transferring a frame at once
Refresh time: 1/30 s	1/60 s
Output: Standard televisions	Computer-based systems
Blurry moving object	Better moving object images
Need only half of the **bandwidth**	No flicker
Must be **de-interlaced** before it is scaled	Higher vertical resolution

Video Color Transforms

- **Video** is represented by a sequence of fields (**odd** and **even** lines). Two fields make a frame.
- Cameras, televisions, phones and computer **monitors** use the additive color model(**RGB** color model**)**.
- **YUV** is used to transmit TV signals.
- In Europe, videotape uses the PAL or SECAM coding's, which are based on TV that uses a matrix transform called YUV.
- The luminance (brightness), **Y**, is retained separately from the chrominance (color).

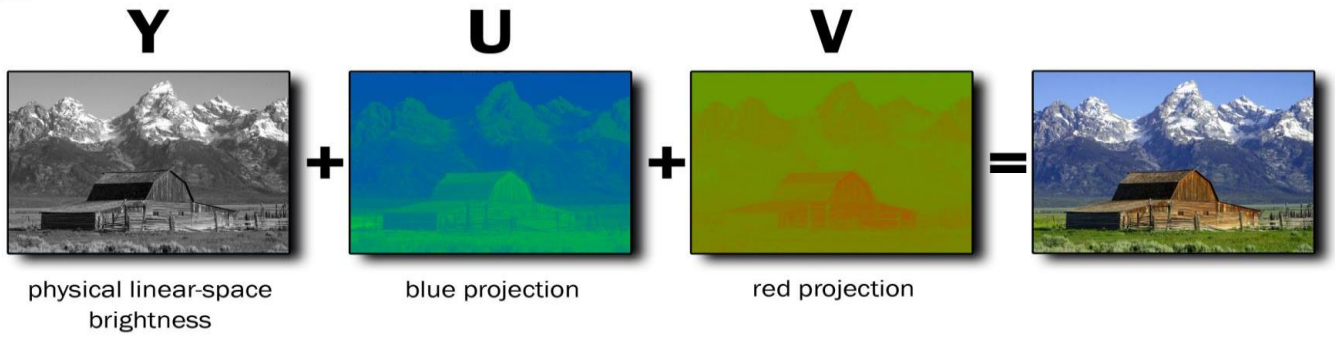
YUV Color Model

- The Y component determines the brightness of the color (referred to as luminance or **luma**), while the U and V components determine the color itself (it is called Chroma).
- U is the axis from blue to yellow and V is the axis from magenta to cyan.
- Y ranges from 0 to 1 (or 0 to 255 in digital formats), while U and V range from -0.5 to 0.5 (or -128 to 127 in signed digital form, or 0 to 255 in unsigned form).



YUV Color Model

- The Y is the component of a television signal which carries information on the brightness of the image.
- **Y**(Luminance) is the intensity of light emitted from a surface per unit area in a given direction.
- Chrominance refers to the difference between a color and a reference white at the same luminance.



YUV Color Model

- **RGB To YUV**

$$Y = W_R R + W_G G + W_B B$$

$$U = U_{max}\frac{B - Y}{1 - W_B}$$

$$V = V_{max}\frac{R - Y}{1 - W_R}$$

$$W_R = 0.299$$
$$W_B = 0.114$$
$$W_G = 1 - W_R - W_G = 0.587$$

$$U_{max} = 0.436$$
$$V_{max} = 0.615$$

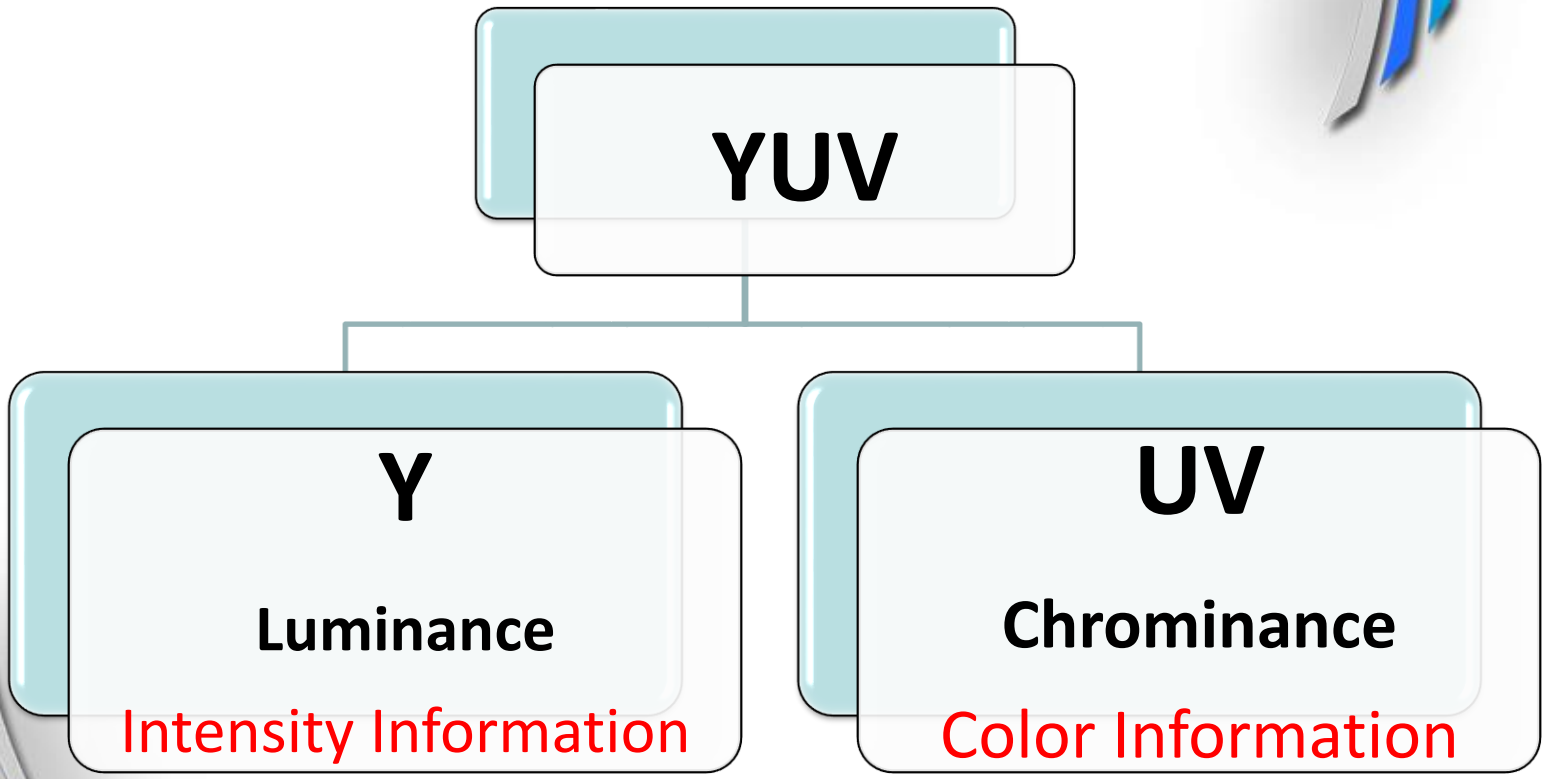
- **YUV To RGB**

$$R = Y + V\frac{1 - W_R}{V_{max}}$$

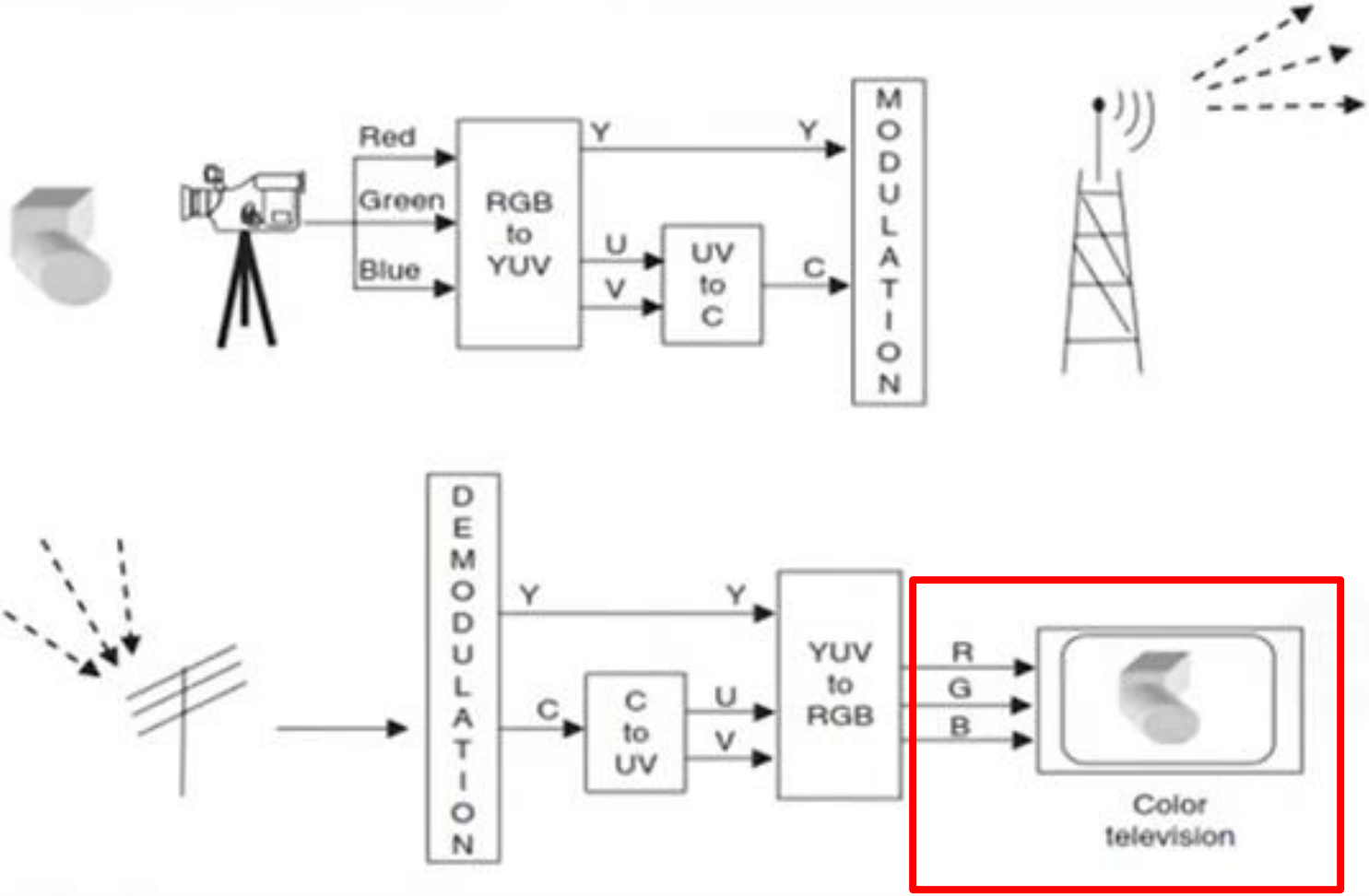
$$G = \frac{Y}{W_G} - U\frac{W_B(1 - W_B)}{U_{max}W_G} - V\frac{W_R(1 - W_R)}{V_{max}W_G}$$

$$B = Y + U\frac{1 - W_B}{U_{max}}$$

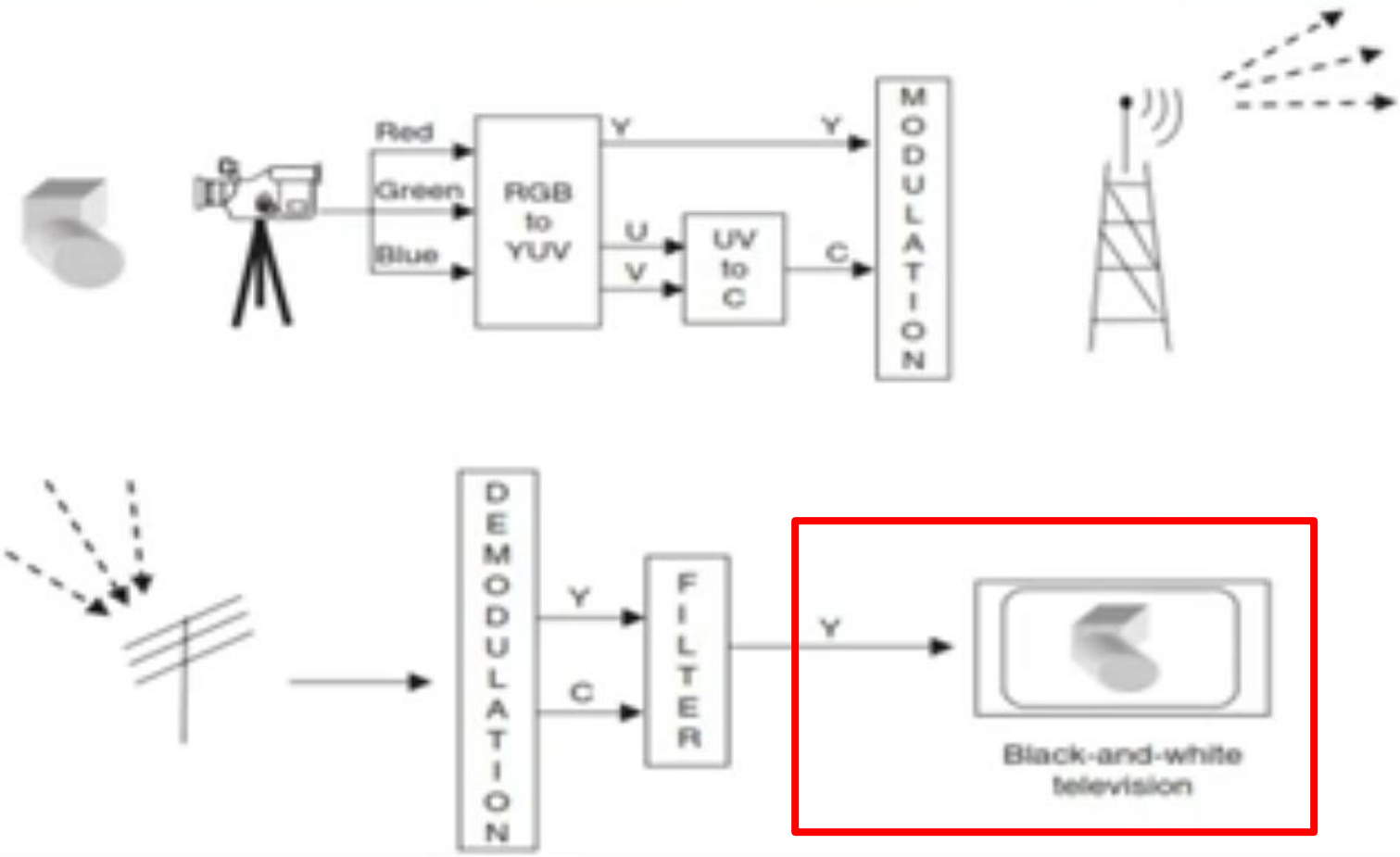
Video Broadcasting (in analog form)



Video Broadcasting (in analog form)



Video Broadcasting (in analog form)

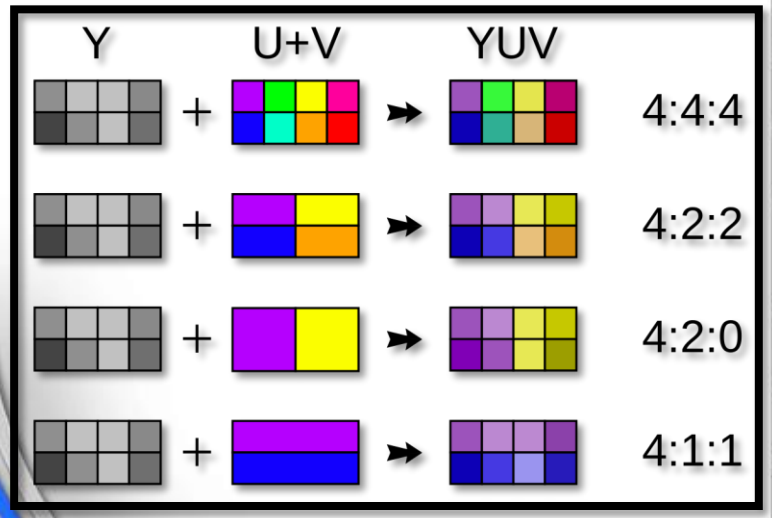


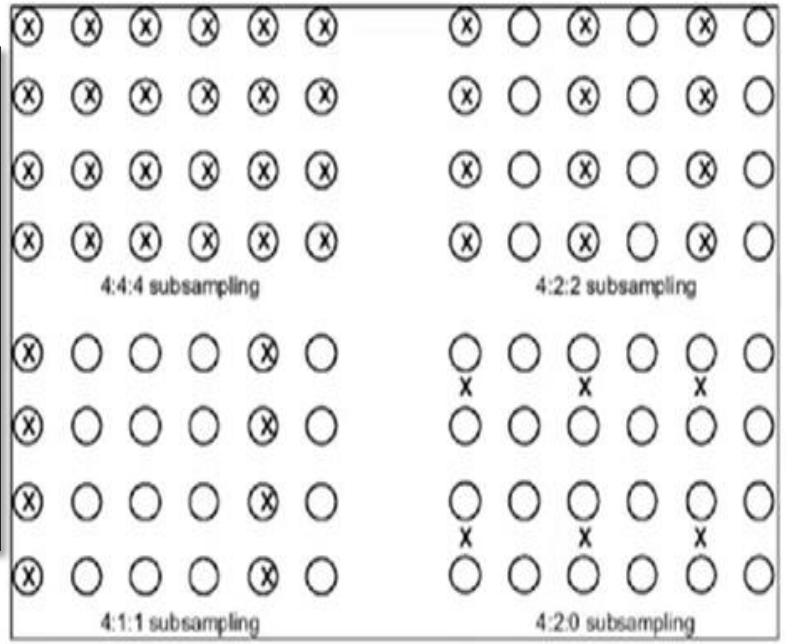
YUV Subsampling Schemes

- Video signals captured by digital cameras are represented in the RGB color space.
- For transmission , the YUV space is commonly used.
- Experiments with the human visual system have shown that this reduction in bandwidth still maintains an acceptable quality of video for broadcast.
- Depending on the way subsampling is done, a Varity of subsampling ratios can be achieved.

YUV Subsampling Schemes

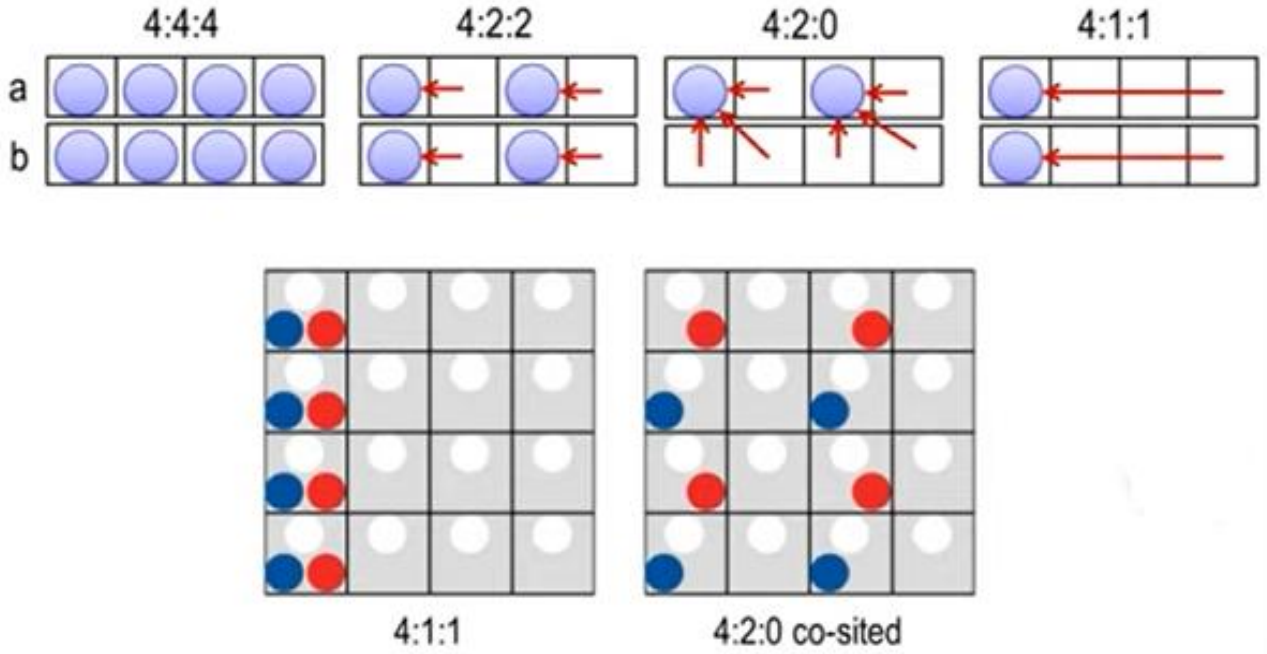
- Keeping the luminance untouched and subsampling the chrominance.





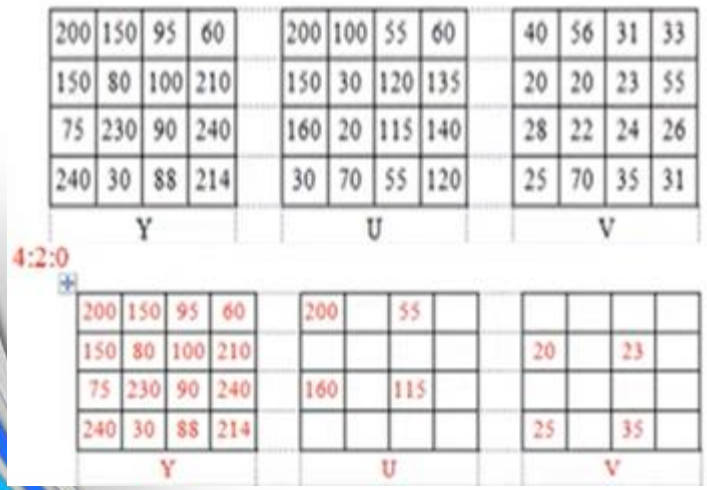
YUV Subsampling Schemes

- **Example_1**:



YUV Subsampling Schemes

- **Example_2**:
  - Subsample the following image with 4:2:2 and 4:2:0 sampling ratio?



Y			
200	150	95	60
150	80	100	210
75	230	90	240
240	30	88	214

U			
200	100	55	60
150	30	120	135
160	20	115	140
30	70	55	120

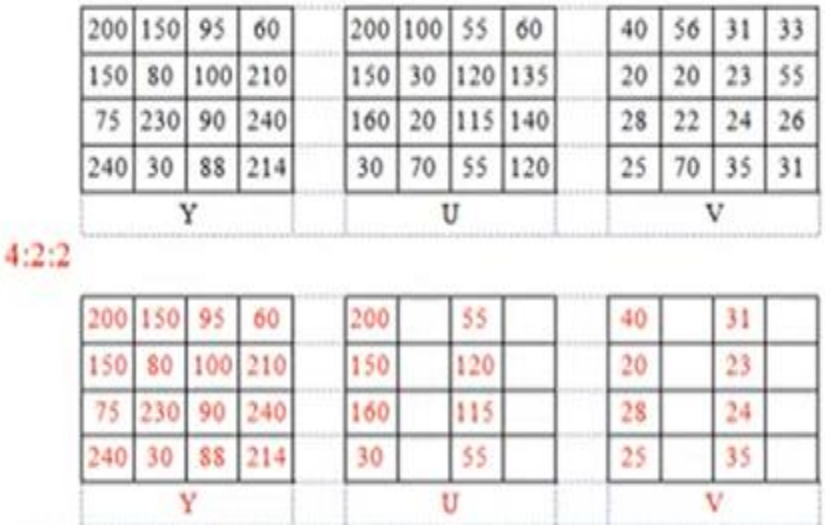
V			
40	56	31	33
20	20	23	55
28	22	24	26
25	70	35	31

4:2:0

Y			
200	150	95	60
150	80	100	210
75	230	90	240
240	30	88	214

U			
200		55	
160		115	

V			
20		23	
25		35	



4:2:2

Y			
200	150	95	60
150	80	100	210
75	230	90	240
240	30	88	214

U			
200	100	55	60
150	30	120	135
160	20	115	140
30	70	55	120

V			
40	56	31	33
20	20	23	55
28	22	24	26
25	70	35	31

Y			
200	150	95	60
150	80	100	210
75	230	90	240
240	30	88	214

U			
200		55	
150		120	
160		115	
30		55	

V			
40		31	
20		23	
28		24	
25		35	

Next Lecture:

LEC.7: MORE ABOUT VIDEO DATA REPRESENTATIONS

Thank you

Any question?