

# CSc 461/561

## Multimedia Systems

### Image Representation

Jianping Pan  
Spring 2006

1/11/06

CSc 461/561

1

## 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



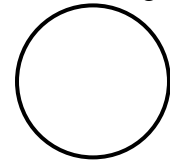
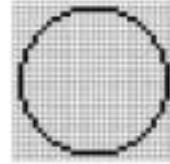
1/11/06

CSc 461/561

2

## 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 different meanings
- E.g., drawing a picture: graphics



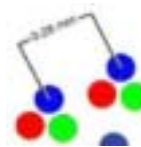
1/11/06

CSc 461/561

3

## 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”



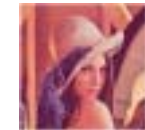
1/11/06

CSc 461/561

4

## 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 lookup table



1/11/06

CSc 461/561

5

## 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 etc



1/11/06

CSc 461/561

6

## 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
  - $C+M+Y=Black$
  - Black is easier to get otherwise
    - CMYK



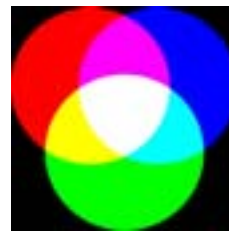
1/11/06

CSc 461/561

7

## RGB vs CMY

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



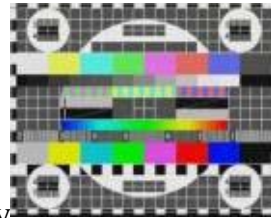
1/11/06

CSc 461/561

8

# 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



1/11/06

CSc 461/561

9

# RGB vs YUV

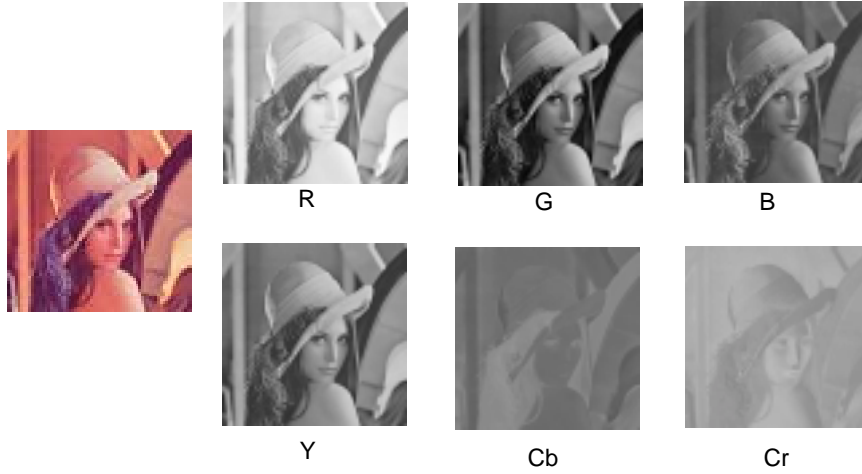
- RGB => YUV
  - $Y = 0.299R + 0.587G + 0.114B$
  - $U = 0.492(B - Y)$   
 $= -0.147R - 0.289G + 0.436B$
  - $V = 0.877(R - Y)$   
 $= 0.615R - 0.515G - 0.100B$
- Let R/G/B in [0,1]
  - Y in [0,1], U in [-0.436,0.436], V in [-0.615, 0.615]

1/11/06

CSc 461/561

10

# RGB vs YUV



1/11/06

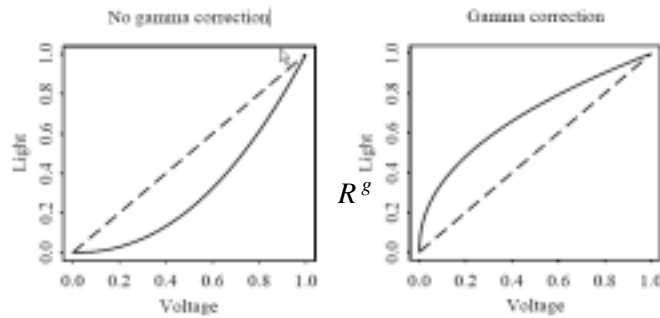
CSc 461/561

11

# Gamma correction

- Non-linearity in display devices

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

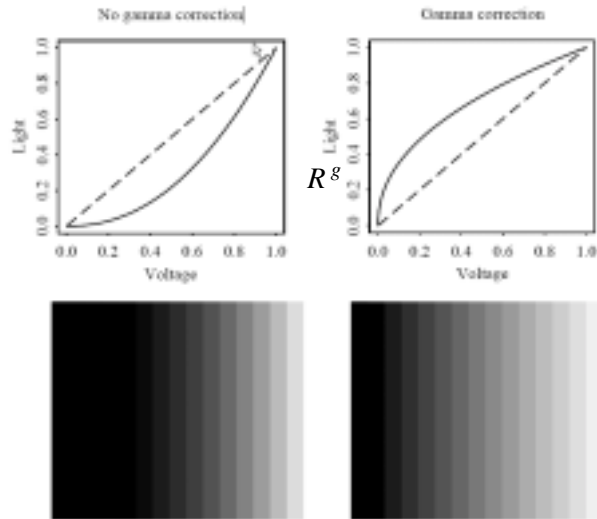


1/11/06

CSc 461/561

12

## Gamma correction examples



1/11/06

CSc 461/561

13

## This lecture

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

1/11/06

CSc 461/561

14

## 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]