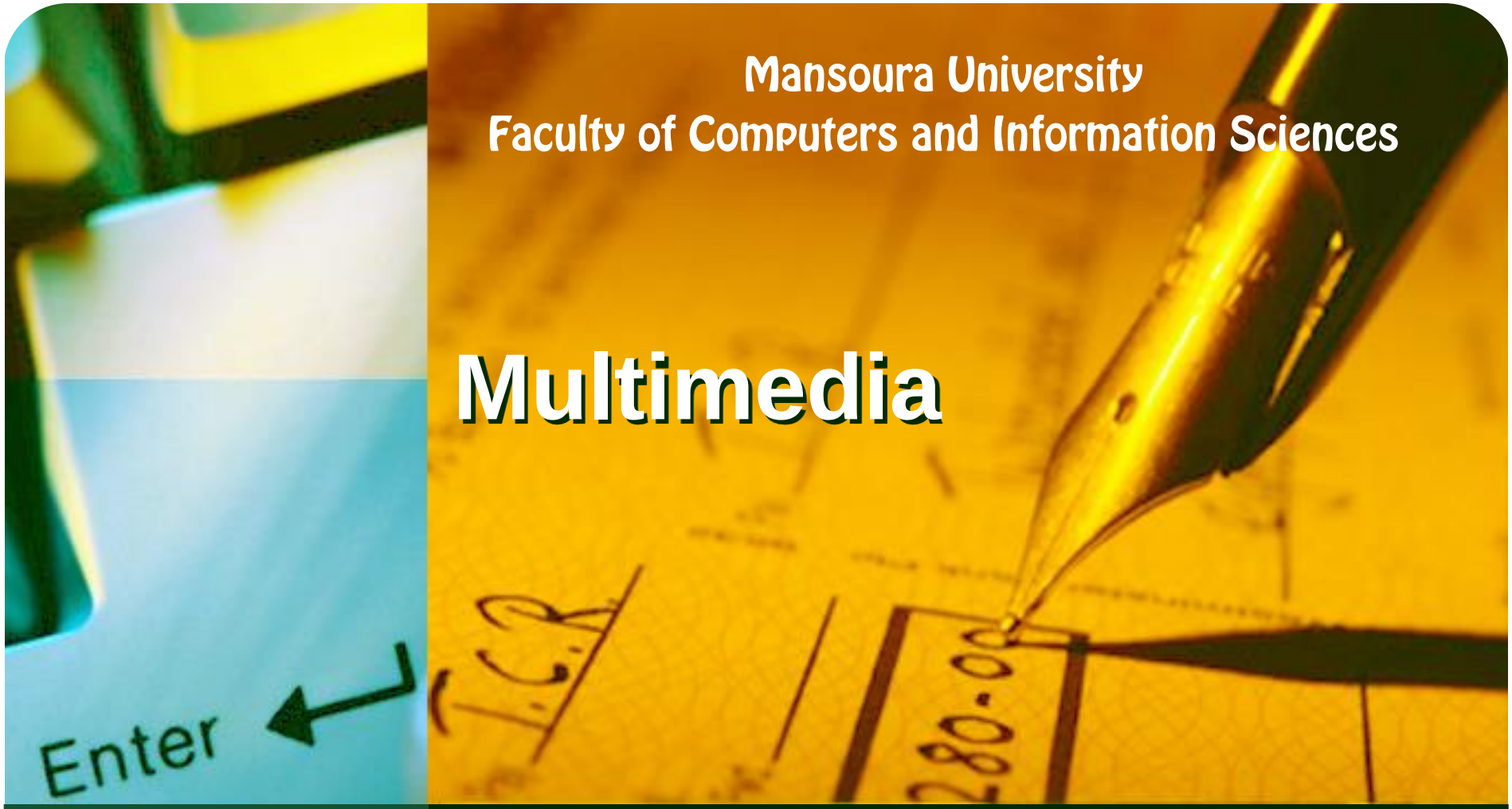

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Multimedia

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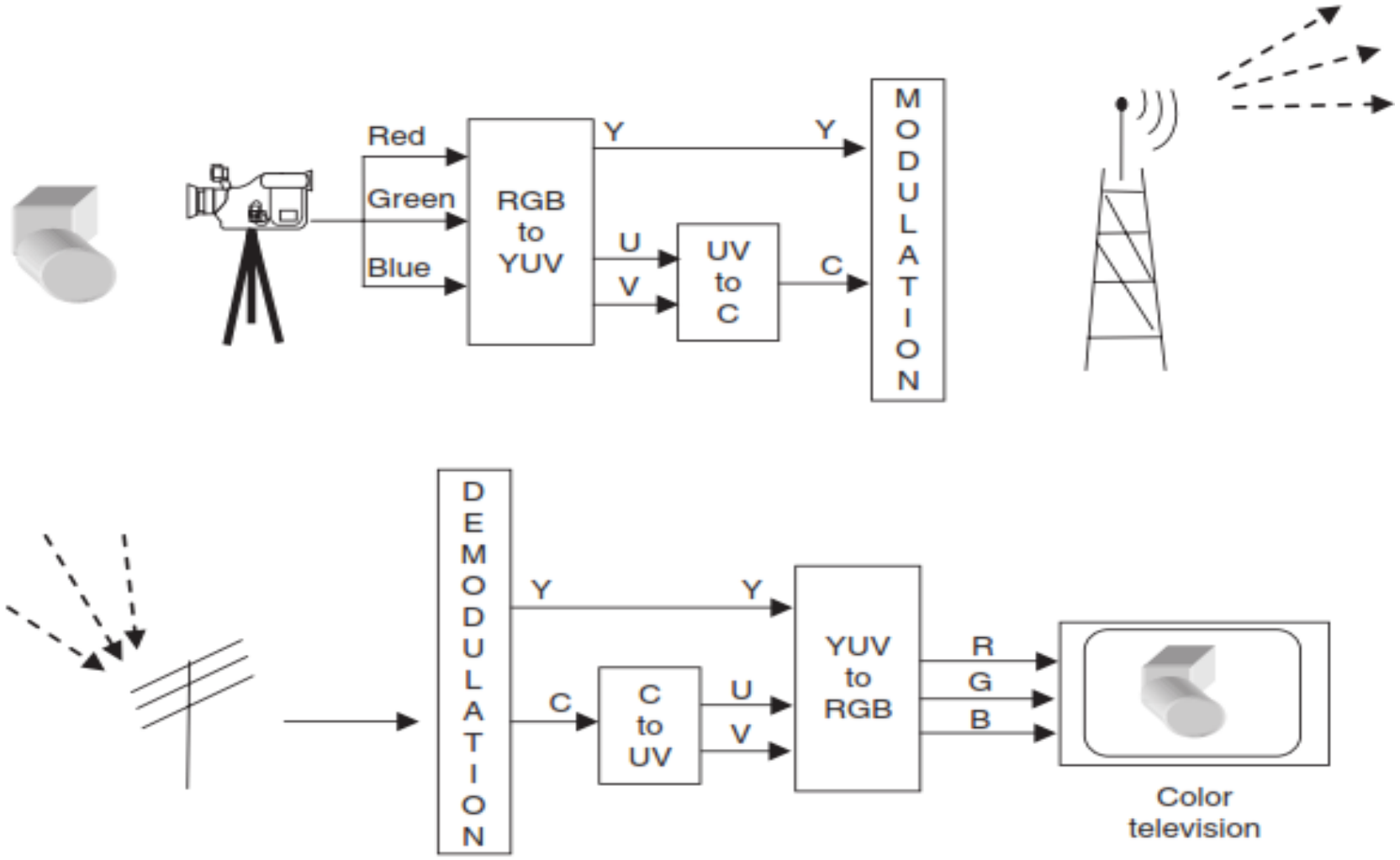
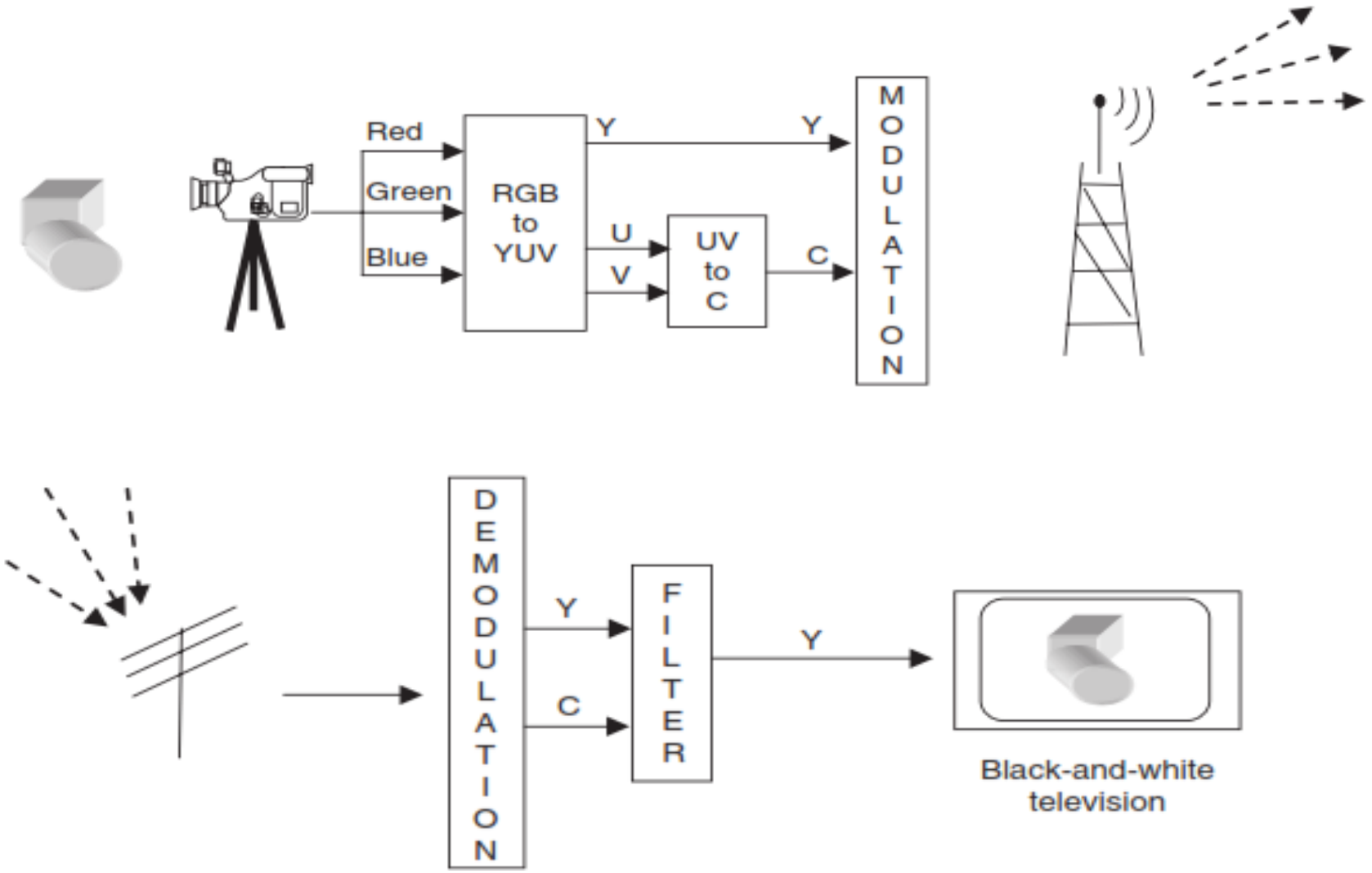
Lecture #6 - YUV Subsampling

Video Broadcasting (in analog form)



Video Broadcasting (in analog form)



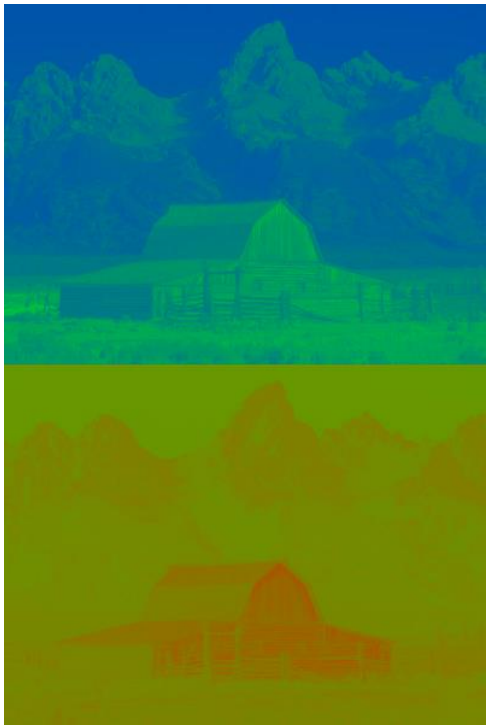
Conversion to YUV

- Decouple the intensity information (Y or luminance) from the color information (UV or chrominance)

RGB

Y (Luminance)

U,V (Chrominance)



Conversion to YUV

- The separation was intended to **reduce** the transmission bandwidth and is based on experiments with the human visual system, which suggests that humans are more tolerant to color distortions.

- In other words, reducing the color resolution does not affect our perception.

YUV color space

- **If We have R, G, B Channels, Y,U and V are calculated as:**

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

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

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

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

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

YUV color space

- If We have Y, U, V, R,G and B are calculated as:

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

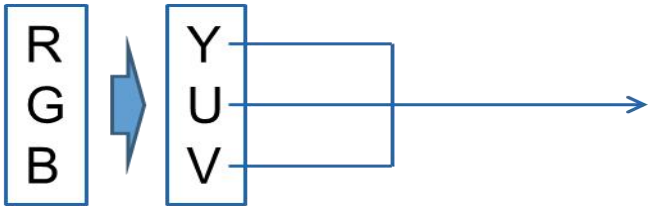
$$G = \frac{Y}{W_G} - U\frac{W_B(1 - W_B)}{U_{max}W_G} - V\frac{W_R(1 - W_R)}{V_{max}W_G}$$

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

Analog Display Interfaces

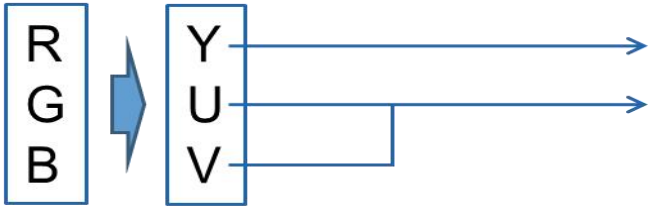
Analog video signals are often transmitted in one of three different interfaces:

Composite Video



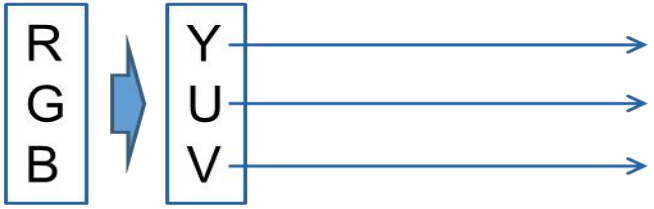
One Signal

S-Video



Two Signals

Component Video



Three Signals

Analog Display Interfaces

Composite Video

- When connecting to TVs or VCRs, composite video uses only one wire (and hence one connector, such as a BNC connector at each end of a coaxial cable), and video color signals are mixed, not sent separately.

- The audio signal is another addition to this one signal.

Analog Display Interfaces

S-Video

- S-video (separated video, or super-video) uses two wires: one for luminance and another for a composite chrominance signal.

- The reason for placing luminance into its own part of the signal is that black-and white information is most important for visual perception.

- Therefore, color information transmitted can be much less accurate than intensity information.

Analog Display Interfaces

Component Video

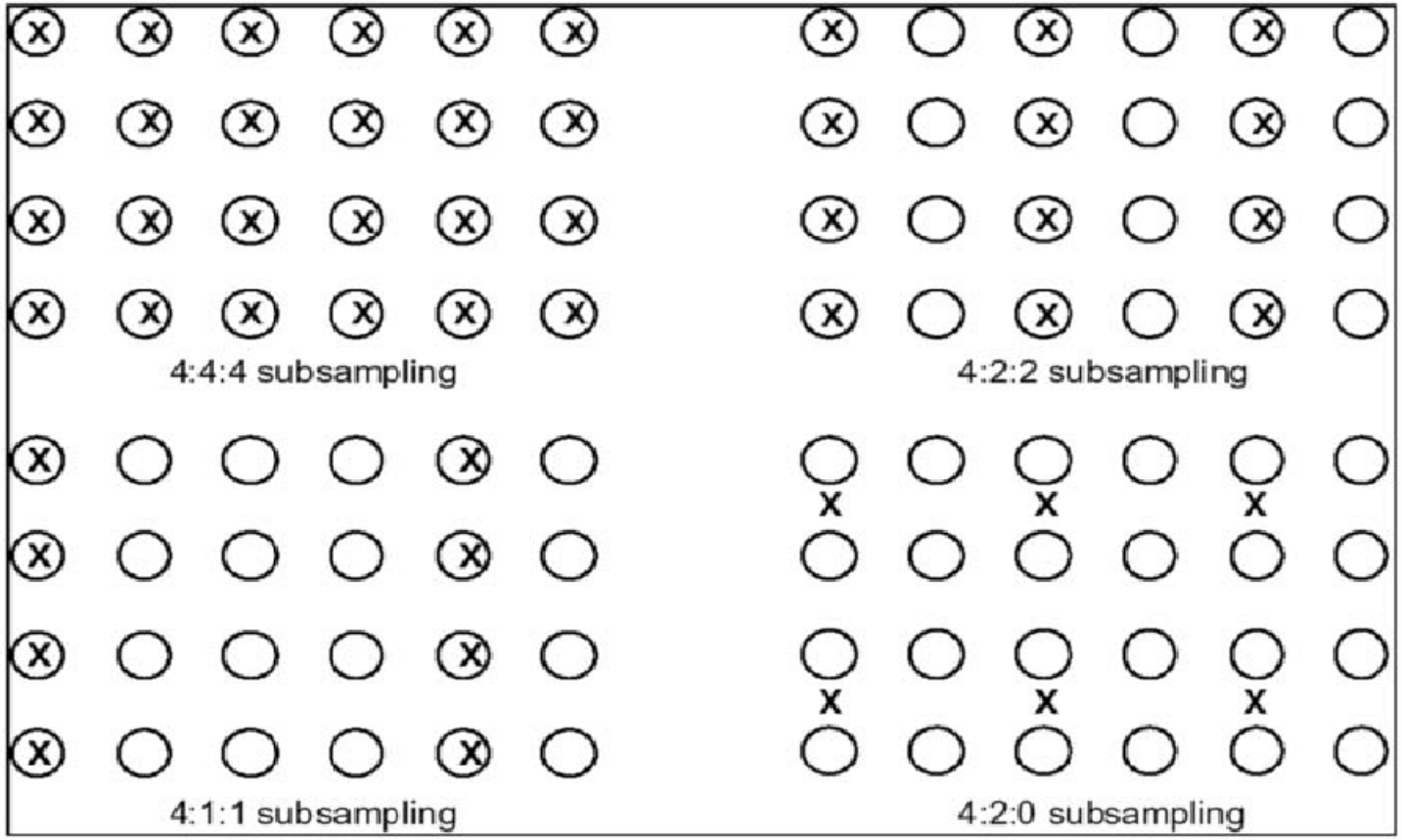
- Higher end video systems, such as for studios, make use of three separate video signals for the red, green, and blue image planes.
- This is referred to as component video.
- This kind of system has three wires (and connectors) connecting the camera or other devices to a TV or monitor.

YUV Subsampling Schemes

- Video signals captured by digital cameras are represented in the RGB color space.
- However, for transmission and other intermediary processing, 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 variety of subsampling ratios can be achieved.

YUV Subsampling

- Keeping the luminance untouched and subsampling the Chrominance



YUV Subsampling

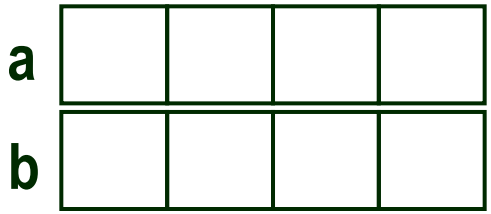
- **The conventional representation of this is in the form:**

j:a:b

j: the number of horizontal samples in the reference block.

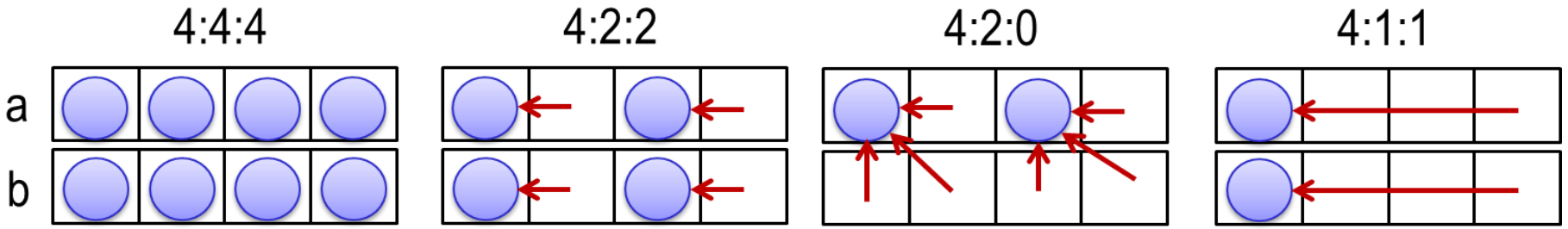
a: the number of pixels in the first row that have Chroma samples.

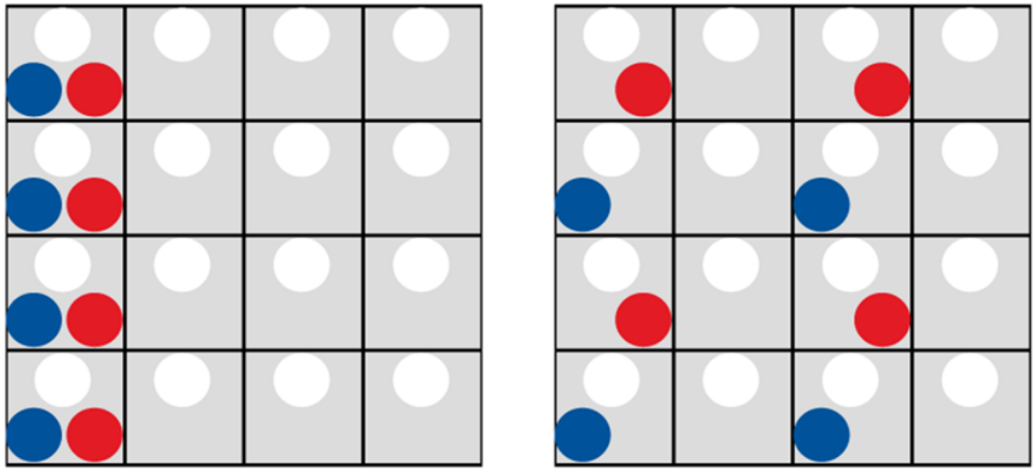
b: the number of pixels in the second row that have Chroma samples.



YUV Subsampling

Examples of different sampling ratios





4:1:1

4:2:0 co-sited

YUV Subsampling Example

YUV Subsampling Example

(b) Subsampling the following image with 4:2:2 and 4:2:0 sampling ratio? (4)

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

4:2:2

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	

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	


Enter
Thank You!