CSc 461/561
Multimedia Systems
Image Representation

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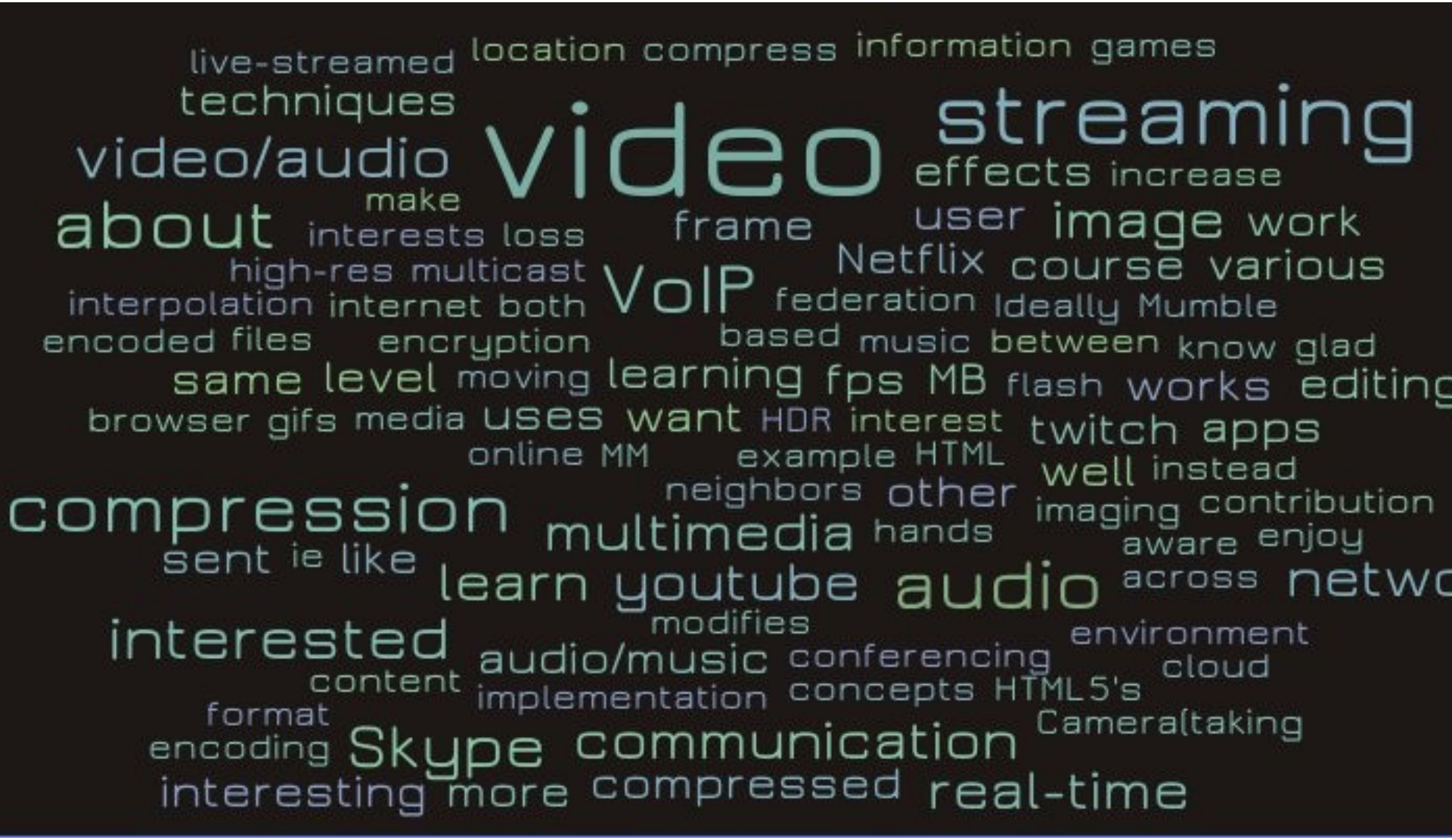
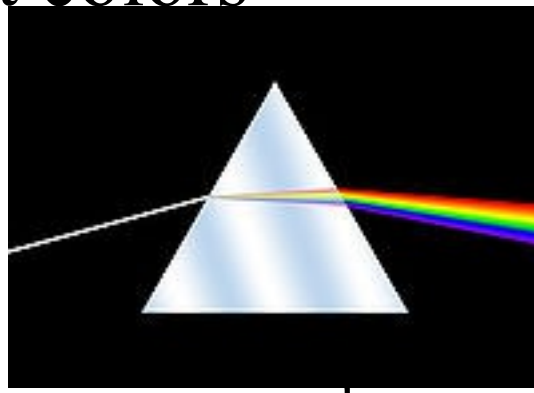
Feedback on A0



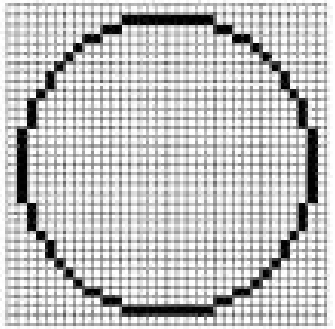
Light is also a wave

- What we see
  - objects either emit lights
  - or reflect lights
- We indeed see objects of different colors
  - different wavelengths
  - visible light: 400 - 700nm
  - white is *more* than a color
    - violet, indigo, blue, cyan, green, yellow, orange, red

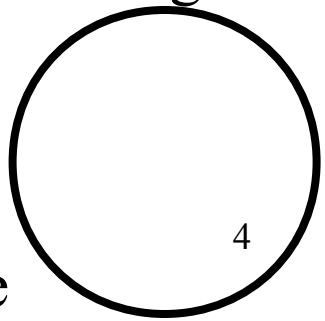


* prism and rainbow; speed of light (299,792,458m/s in vacuum)

Digitizing what we see



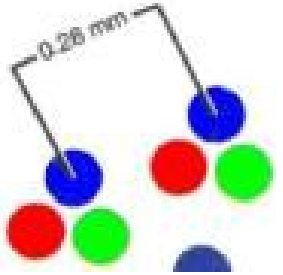
- E.g., scanning a picture: images
  - a 2-dimension array of pixels
    - a pixel showing a certain color (picture element)
    - dpi (dots per inch): e.g., 600 dpi
  - each pixel is represented by a (few) number(s)
    - similar to digitizing audio signal
    - but often by a few numbers with <u>different</u> meanings
- E.g., drawing a picture: graphics



* one data format might be better than another in one case

Image is a 2-d array of pixels

- Image attributes
  - image resolution: array size, e.g., 640x480
  - pixel depth: bits per pixel, e.g., 8-bit
- Display attributes
  - display resolution: e.g., 1024x768
  - dot pitch: e.g., .28mm
  - how to keep “aspect ratio”



* 20”? 16:9 vs 4:3? who got the most of pixels?

Pixel is represented by bits

- Black-white (monochrome): 1-bit
- Grayscale: e.g., 8-bit

- (true) color
  - e.g., 8-bit each for RGB; i.e., 24-bit total
  - 32-bit total w/ alpha channel

- (pseudo) color
  - e.g., 8-bit in total for (pseudo) RGB
  - with a lookup table

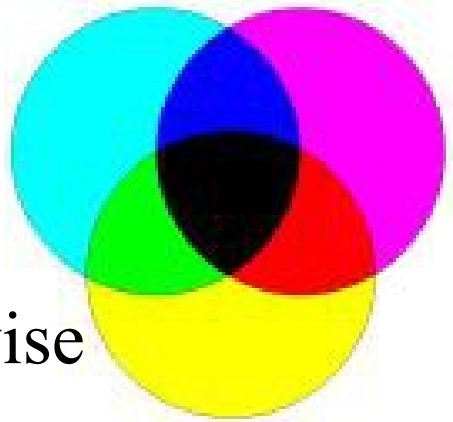
* transparency

Color space: RGB

- Red, Green and Blue
  - human eyes have three types of "light sensors"
  - sensitive to red, green and blue, respectively
- Primary color
  - mixing RGB to get other colors
  - additive color
  - used in CRT/LCD etc

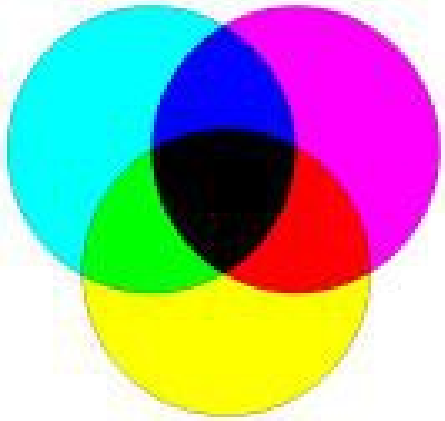
CMY and CMYK

- Cyan, Magenta and Yellow
  - primary color in CMY space
  - widely used for printing (paper reflecting color)
  - mixing CMY to get other colors
  - subtractive color
  - Cyan+Magenta+Yellow=Black
  - Black is easier/better to get otherwise
    - CMYK



RGB vs CMY

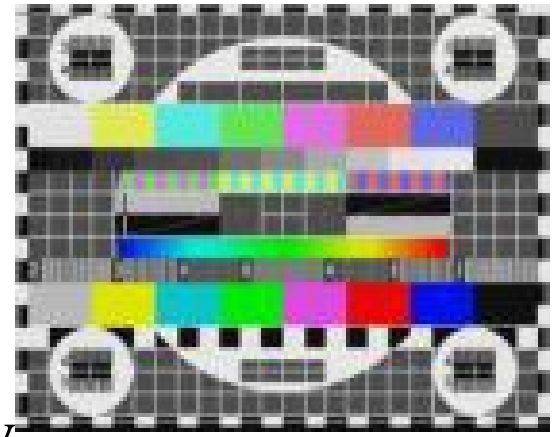
- RGB and CMY are related
  - Let R/G/B in [0,1]
  - Let C/M/Y in [0,1]
    - R+C=1
    - G+M=1
    - B+Y=1



* know how to do the transform

YUV

- Widely used in black-white/color TV
- Y: luminance
  - brightness (black-white TV)
- UV: chrominance
  - color difference w/ reference
  - (color TV)
- Further humans see
  - brightness and color differently



RGB vs YUV

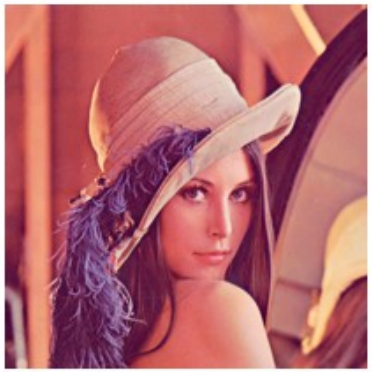
- RGB => YUV
  - Y = 0.299R + 0.587G + 0.114B
  - U = 0.492 (B - Y)

    = - 0.147R - 0.289G + 0.436B
  - V = 0.877(R - Y)

    = 0.615R - 0.515G - 0.100B
- Let R/G/B in [0,1]
  - Y in [0,1], U in [-0.436,0.436], V in [-0.615, 0.615]

* know how to do the transform

RGB vs YUV

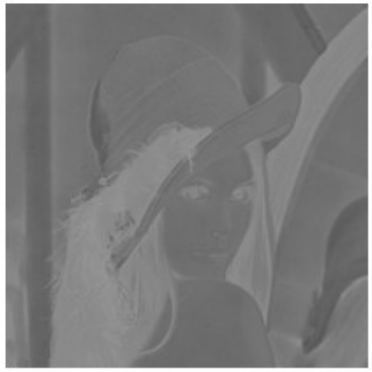


R

G

B

Y



Cb

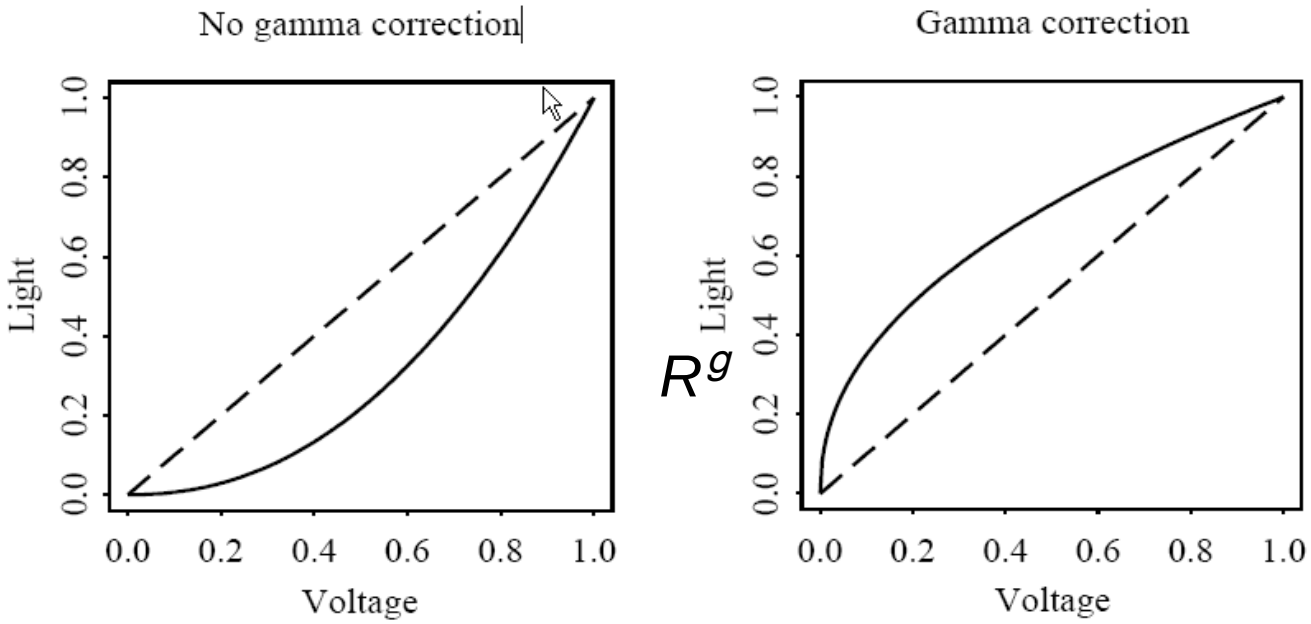
Cr

* Lena

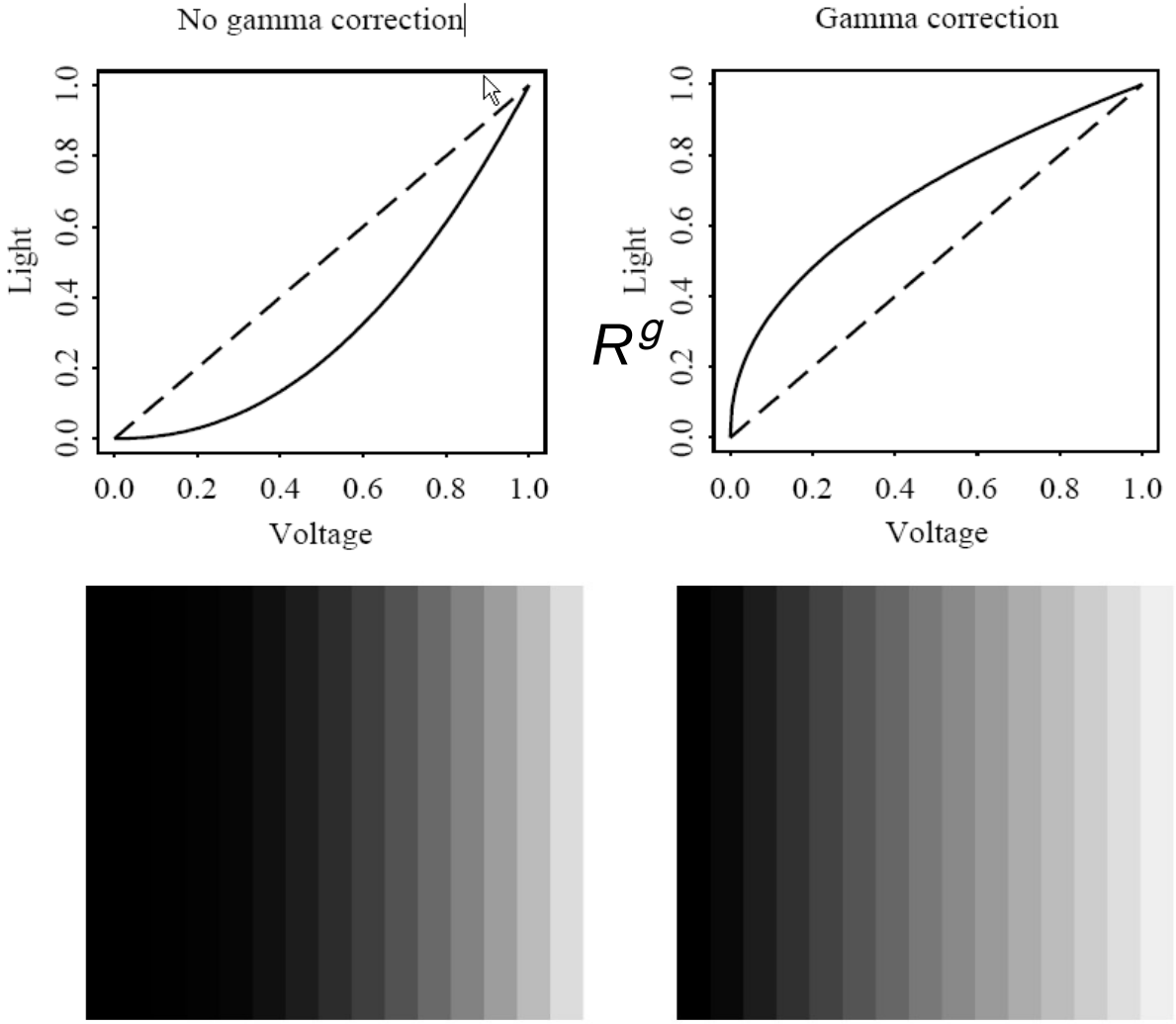
Gamma correction

- Non-linearity in display devices

$$R \rightarrow R' = R^{1/\gamma} \Rightarrow (R')^{\gamma} \rightarrow R$$



Gamma correction examples



This lecture

- Image representation
  - image: resolution and depth
  - color space and transform
  - gamma correction
- Explore further
  - more color spaces [Li&Drew 4.3.3]

Next lecture

- Multimedia representation
  - video [Ref: Li&Drew Chap 5]
    - types of video signal [5.1]
    - analog video (e.g., TV) [5.2]
    - digital video [5.3]